Greenhouse Gas Balance of Willow Crops

KEY POINTS

1. Growing willow biomass on cropland and pastureland and using willow to produce bioenergy and bioproducts, like bioplastics or biochemicals, provides real and permanent climate change benefits. Willow crops sequester more carbon than they emit over their 23-year life cycle.

2. Willow biomass crops remove more CO_2 from the atmosphere as they grow than is added to the atmosphere by the fossil fuels used during the planting, management, harvesting and delivery of the willow biomass to a heating, combined heat and power, or biofuels plant.

3. Willow crops convert atmospheric CO_2 into woody biomass that can be used for bioenergy and bioproducts and belowground material that stores carbon for long periods of time in root systems and soils.

4. Willow biomass crops provide a variety of other benefits such as creating jobs, supporting pollinators and biodiversity, and improving water and soil quality.

ESF
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CALCULATING THE GREENHOUSE GAS EMISSIONS FROM WILLOW CROPS

- ESF Researchers identified over 520,000 acres (9,700 parcels) suitable for growing willow in a five-county region (Jefferson, Lewis, Oneida, Oswego, St. Lawrence) in central and northern New York. Cropland and pastureland made up almost 90% of this suitable land for willow production.
- Willow yields on each parcel were predicted using USDA soil information and data from nearly three decades of research at ESF and over 1,200 acres of commercial-scale willow fields in New York.
- This research analyzed greenhouse gas (GHG) emissions over a 23-year timeframe that represents seven three-year harvest cycles and a year for planting and a year for removing the willow crop (Figure 1).
- Researchers completed a life cycle analysis (LCA) of willow biomass crops to determine the overall GHG impact of growing, harvesting, and transporting willow biomass to a biomass plant. Changes in soil and willow root system carbon were included in these LCA analyses. The carbon stored in willow stems was not included because when stems are harvested and converted to energy, the carbon in them is returned to the atmosphere where a similar amount of carbon is recycled in the next three-year willow crop.
- The LCA was applied to each of the parcels in the five-county region to assess how GHG emissions vary spatially across the landscape.

Figure 1. Willow crops grow rapidly above and below ground and provide 7 harvests during their 23-year life cycle. These willows in northern NY are 4 years old. They were harvested after the photograph was taken and regrew to this height 3 years later (when they were harvested again).

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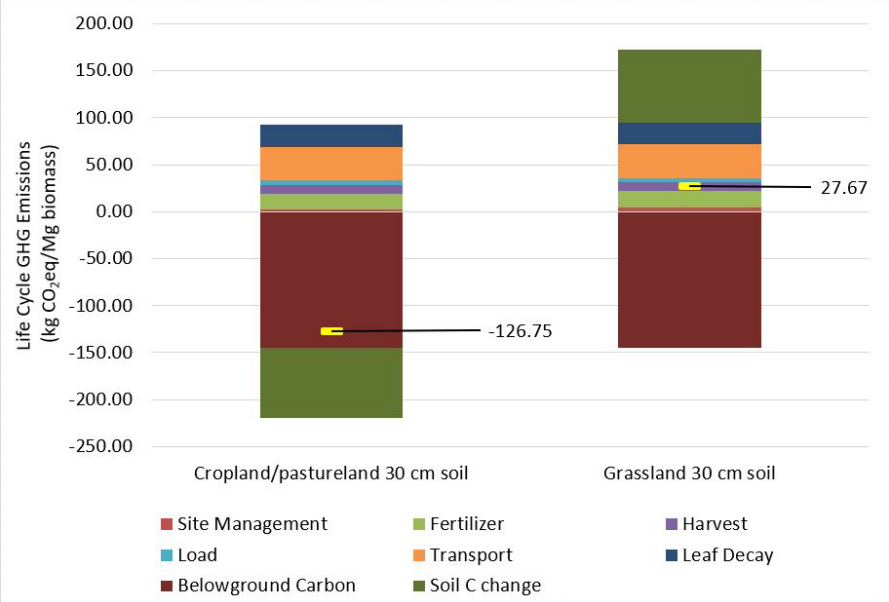
KEY DISCOVERIES AND POTENTIAL IMPACTS

The climate change benefits of willow crops are based on their rapid below ground growth and the additional carbon they add to the soil. Willow crops store large amounts of carbon in the parts of the plant that are not harvested, such as the woody roots and stump.

On average, across the 5-county region, the GHG emissions of willow grown on **cropland and pastureland** were -127 kg CO_2eq/Mg of biomass produced (Figure 2) or just over 11.3 metric tonnes sequestered per acre over a 23-year period. This sequestered carbon is in addition to the benefits of the renewable woody biomass that is produced and used in place of fossil fuel intensive products.

The lifecycle GHG emissions for willow grown on **grassland** was slightly positive at 28 kg CO_2eq/Mg. This is because when willow is grown on grassland, soil carbon decreases. Whereas when willow is grown on cropland and pastureland, soil carbon increases. However, regardless of where it is grown, willow crops provide additional climate change benefits when used as a feedstock in place of fossil fuel-based products, such as when willow is used to produce heat, power, or bioplastics.



The GHG impact of willow crops varied across the 5-county region with a more negative GHG footprint when willow crops were grown closer to the biomass plant (due to less transportation-based fossil fuel emissions). Changes in soil characteristics across the region also impacted yields and prior land use (cropland and pasture vs. grassland) influenced changes in soil carbon.

Policymakers can maximize the climate change benefits from willow crops by providing incentives for those crops to be planted closer to biomass plants while simultaneously creating jobs, improving water and soil quality, and supporting biodiversity.

Contact CAFRI experts for more information on **willow biomass crops**.

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