



Crop Removal

Shrub Willow Roots and Stools

A common question when considering growing willow bioenergy crops is *what happens after multiple harvests if the landowner wants to remove the willow and plant a different crop?* This is an important consideration in the initial decision to grow willow bioenergy crops and the long-term investment required. It is important to remember that willow bioenergy crops are *shrub* willow (Figure 1), not tree willow. This impacts the type of root system that develops and how the crop can be removed. Shrub willow root systems are typically made up of many smaller roots rather than larger diameter roots more typical of tree. The root system on shrub willow is a diffuse network of roots.



Figure 1: Willow bioenergy crops have a shrub form different from willow trees, and a more fibrous root system belowground. Willow bioenergy crops are also harvested every three to four years, further limiting the size of the root system.

Another factor to consider is that willow bioenergy crops are harvested every three to four years, and the above ground stems are cut and removed in this process. Plants have to maintain a balance between the amount of aboveground stem biomass and root biomass to survive and function, so the size of the root system is limited through regular and repeated harvest of stems causing root dieback and limiting expansion. These factors play a role in the techniques that have been developed and the tools used to remove the root system of willow crops. After harvest, the willow stool, coarse roots and fine roots remain in the field. All of these components can be thoroughly broken down with the proper equipment and techniques, but there is a financial cost of removal.

Timing, Process and Machinery

Willow crops are intended to stay in the ground for seven or more rotations on a three-year harvest cycle, or about 22 years including the first growing season and coppice. After this period of time, it is expected that the size of the stools in the field will begin to restrict harvesting machinery access as stools grow outward from repeated coppice regrowth. There will also likely be improved cultivars with higher yields and other traits to replace the older varieties after two decades. However, it may be possible to let willow grow for additional harvests.

Crop removal should begin in spring following the final harvest. To remove above ground stems, remaining willow stools are terminated with a forestry mulcher (Figures 2-4) in early spring. The forestry mulcher will grind stools, coarse roots and fine roots so they can decompose and be incorporated back into the soil more



Figure 2: A PTO-driven forestry mulcher is used to chop and grind remaining willow after harvest (photo courtesy of Fecon Inc.).



Crop Removal

quickly. After mulching, wait several weeks into the growing season then apply a broad-spectrum contact herbicide to kill any regrowth of willow stems. Follow the manufacturer's instructions on the label.

Ten to fourteen days later, disc the field to mix mulched stools with soil and further break up fine roots. In another ten to fourteen days, evaluate the field to determine if additional disking and/or herbicide treatments are needed. A cleared field can potentially be replanted in the same growing season, but waiting one year to let the chopped roots and stools decompose can be beneficial. If waiting until the following growing season to replant, cultivate the field and plant a cover crop in fall. Studies have shown little to no re-sprouting of willow once these steps have been taken. The cost to remove willow using these methods is estimated to be about \$400 per acre for one round of mulching, spraying and disking.

The above scenario presents one possible method for removing a willow crop, but other techniques and order of steps are possible. If field conditions are too wet in spring, herbicide can be applied to willow after it has sprouted and grown one to two feet high, followed by mulching. Other models of forestry mulchers can be mounted or rented on skid steers and other tracked equipment if working in wet fields. A flail mower has been used to chop stools, but forestry mulchers are more effective. Willow has also been successfully removed by applying herbicide to stools in winter, then mulched and disked in spring after herbicide kill is confirmed. In these and related scenarios, if herbicide, mulching and disking is successful in spring, a new willow planting or summer cover crop can sometimes be established in the same season.



Figure 3: A PTO-driven forestry mulcher grinding cut willow stools and roots so they can decompose back into the soil. The areas around the tractor show previous willow plantings that have already been ground using this method.



Figure 4: Close-up image of a forestry mulcher grinding cut willow stools after harvest. The drum spins at high speeds and the heavy-duty tines chop and grind the woody material and fibrous roots left in the field after harvest.

The Willow Project at SUNY-ESF

www.esf.edu/willow | (315) 470-6775 | willow@esf.edu

Northeast Woody/Warm-Season Biomass Consortium

www.newbio.psu.edu

Justin P. Heavey and Timothy A. Volk. © 2017 The Research Foundation for the State University of New York College of Environmental Science and Forestry. This work was supported by the New York State Energy Research and Development Authority (NYSERDA), the US Department of Energy (USDOE) and the US Department of Agriculture National Institute of Food and Agriculture (USDA NIFA). No funding agencies, SUNY, nor any of their employees makes any warranty, express or implied, or assumes any legal responsibility for the completeness, accuracy, or usefulness of any information or process disclosed here.