The Canadian Wood Fibre Centre’s Short Rotation Woody Crop Program
So Who Is The Canadian Wood Fibre Centre?

FPInnovations works towards optimizing the forest sector value chain. It capitalizes on Canada’s fibre attributes and it develops new products and market opportunities within a framework of environmental sustainability.

Public/Private Forest Research Institute

Optimizing The Forest Sector Value Chain
FPInnovations – Research Scope by Division

So Where Does SRWC Fit In?

- Forest Inventories and Fibre Attributes
- Forest and Harvesting Operations
- Solid Wood Products and Building Systems
- Pulp & Paper and Bio-products
So Where Does SRWC Fit In?

**Forest Inventories and Fibre Attributes**

- Increase Fibre Value Through the Reduction of Fibre Variability
- Increase Fibre/Biomass Availability
- Growing Fibre With Desirable Attributes To Meet Specific Customer Needs
What are The Customer Needs?

New high-yield woody fibre sources designed to produce desirable attributes for developing fuel, energy, forest products and carbon capture values.

- **Biomass**
- **Solid Wood**
- **Pellets**
- **Pulp**
- **Carbon Credits**
Short-rotation Woody Crops Systems Development and Value-chain Analysis

Objective: To develop, assess and refine new practices related to purpose-grown woody bioenergy feedstock that enhance production yields, reduce input costs and optimize the value-chain components and values.

Approaches
1) Establish And Manage A National Network Of Short-rotation Woody Crop Sites Demonstrating Management Options, Tracking Growth, Sustainability And Characterization Of Biomass/Fibre Attributes.

2) Complete Value-chain Analysis Of Input Activities And Costs For High-yield And Concentrated Biomass Plantation Systems.

3) Organize Field Tours/ Demonstrations Source To User For Short-rotation Woody Crops (Alberta Or Ontario) .
Site Suitability of Short-rotation Woody Crops In Canada

Afforestation Land Suitability
High-Yield (8x Native Yield), Area-Based Hybrid Poplar Plantations

Suitability
- High
- Low
## Site Suitability of Short-rotation Woody Crops in Canada

<table>
<thead>
<tr>
<th>Province</th>
<th>High</th>
<th>Good</th>
<th>Marginal</th>
<th>Poor</th>
<th>Not</th>
<th>Total</th>
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<td>British Columbia</td>
<td>2,140</td>
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<td>649</td>
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<td>14</td>
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<td>96</td>
<td>37</td>
<td>2</td>
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<td><strong>Total</strong></td>
<td>146,624</td>
<td>99,385</td>
<td>189,699</td>
<td>120,206</td>
<td>91,548</td>
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Figures in km²

**14,966,200 ha**
Site Suitability of Short-rotation Woody Crops In Canada

Wood Processing in Canada
Major Mills

Legend
- 0 - 500,000
- 500,001 - 750,000
- 750,001 - 1,000,000
- 1,000,001 - 3,000,000
- > 3,000,000

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National Network of Sites
Alberta Epicenter of Operations

**MDI Satellite Site**
- High Yield
- Afforestation Using Hybrid Poplar and Clonal Aspen
- 24 ha Established in 2009

**University of Alberta St. Albert Research Station Satellite Site**
- High Yield Afforestation Using Hybrid Poplar and Clonal Aspen
- 20 ha Established in 2009

**University of Alberta Ellerslie Research Station Satellite Site**
- Short Rotation Woody Crop
- 18 ha Established in 2002-2006

**FT Sask. Satellite Site**
- Moderate - High Yield
- Afforestation Using Hybrid Poplar
- 57 ha Established in 2005

**Gibbons Satellite Site**
- Concentrated Hybrid Poplar Plantation
- 28 ha Established in 2005
- 26 ha Established in 2009

**Athabasca/Al-Pac Satellite Site**
- Concentrated and High Yield
- Afforestation Using Hybrid Poplar
- Evaluating Two Establishment Regimes
- 60 ha to be Established 2010
- 2 x 20 ha Established in 2009
- 4 ha Established in 2009

**Millar-Western Satellite Site**
- Moderate - High Yield
- Afforestation Using Hybrid Poplar
- 20 ha Established in 2004

**Weyerhaeuser Satellite Site**
- Mixedwood Plantation on Previously Harvested Site
- 4 ha Established in 2002
High Yield Afforestation

1100 - 1600 Stems Per Hectare

- Hybrid Poplar and Clonal Aspen
- Manually Planted
- 15-25 Yr Rotations
- One Rotation Per Life Cycle
- $2500-3000/ha Establishment and Management Costs
- 25-30 cm DBH, 18-24 m Height at Harvest
- 150-260 m³/ha Stem Volume
- 5-9 ODT ha⁻¹ yr⁻¹ Including Limbs and Tops
- $40/ODT Harvesting and Transportation Costs
- 5.6 MW or 19 MJ per ODT

Initiated 2002
Concentrated Woody Biomass

14,380 - 15,625 Stems Per Hectare

- Mechanically Planted Using Willow and Hybrid Poplar Cuttings (25cm)
- Coppiced Following Year 1
- 3-Year Rotations
- 4-6 Metres in Height at Harvest
- Up to 7 Rotations Per Life Cycle
- $8-12,000/ha Establishment and Management Costs
- 7-12 ODT ha\(^{-1}\) yr\(^{-1}\)
- $50/ODT Harvesting and Transportation Costs
- 5.6 MW or 19 MJ per ODT

Initiated 2005
Hybrid Biomass and Afforestation

6,400 Stems Per Hectare

- Primarily Hybrid Poplar
- Manually Planted
- 75% Harvested At Year 4
- Remaining 1,600 Stems/ha on 15-25 Yr Rotation
- $7,000 – 9,000/ha Establishment and Management Costs
- Newly Developed Establishment Design
- Created to Reduce Management Requirements and Time Frame
- Enables For Multiple Opportunities for Biomass Supply

Initiated 2009
SRWC Research Site Example

- High-Yield Afforestation
- Concentrated Biomass
- Agriculture
Opportunities Along The Forest Fringe

Mixedwood Afforestation Plantations

Short Rotation Woody Crop Systems for Value in Canada

**Mixedwood Afforestation Plantations**
- Plantations qualify as either afforestation or reforestation under the Kyoto Protocol definition.
- According to the document, the carbon sequestered by the plantations qualifies for carbon credits.
- Afforestation using bio-geo-climatically suitable hybrid poplar (Populus spp.) cultivars and white spruce, under intensive management regimes, has been established on moderate- to high-quality lands across Canada.
- A two-rotation strategy designed to maximize biomass accumulation, carbon sequestration, and fibre production over both the short-term (10 years) and long-term (70 years) through the development of both hardwood and softwood crops.
- Preliminary assessments of below and above ground carbon budgets estimate potential carbon increases of 664-820 t CO₂·ha⁻¹ over the 20- to 70-year rotations for the respective hardwood and softwood crops.

**Hybrid Poplar and White Spruce**
- The primary hardwood tree species to be considered for high yield and carbon sequestration afforestation efforts over the medium-term is hybrid poplar.
- Similar to the dynamics that exist within the mixedwood forests in Western Canada, the hardwood (hybrid poplar) provides the protection required by the young spruce understory.
- Harvesting the hybrid poplar biomass or fibre at year 20 allows its value to be realized and permits the softwood understory to release and mature over the following 50 years.
- The dual-crop strategy maximizes the biomass, fibre, and carbon values available from a given land base.

Plantation Design
- Species: hybrid poplar, white spruce
- Density: 1,500 stems/ha hybrid poplar, 1,200 stems/ha white spruce
- Spacing: 2.5 m × 2.5 m for hybrid poplar, inter-plant spruce
- Planting: Manual
- Rotation: hybrid poplar @ 16-20 yrs; white spruce @ 70 yrs
- Yields: hybrid poplar > 13,500 m³/ha yr or 7.9 t 0.36 OD/ha yr
  - White spruce > 6,000 m³/ha yr or 1.9 t 0.36 OD/ha yr

Plantation Costs (2,800 stems/ha)

Year 2
- Site Preparation: $1,500
- Insect Pesticides: $100
- Hail Pesticides: $500
- Marking: $500
- Plant Material (seedlings or rooted cuttings & seedlings): $6,350
- Planting: $3,500
- Split Cultivation: $2,750
- Mechanical Cultivation: $1,500
- Environment: $100
- Total (5 yrs): $6,200

For more information please contact Derek Sidders, Tim Keddy or Brent Johns
Website: www.fpinnovations.ca
To increase productivity and reduce planting costs the Canadian Forest Service (CFS) has tested and operationally employed the Mechanical Transplanter for the establishment of 3-row biomass for energy plantations. The Mechanical Transplanter was designed for transplanting small seedlings for fruit and vegetable production and consists of independent transplanters attached to a drawbar which is then attached via a 3-point hitch to a minimum 50 horsepower tractor. For the CFS operations, a three transplanter configuration was used to plant 25 centimetre willow and hybrid poplar cuttings in three parallel rows at a spacing of 60 centimetres between rows and between trees within the rows. The transplanter used for the operational trials was equipped with deep, 10-inch planting shoes to facilitate the planting of long 25 centimetre cuttings.

**Site Preparation**

For the Mechanical Transplanter to operate the soil must be disced to a depth of 30 centimetres with the top 10-15 centimetres finely mixed. Any variance from these pre-requisites will result in reduced productivity and planting quality.

**Transplanter Set-up**

The transplanter is attached to the tractor via the 3-point hitch. Care must be taken to ensure that the 2 lower hitch arms are adjusted so that the transplanter sits level once the transplanter staff are sitting in their seats. By levelling the unit, one will ensure that each of the three rows will be planted at a consistent depth. This can be easily determined by ensuring the planting shoes of each unit touch the ground simultaneously.

Once the machine is level, the pitch of the machine requires adjustment. The pitch of the machine must be set so that the packing wheels are able to adequately pack the soil around the cutting once it is planted. The pitch of the transplanter is set using the adjustable top link of the 3-point hitch. This adjustment requires that the staff be sitting on the machine to mimic planting operations.

**Vegetation Management**

The importance of vegetation management of concentrated biomass for energy plantations cannot be overstated. The transplanter is attached to the tractor via the 3-point hitch. Care must be taken to ensure that the 2 lower hitch arms are adjusted so that the transplanter sits level once the transplanter staff are sitting in their seats. By levelling the unit, one will ensure that each of the three rows will be planted at a consistent depth. This can be easily determined by ensuring the planting shoes of each unit touch the ground simultaneously.

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Biomass Value Simulator

• Spreadsheet-based Model/Calculator
• Feedstock: Purpose-Grown & Opportunity Sources
• Developed based on case scenarios
• Incorporates:
  • Establishment & Management Costs
  • Harvest Costs
  • Handling and Transportation Costs
  • Opportunities for End-Use & Associated Values
  • Accounts for feedstock properties, equipment productivity and conversion efficiencies
Biomass Value Simulator

Feedstock Source ➔ Handling/Conversion ➔ Desired End-Product

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### Biomass Value Simulator

**Feedstock Source Handling/Conversion Desired End-Product**

**Biomass Value Simulator**

<table>
<thead>
<tr>
<th>Inventory</th>
<th>Costs</th>
<th>Values</th>
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</thead>
</table>
| **High Yield Afforestation (Hybrid Poplar)** | **Harvesting:** $25/ODT ($3,658/ha)  
**Rotation:** 20 years  
**Density:** 1,600 stems/ha  
**Yield:** 13.6m³/ha/yr or 7.3 ODT/ha/yr  
**Establishment Costs:** $3,400/ha or $23/ODT | **Energy, Carbon Sequestration & Offsets**  
**Heat Energy Value:** $129/ODT ($18,943/ha)  
**Below Ground C Value:** $8/ODT $1,095/ha  
**Carbon Offset Value:** $62/ODT ($9,101/ha)  
**Gross Value:** $199/ODT ($29,114/ha)  
**Net Value:** $85/ODT ($15,800/ha) |
| **White Spruce**  
**Rotation:** 100 years  
**Yield:** 180m³/ha | **Fibre Production:** $69/ODT  
**Chemicals:** $23/ODT  
**Energy:** $24/ODT  
**Labour:** $34/ODT  
**Materials:** $17/ODT  
**Total Costs:** $187/ODT ($17,354/ha) | **NBSK Pulp, Heat Energy Values & Carbon Offsets**  
**Pulp Value:** $315/ODT  
**Energy Value:** $358/ODT ($7,741/ha)  
**Carbon Offset Value:** $23/ODT ($397/ha)  
**Gross Value:** $419/ODT ($38,883/ha)  
**Net Value:** $232/ODT ($21,529/ha) |
| **White Spruce Roadside Residues**  
**Rotation:** 100 years  
**Yield:** 180m³/ha  
**Residues:** 54m³/ha (17.28 ODT) | **Processing:** $20/ODT ($346/ha)  
**Transportation:** $20/ODT ($346/ha)  
**Conversion:** $153/ODT ($2,644/ha)  
**Total Costs:** $193/ODT ($3,336/ha) | **Electrical Energy & Carbon Offset Values**  
**Electrical Energy Value:** $358/ODT ($7,741/ha)  
**Carbon Offset Value:** $23/ODT ($397/ha)  
**Gross Value:** $381/ODT ($6,584/ha)  
**Net Value:** $188/ODT ($3,249/ha) |

**Basis for Value Calculations:**  
- Electrical Cost @ $180/MW ($5.6 MW/ODT)  
- Average Natural Gas @ $8.00 GJ (19 GJ/ODT)  
- CO₂ tonne value = $15  
- Heat & Electrical Conversion Efficiency = 80%  
- Heat Conversion Cost = $2.50/GJ

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Focused Research w/ CWFC

- Soil Fertility and Sustainability
  - Canadian Forest Service
- Carbon Budgeting and Water Usage
  - Canadian Forest Service
  - University of Alberta
  - University of BC
- Life Cycle Analysis
  - University of Alberta
  - University of Guelph
- Bioremediation
  - City of Prince George
  - City of Edmonton
- Wood Fibre Characterization
  - FPInnovations – Paprican
- Spatial Economic Modelling
  - Canadian Forest Service
Diversification of the forest/agriculture land base in Canada, through the introduction of innovative woody crop land management regimes in close proximity to final users, and designed to meet specific final product options and values.
Challenges!!

Costs!!!!!!!!!

Actual and Perception!

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The Harvesting Question!

Evaluating Various Options!
Points to Ponder!

✓ No Silver Bullet!
  ✓ Consider all management regimes
  ✓ Consider both hybrid poplar and willow

✓ The Volumes Are There!
  ✓ Yields at or above acceptable range

✓ Numerous Revenue Options!
  ✓ Consider bioenergy, carbon, conventional forest products and other bioproducts

✓ Need More Harvesting Options!
  ✓ Consider bundling, various scales

SRWC systems are one land use option for consideration!
Thank-You!!