Digging Into the Costs of Short Rotation Coppice Crops in Canada

Dan McKenney, Denys Yemshanov, Darren Allen, Saul Fraleigh (CFS-GLFC)

Presented by: Darren Allen

Forum on the Culture of Willows and Hybrid Poplars for Energy Production: Potential Challenges

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Important Collaborators

- Derek Sidders, Brent Joss, and Tim Keddy (CWFC-NoFC)
- Other ecoETI partners for input and feedback
- Two other related projects underway:
  - PERD project with AAFC – “Maximizing environmental benefits of the bioeconomy using agricultural feedstock” (Ag “feedstock” includes trees and woody crops from Ag land);
  - University of Guelph OMAFRA project …”Land-use and policy impacts of the transition to a green economy”… PhD project (Aaron Delaporte; Alfons Weersink)
Talk Overview

- What is new?
- Relevant questions and models
- Some northern Ontario examples and national perspectives
- Concluding comments and future directions
What is new?

(1) Comparison of finer scaled data to existing data to determine optimal resolutions for modeling purposes
   • Existing land base for afforestation (SPOT VGT) 1000 m x 1000 m - 100 ha grid cell size (nominal)
   • Comparison of new product from AAFC, NRCan/CFS (NLWIS 30m Landsat TM derived land cover estimates) at various resolutions - 90m(0.81ha), 270m(7.29 ha), 510m(26 ha), 1000m(100 ha)

(2) Cost scenario updates and development for SRC (willow and poplar)

(3) Model runs incorporating above-noted agricultural land estimates and cost scenarios (end-2011)
Our objectives are both normative, from a private investor point of view (is it worth it?) and positive from a policy point of view (what are likely outcomes given particular prices)…

Surprisingly difficult to ascertain a national perspective on establishment and management costs (why? – practices vary, perceptions of opportunity costs and risks, still primarily in a R&D phase, weather, timing, and other stochastic events, etc)
What types of questions can (should) you ask?

How much carbon might be expected to be sequestered under different price (or subsidy, or tax credit) levels?

How much land-use change pressures might there be under different prices?

What regions appear to have the most investment potential? Why - physical or economic advantage?

What energy price changes could affect forest management decisions; when will woody biomass from forests become an attractive energy source?

What research is required to decrease uncertainty, increase financial attractiveness or adoption possibilities?
Economic Models

Three models developed and being applied to our work:

**CFS-AFM (Afforestation Feasibility Model)**
- Very long run Faustmann-type model including carbon and fibre benefits
- Extensively used in Forest 2020 Plantation Demonstration and Assessment Initiative (PDA) to assess feasibility of fast-growing plantations, published in peer-reviewed media

**CFS-FBM (Forest Bioeconomic Model)**
- More complex and uses specified time horizons
- Uses improved 18-pool carbon model
- Better addresses more complex forest management and bioenergy scenarios (species rotation, fixed time horizons, multiple thinnings)

**SRC-GHM (Greenhouse Bioenergy Cost-Benefit Model)**
- Cost-benefit spread-sheet model of joint project options:
  Heating greenhouses with SRC biomass – (also includes break-even metrics of fossil fuel substitution)
Typical Output Metrics from Models

ROI, (%) – real rate of return yielding NPV = 0

Break-even wood prices, ($/ODT or $/m³) – the unit price yielding NPV = 0
(wood price is 0 when NPV is positive)

Physical carbon, (t/ha) – total ecosystem carbon sequestered over a project life (minus carbon in harvested biomass and decay emissions)

Geographical variation of the output metrics
(e.g. helps to identify economically attractive areas for afforestation)

Other metrics include Present Values, break-even carbon prices, aggregate quantities
Where do we get our information?

National network of sites – Derek Sidders team (CWFC):
site suitability modeling, yields, practices, costs

Selected operator experiences

Extrapolation from literature and agriculture costs

Independent private landowner experiences
Example of old input (SPOT VGT) compared to newer product (NLWIS land cover)

Blue = existing land base based on 1-km SPOT-VGT land cover classification = 5,627,400 ha
Red = new 30-meter NLWIS data product (Agriculture and Agri-food Canada) = 7,509,501 ha
Aggregated to:
- 90-meter resolution = 7,572,581 ha
- 270-meter = 7,588,146 ha
- 510-meter = 7,602,489 ha
- 990-meter = 7,580,387 ha

(all area estimates are “nominal” areas)
**Cost scenario summary**
*(end 2011 base year)*

- All base scenarios assume 10 ODT/ha/yr yield (then adjusted using a spatially explicit site suitability (bio-geo-climatic) model.

- Agricultural opportunity costs (spatial) also considered in model.

- Stool removal included in costs.

- Model runs conducted at 3 discount rates: 4%, 6%, 8%

<table>
<thead>
<tr>
<th>Variable</th>
<th>Assumption</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1</td>
<td>Establishment (yrs 0-1) - $2612/ha</td>
<td>A localized cost description based on an operator in southern Quebec.</td>
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<tr>
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<td>Maintenance (yrs 2-21) - $564/ha</td>
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<tr>
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<td>Total (yrs 0-21) - $3176/ha</td>
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<td>Maintenance (yrs 2-21) - $2110/ha</td>
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<tr>
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<td>Total (yrs 0-21) - $4309/ha</td>
<td></td>
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<tr>
<td>Scenario 3</td>
<td>Establishment (yrs 0-1) - $3720/ha</td>
<td>Provincial average costing based on current costs across Ontario (OMAFRA). Based on recent custom farm work rates.</td>
</tr>
<tr>
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<td>Maintenance (yrs 2-21) - $1709/ha</td>
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<tr>
<td></td>
<td>Total (yrs 0-21) - $5429/ha</td>
<td></td>
</tr>
<tr>
<td>Scenario 4</td>
<td>Establishment (yrs 0-1) - $5305/ha</td>
<td>&quot;National Level&quot; averaged costing at R &amp; D scale.</td>
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<td></td>
<td>Maintenance (yrs 2-21) - $3055/ha</td>
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</tr>
<tr>
<td></td>
<td>Total (yrs 0-21) - $8360/ha</td>
<td></td>
</tr>
<tr>
<td>Harvesting</td>
<td>$25/ODT</td>
<td>This assumes costs for harvesting using a commercial harvester. Includes in-field handling and transportation to farmgate.</td>
</tr>
<tr>
<td>Biomass Price</td>
<td>$85/ODT</td>
<td>The market price assumed for all scenarios. This price reflects farmgate prices.</td>
</tr>
<tr>
<td>Carbon Value</td>
<td>$10 CO₂e</td>
<td>Reflects a market value for carbon.</td>
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Agricultural Opportunity Costs
(land rents from Ag Census data)

Range from:

Minimum = $4/hectare
Average = $44/hectare
Maximum = $490/hectare

In southern Quebec, one might expect higher values than this…
Site Suitability Modifiers

As stated earlier (by other speakers, these assumptions for growth and yield are a very important consideration in regards to the potential economic attractiveness of such plantation ventures.
Model initial input of 10/ODT/ha/yr, then gets modified based on site.
Example of Best 10,000 Hectares in Northern Ontario:

combination of site suitability and opportunity costs (land rents) = most financially attractive based on NPV
### Northern Ontario example

#### 6% discount rate

<table>
<thead>
<tr>
<th>Silviculture Cost 22yrs &gt;</th>
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<th>Scenario 3</th>
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<th>Real Discount Rate</th>
<th>Scenario</th>
<th>NPV</th>
<th>NPV</th>
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<tr>
<td>6%</td>
<td>Base Scenario</td>
<td>1099</td>
<td>-578</td>
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<td>$10 CO₂e</td>
<td>2003</td>
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<td>1.5 Yield</td>
<td>3027</td>
<td>1350</td>
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<td>1/2 Years 0-1 costs paid</td>
<td>2331</td>
<td>1177</td>
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<td>75% Farmgate Price</td>
<td>-277</td>
<td>-1954</td>
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<tr>
<td></td>
<td>125% Farmgate Price</td>
<td>2003</td>
<td>325</td>
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</table>

**Average of the best 10 000 Hectares**

- **Base Scenario**: NPV = 1099, NPV = -578
- **$10 CO₂e**: NPV = 2003, NPV = 325
- **1.5 Yield**: NPV = 3027, NPV = 1350
- **1/2 Years 0-1 costs paid**: NPV = 2331, NPV = 1177
- **75% Farmgate Price**: NPV = -277, NPV = -1954
- **125% Farmgate Price**: NPV = 2003, NPV = 325
Scenario 3
Base Case
Scenario 3
$\text{CO}_2\text{e @ $10}$
Scenario 3
Yield x 1.5
Scenario 1
Base case
Scenario 1
CO₂e @ $10
Scenario 1
Yield x 1.5
## Canadian Perspective

### Average of the best 100 000 Hectares

<table>
<thead>
<tr>
<th>Silviculture Costs 22yrs</th>
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<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
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<tr>
<td><strong>4%</strong></td>
<td>Base Scenario</td>
<td>2649</td>
<td>2143</td>
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<td>$10 CO$_2$e</td>
<td>3767</td>
<td>3261</td>
<td>1967</td>
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<td></td>
<td>1.5 Yield</td>
<td>5508</td>
<td>5002</td>
<td>3709</td>
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<tr>
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<td>1/2 Years 0-1 costs paid</td>
<td>3904</td>
<td>3199</td>
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<td>75% Farmgate Price</td>
<td>602</td>
<td>96</td>
<td>-1197</td>
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<td>125% Farmgate Price</td>
<td>4695</td>
<td>4189</td>
<td>2895</td>
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<td><strong>8%</strong></td>
<td>Base Scenario</td>
<td>1125</td>
<td>839</td>
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<td>$10 CO$_2$e</td>
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<td>1876</td>
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<tr>
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<td>1.5 Yield</td>
<td>3088</td>
<td>2802</td>
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<td>1/2 Years 0-1 costs paid</td>
<td>2334</td>
<td>1857</td>
<td>1278</td>
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<tr>
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<td>75% Farmgate Price</td>
<td>-279</td>
<td>-565</td>
<td>-1848</td>
<td>-4158</td>
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<tr>
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<td>125% Farmgate Price</td>
<td>2529</td>
<td>2243</td>
<td>960</td>
<td>-1350</td>
</tr>
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Conclusions and Future Work

• Model / data development quite well advanced – new capacities being developed
• Models have already been used to support policy development
• SRC can be economically attractive based on cost assumptions (best 100 000ha and 10 000 ha examples); **local growers will likely be the best judge of their cost regimes**
• Multiple revenue streams: co-projects and joint products will help make SRC more attractive

Other Needs/ Activities
• “Option” value modeling for land-use change (with University of Alberta)
• Forest crops vs Ag crops (with University of Guelph)
Example references - previous work


Acknowledgements

Funders

Natural Resources Canada
- Feasibility Assessment of Afforestation for Carbon Sequestration (FAACS)
- Forest 2020 Plantation Demonstration and Assessment Initiative (PDA)
- Canadian Biomass Innovation Network (CBIN) - Project TID8 31
- EcoETI - Bio-based Energy Systems

FedNor

Northern Ontario Heritage Fund Corporation (NOHFC)
Thank You

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