Using short rotation willow crops: A win-win for the environment
Short rotation willow crops: A win-win for the environment

Martin Labelle

- Forestry background
- British Columbia RFT
- 20 years managing plantations
- Conifers & some hardwoods
- Trees are initially grown in nurseries
- Then planted: in forests.
- Plugs have soil & roots
Short rotation willow crops: A win-win for the environment

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PREVIOUS WORK:

• Wildlife: Bears, cougars, wolves
• Complicated logistics: Floating camps, islands, inlets

• Spring 2015: Joined Bionera to establish willow plantations on marginal farm land in Alberta
• I thought this would be easier work
• With wind, drought, & hail: still challenging
• Now I’m working as a ‘farmester’
Short rotation willow crops: A win-win for the environment

This presentation will discuss:

• The evolution of willow biomass in western Canada
• Various applications for short rotation willow crops, including:

  - Biosolid use
  - Wastewater uptake
  - Bioheat feedstock
  - Land reclamation
Who is bionera?

Bionera is a subsidiary of PRT Growing Services,
PRT:

• 30 years growing trees
• North America’s largest producer of container-grown forest seedlings
• Network of 15 nurseries across Canada and the United States
• More than 4 billion seedlings planted
Bionera’s history:

- **2007**  PRT diversifies operations: Woody Crops.
- **2008-09**  First plantation & biomass boiler in Red Rock.
- **2010**  Plantations: Campbell River, BC and Oregon.
- **2011**  Wastewater project at Beaver Lodge, AB.
- **2014-17**  1000 acres: North Strathmore (6.7M cuttings).
- **2015**  70 acres: Ryley, AB
- **2017**  First wastewater project in SK: East of Regina.
- **2019-21**  Exciting new mine reclamation project, Forestburg
In 2006-2008: High energy prices

Initial premise for Bionera was to establish willow plantations to provide:

- purpose-grown woody biomass
- & stabilized energy supply and costs

In turn, this would:

- reduce greenhouse gas emissions
- shrink carbon footprint.
Natural Gas prices have since been on steady decline.

- 2006-08: > $7.00-$10.50/GJ
- 2016-18: under $3.00/GJ
- Hard to compete

Bionera needed to find new markets
In 2013, we joined forces with Sylvis Environmental to offer project management services and feedstock solutions to:

- **Municipalities and Industry:**
  - Alternate solutions to wastewater and biosolids management
  - Phytoremediation options
  - Land reclamation choices

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We now have the largest contiguous willow plantation in North America:

- 3 fields, North of Strathmore:
  - ~1000 acres of marginal farm land
  - 6.7 M⁶ cuttings planted
  - 2014 section was harvested in early spring 2017

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Strathmore, AB project:

- Outlet for the biosolids of the City of Calgary
- > 150,000 bulk tonnes of biosolids applied so far
- > 4,000 truck loads
- > 32,700 dry tons so far
- Target of 8,000 dry tons / yr
Biosolids utilization: How does it work?

- Biosolids are applied to marginal farmland
- Incorporation is done, using a disking implement.
- The site sits over the winter, until new willows are planted, in early spring.
The light disking incorporates the biosolids and also provides a smooth surface to plant, with good soil aeration for cuttings’ root development.

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Multiple winners:

- City of Calgary: Biosolid disposal on non-food crop
- City of Calgary: ‘Bonus’ biomass for multiple uses:
  - Composting, landscaping, zoo
- Land Owner: Soil improvement of marginal farm land: increased fertility and moisture retention
Environmental Monitoring

Critical to ensure:

Soil quality

- Spring sampling, year following biosolids application (fertility)
- Fall sampling, year following application (fertility and metals)

Water quality

- Spring meltwater
- Stormwater catchment, willow irrigation
- Voluntary well monitoring (spring & fall)
Other Willow Applications:

- Community Wastewater Treatment
- Bioheat & Bioenergy

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Community Wastewater Treatment

• Throughout the prairies: there are more than 2,000 small communities that treat wastewater with lagoon systems.
• Excess wastewater is often discharged overland or in adjacent streams during spring runoff
• This can be a health and environmental hazard
Community Wastewater Treatment

Irrigating an adjacent willow plantation with the excess wastewater is a great alternative that is:

• Environmentally-friendly
• Cost effective
Wastewater Treatment: How does it work?

- Wastewater is pumped through the willow field via an irrigation system and provides moisture and **increased nutrients** for the willows, which in turn grow faster.
Wastewater Treatment: How does it work?

• Willows are like big filtering pumps, using their highly effective evapotranspiration to extract water & nutrients.

• 1 hectare of willows can treat 6-7 million litres of wastewater effluents per year (40-60 people’s waste).
Numerous Benefits:

• **Reduction in environmental risk** to rivers and streams by eliminating spring runoff discharge.
• **Meeting wastewater treatment standards**, while **reducing capital expenditure** for future growth.
Benefits (continued):

- Irrigating willow fields with wastewater helps **prolong existing infrastructure lifespan.** The system can remain viable for up to **twice the existing population.**
- The biomass produces a **valuable crop** for the municipality, which can result in project cost recovery.
Benefits (continued): example of a real active project

• **Ohaton** is a hamlet located in **Camrose County**. This is a **Canadian Forest Service** Project where the willow fields are irrigated with municipal wastewater.

• The biomass is used to heat buildings at the Camrose County regional facility.
Benefits (continued): Environment

• A large willow plantation development is a **wooded ecosystem**.
• It provides habitat, food, and foraging grounds for **songbirds, small mammals, and ungulates**.
• It also acts as a **wind barrier**, which can mitigate noise and smell around the lagoon installations.
Bioheat

- The biomass from a willow plantation can help offset energy expenses, notably heating costs in colder climate portions of the country.
Bioheat: How does it work?

• The biomass is collected from the plantation, every 3 years, with a specialized harvester.
• Willows grow back from the same root stock.
Bioheat: How does it work?

- Biomass can be stored as **chips** or as **whips**, depending on the type and size of storage facility available.
- There are **available harvesters** for the different end uses.

Up to 40 t/hour

Up to 20 t/hour
Bioheat: How does it work?

- Willow chips are burned in a boiler.
- Hot water circulates in pipes to heat buildings, like these greenhouses in Prince George, BC.
Bioheat benefits

- Renewable ‘green’ resource
- Reduced dependency on fossil fuel
- Reliable, carbon-neutral feedstock

Willow Energy Value (conservative):

- 11.3 BDT per hectare / year
- 203 GJ generated in oven dry wood equivalent / year
- 56,388 kWh / hectare
- 4.7 ODT per acre / year
- 77.8 M^6 BTU / acre
- 22,860 kWh / acre
PRT Red Rock Nursery, Near Prince George, BC. *A real success*

- 100 burn cycles, starting early January.
- Replaces 80% of work done by 40 360,000 BTU furnaces.
- Offset is the equivalent of $70,000 in natural gas costs.
How do we establish a willow plantation?

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Willow Plantation Processes

**INTEGRATED APPROACH**

- Suitable site selection
- Site preparation
- Plant willows
- Weed Control
- Final inventory & decision making
- Coppicing
- Harvest willows

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Willow Plantation Processes

• Suitable site selection
  • Climate
  • Soils
  • Drainage
  • Irrigation available?
    • Water
    • Wastewater
Willow Plantation Processes

- **Site preparation** (August-October)
  - Initial weed control
  - Soil depth preparation
  - Biosolids application

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Site preparation (August-October)

Initial weed control

- Key to success
- Site sanitation: start fresh
- Herbicide-resistant weeds?
- Pay now vs later
Site preparation (August-October)

Soil Depth Preparation

- Cuttings are 8"
- Compaction can be a problem for rooting
- Must also retain moisture
- Prevent soil erosion
Site preparation (August-October)

Biosolids application

- Good incorporation is key
- Timing: before fall rains
- Alternative: all weather stock pile

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Willow Plantation Processes

Plant Willows (May-June)

- Moisture Availability
- Warm soil temperatures
- Weed control: last chance
- Soil depth

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Bionera uses a mechanical planter

- 4 row unit
- Average production of 18-25 acres per day
- Uses 4’-7’ whips
- Cuts whips into 8” cuttings and plants them
Advantages of a mechanical planter:

• Consistent, high quality planting
• Increased daily production
• Reduced breakdowns / maintenance
• Whips require less handling at nursery and in the field
• Better moisture retention
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Cuttings are key to success

- Well hydrated
- Buds tight and hard
- Straight and well nourished
- Robust hybrid varieties, well suited for your site
How quickly do willows grow?

Within 2-5 weeks, roots grow below ground (4 weeks old on this photo)

Shoots emerge above ground (5 weeks old on this photo)
6 week old trees in sandy soils, southern Alberta

12 week-old, 130cm tall willows in southern Alberta (near the end of August)
How quickly do willows grow?

15 week old 170-200cm willows, southern Alberta (near the end of September)

200-250cm at the start of the second growing season, southern Alberta (May)
How quickly do willows grow?

End of the second growing season: 300-400cm+ (September)

Start of third growing season: 400-600cm (May)
Willow Plantation Processes

• Coppicing: Why do it?
Willow Plantation Processes

• Coppicing: Why do it?

10 weeks after coppicing, willows occupy land and start to shade out weeds
Willow Plantation Processes - Summary

• Based on sound agricultural practices
  - Soil pH (6.5-7) and fertility correction, if needed
  - Weed management
• Most cost incurred at establishment phase
• Long term costs are low
  - Many harvests taken from the same planting
  - Weed control not needed after first two years
  - Fertilizer inputs are low / not required
  - Once established, crop requires little maintenance
• Harvest cost is low due to mechanization and compatibility with agricultural harvest methods

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New Markets?

- Industrial Land Reclamation & Phytoremediation
- Value added products
- District Heat for remote communities
- Small scale Bioenergy
- Cogen firing with coal

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Agrium - Fort Saskatchewan, AB

Biochar

Portable Gasifier
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• Camrose County: for promoting the benefits of wastewater treatment & bioheat with willows
• You: for attending this presentation
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Questions?

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