

PERENNIAL BIOENERGY CROP GROWING GUIDE

SHRUB WILLOW

Introduction

Growing shrub willow as a perennial bioenergy crop provides ecosystem services in low lying areas near flood plains and areas with poor drainage where crop productivity is limited. The expansive fast-growing root system of shrub willow is well-suited to poorly drained soils. The roots stabilize soils and reduce erosion and nutrient runoff.



Early established Shrub Willow, Argonne National Laboratory

Farmland that has the following conditions may be ideal for adopting shrub willow cropping systems:

- silt and clay soils
- wet, poorly drained fields,
- ponding,
- high levels of nutrient and sediment runoff

Environmental benefits provided by shrub willow boost soil health function and improve water quality on the farm. Willow can also create wildlife habitat and provide wind break as well as riparian buffers to intercept runoff nutrients.

Growing Considerations

It takes 3 years to establish shrub willow as a perennial bioenergy crop. This provides adequate time for cuttings to establish and increase above and belowground biomass to maximize yield. Shrub willow is best suited in wet areas of the farm and thrives near waterways and drainage ditches due to consistently wet conditions.

Some sources have expressed concerns that shrub willow may become invasive. Twenty years of research on shrub willow for bioenergy in the Midwest shows it is highly unlikely for this crop to become invasive and spread to undesired areas. Shrub willow varieties bred for bioenergy use are sterile and do not spread naturally.

Planting

Site preparation includes plowing, discing, seeding a cover crop, and other weed control methods. While tillage is not a recommended agricultural practice, it is beneficial to till before the one-time planting of shrub willow as it will ensure better establishment for the crop's 20-year lifespan. Tillage will not be necessary after that. The ideal time to prepare fields is late summer or fall before planting a shrub willow crop in the spring.

Fully established shrub willow plot, Argonne National Laboratory

Shrub Willow Optimal Growing Conditions

Soil & Field Conditions

- Wet conditions
- Fine-loamy soils
- Gentle to steep rolling hills
- Flood plains

Equipment Needs

- Tractor-mounted planter
- Coppicing equipment
- Harvester & bins
- Storage

Nutrient Management

- Optional, but beneficial to maximize yield



Willow cuttings, Argonne National Laboratory



Shrub Willow Plot, Argonne National Laboratory

Recommended planting for shrub willow is between April and June in the northern region of the Midwest. Timing will vary with weather and specific location. Planting too early increases the risk of cold air and soil temperatures slowing the onset of bud-break or a hard frost damaging new sprouts. Planting too late increases the risk of soil and plants drying out before a sufficient root system is established. Specialized willow planters can plant two rows of willow cuttings from long propagules called "whips." Currently, two models of planters are available for rent or custom hire in the U.S. However, they are not located in the Midwest, which pose logistical concerns for shrub willow bioenergy adopters.



Willow planter, Argonne National Laboratory

Whips are planted through the terminated cover crop residue or into bare ground using a mechanized tractor-mounted planter. A minimum 140-horsepower tractor is required to operate a willow planter. Whips are loaded onto the planter in bundles and fed individually into guide belts. The planter cuts each long stem into smaller sections (cuttings) and inserts them into the ground. The length of the cutting is generally set at eight inches but can be varied if necessary for different soil types.

Coppicing

Coppicing is the process of cutting or pruning all the canes or rods back to the base to promote growth. This is an effective method of stimulating new growth on newly planted shrub willow cuttings the second year after planting. A sickle-bar mower can be used to coppice willow. It is important that the mower has sharp blades and is driven at the appropriate speed to ensure that the cut is clean and the willow is not pulled out of the ground. Willow stems should be cut to about two to three inches above ground level. There is little economic value in biomass cut after one growing season, so stems are left in place on the ground to decompose and provide mulch.

Harvesting & Storage

Willow can be harvested in late fall or winter of years 3 or 4 and every 3 years thereafter. A typical scenario is a harvest in year 4 and then 7 rotations for 22 years. Custom harvest machinery is needed, such as specialized self-propelled forage harvesters equipped with a cutting head designed to cut woody crops or specially designed forage choppers pulled by tractors. Chip haul wagons, trucks, and labor add to total harvest costs.



Chipped willow harvest, U of I Extension

Storage needs will depend on intended end use of shrub willow feedstock. A conservative yield of 4 dry tons (8 wet tons) per acre per year is expected (12 dry tons every 3 years). Take note that prices may be reported either in wet (fresh) or dry tons. The difference is moisture content. Generally, 50 percent moisture content is assumed in a wet ton, so mass is double compared to a dry ton. Farm-gate prices for willow chips can vary due to market competition, location, and fuel use.

Barriers to Adoption

Large scale adoption of this crop is currently limited by lack of access to planting and harvesting equipment. Currently only two harvesters suited for shrub willow production exist in the United States, which drastically limits access in the Midwest.

Farmers motivated to improve their farm's soil health function, water quality and overall productivity may adopt shrub willow to create positive environmental impact to their land, especially in marginally unproductive areas. Things to consider with the adoption of shrub willow as a perennial bioenergy crop are operation logistics and equipment needs. Specialized planting, coppicing, and harvesting equipment is required for large scale production. The breakeven prices for this crop depend significantly on the quality of farmland being used for production. Currently, growing shrub willow in marginal areas is significantly more cost effective than growing on premium farmland suitable for cash crop production.

Shrub Willow Resource Directory



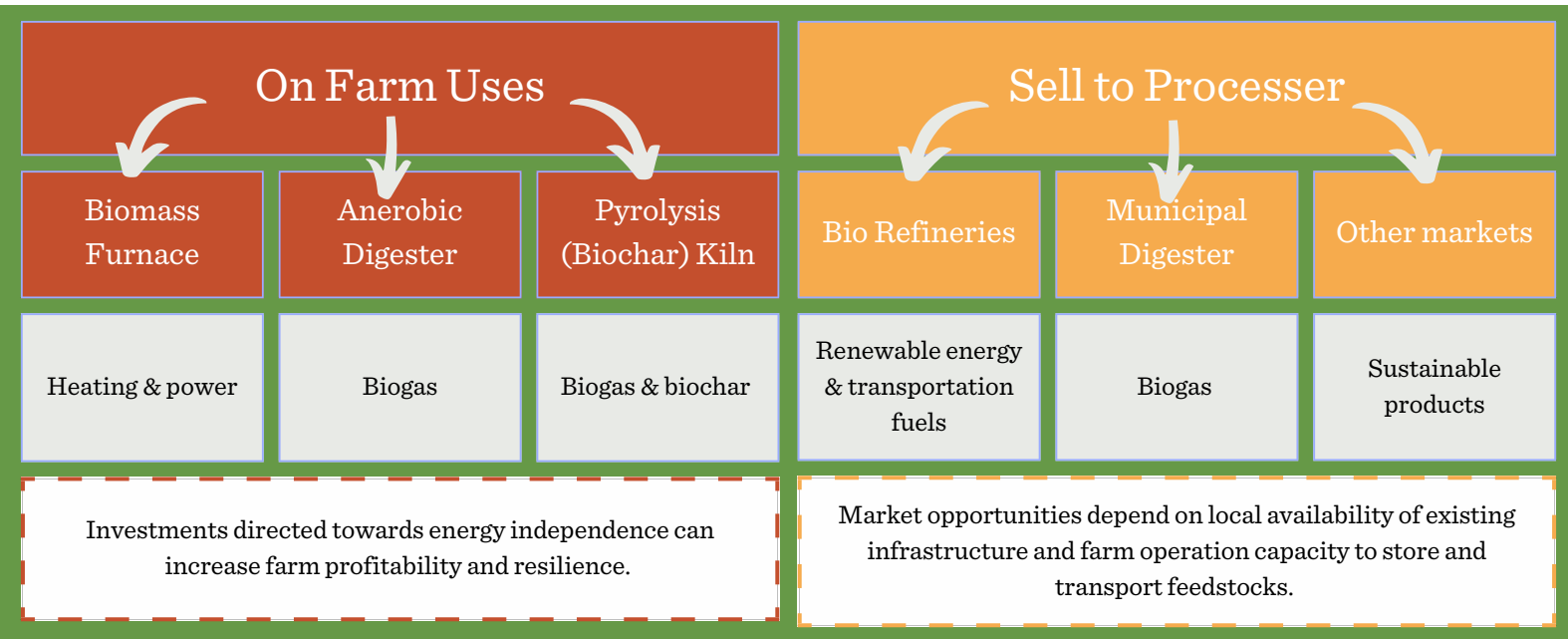
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Anaerobic digester tanks, US EPA

END USES FOR BIOENERGY CROPS

Shrub willow feedstock can be used on- and off-farm to produce renewable energy & sustainable fuels.



Sources

Justin P. Heavey and Timothy A. Volk. Living snow fences show potential for large storage capacity and reduced drift length shortly after planting. © 2016 The Research Foundation for the State University of New York College of Environmental Science and Forestry.

Jacobson, M. (n.d.). Shrub willow budget for biomass production. Penn State Extension. Retrieved February 13, 2023, from <https://extension.psu.edu/shrub-willow-budget-for-biomass-production>

For more information on this project or to discuss bioenergy cropping systems please contact Marlee Giacometti, AFT Midwest Program Associate, mgiacometti@farmland.org, 815-267-1326

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