Willow Biomass Crops: Past Lessons, Future Potential

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Deploying Purpose-Grown Energy Crops for Sustainable Aviation Fuel

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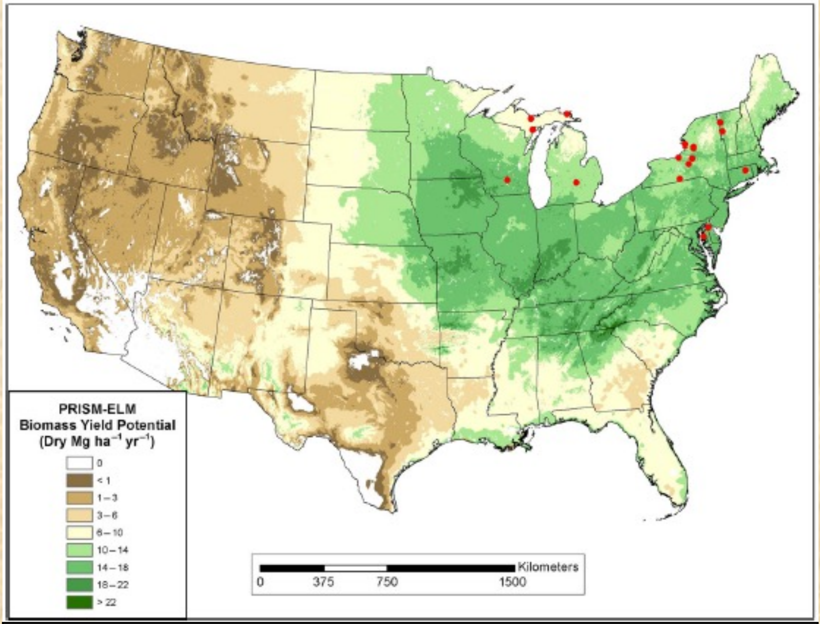
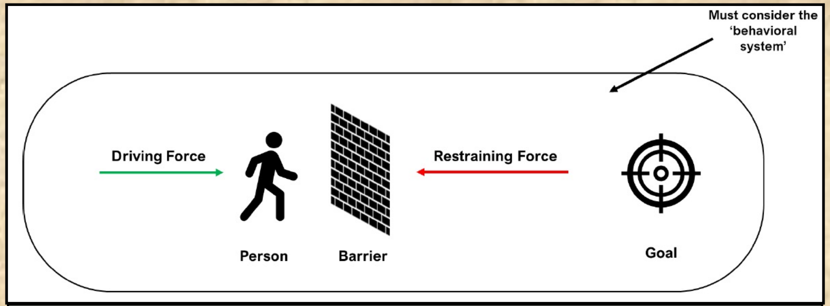
Lessons Learned



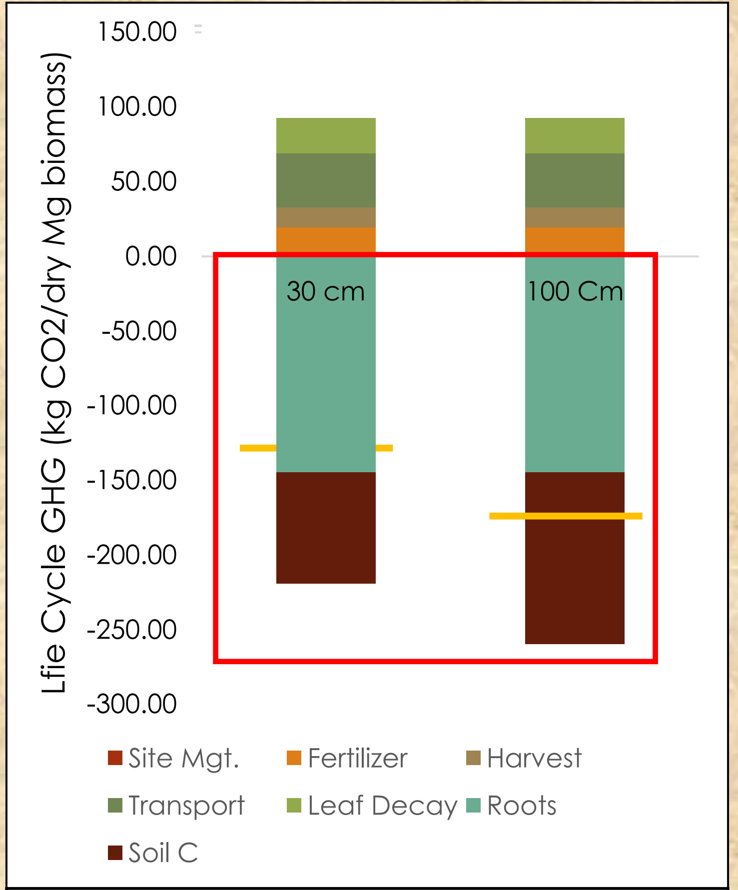
Willow yield map based on data from Regional Feedstock Partnership trials (Volk et al. 2018)



Framework for BSA (Evidn 2023)

- 30+ years of experience in North America and almost 50 years in Europe
  - Yield potential of current willow with cultivars is up to 16 Mg ha^{-1} yr^{-1} (Volk et al. 2018)
  - Large potential for improved cultivars - genetic base is broad (~175 species of shrub willow), genome is mapped
    - Limited breeding and selection efforts have resulted in large yield gains of 20 – 30%
  - Crop management protocols developed from research and implementation over thousands of acres
    - Thousands of acres currently being planted in Canada to address climate change and biodiversity challenges (Part of 2 Billion Tree program)
  - Multiple benefits identified – carbon negative feedstock and biofuels, enhanced biodiversity, pollinators supported, minimal soil erosion, improved soil health, belowground carbon storage, improved water quality
- Ongoing behavioral systems analysis (BSA) of willow to renewable diesel system is identifying driving and restraining forces and key barriers as well as recommendations to overcome them

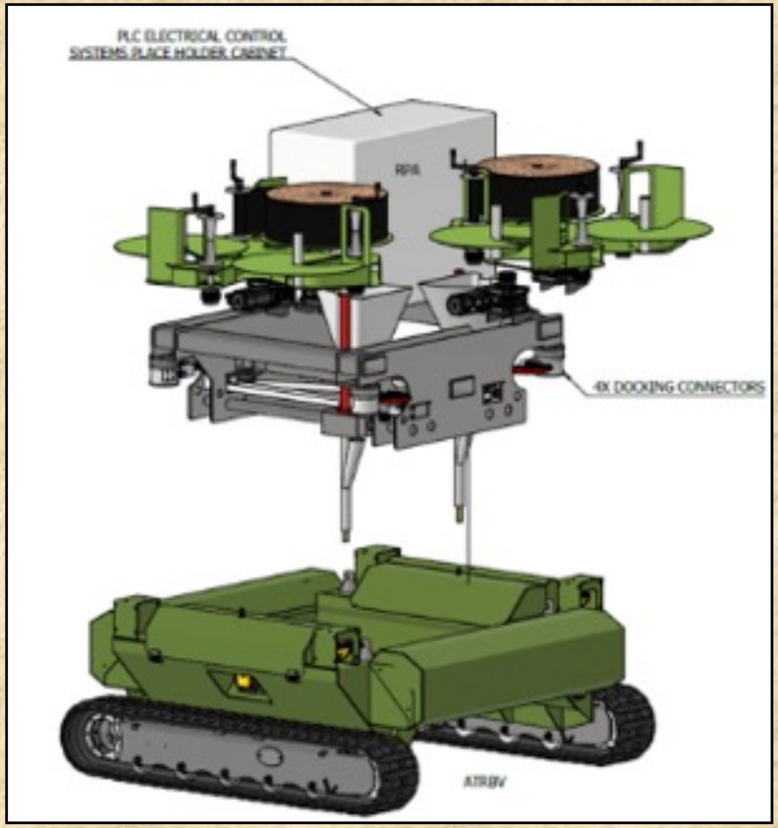
Data and Information Gaps



Life cycle GHG emissions of willow for soil C depths of 30 and 100 cm (Yang et al. 2020)

- Currently available varieties with 20 – 30% yield increase in single selection trials have not been tested in regional trials
  - Understand drivers of yield differences across space and time
  - Future breeding and selection to address: (a)yield, (b) adaptation to changing climate, (c) quality, (d) use in multifunctional systems
- Understand yield and other aspects of large-scale willow crops
  - BCAP with ~1,200 acres of 11- to 17-year-old willow due to expire in August 2023 with many landowners planning to remove crop
- Need long term yield data from commercial fields and research trials to reduce uncertainty of modeling projections
  - Most yield data from first and second rotation, but system is operational for 7 – 10 rotations (20 – 30 years)
- Understand variation and drivers for soil and belowground carbon
  - Soil and belowground carbon are key in overall GHG balance of feedstock and biofuels (Yang et al. 2020, Therasme et al. 2021)
  - Need to understand changes in belowground carbon over time and space due to variation across the landscape and the 20 – 30 year lifespan of willow crops

Opportunities for Improvement



- Improved commercial operations driven by market pull from federal and state initiatives (i.e. SAF Grand Challenge, NY Climate Act calls for ~950 MGY renewable diesel by 2030
- Performance to reduce costs and improve GHG emissions
  - Planting systems are key cost drivers and timing is key
    - New approaches and autonomous systems
  - Harvesting systems impact costs and GHG emissions
    - Commercial system developed but improvements needed, to accommodate changing weather patterns that impacts timing of harvesting and costs and GHG emissions
  - Optimize nutrient applications - fertilizer is a cost and GHG emissions driver
- Harvesting and logistics (storage and changes in quality) for year-round supply to end users
- Quantification of ecosystem services so valuation can occur
  - Soil carbon – reduce uncertainty and long-term changes
  - Belowground carbon – long term changes and at end of crop
  - Other ecosystem services: water quality, remediation, biodiversity

Contact Information

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