Bioeconomy Overview of Activities within the Agriculture Development Branch, OMAFRA

Ian Mcdonald
April 13, 2010
Ontario Ministry of Agriculture, Food and Rural Affairs
OMAFRA Organization

Divisions

• Economic Development
• Food Safety and Environment
• Policy
• Research and Corporate Services
OMAFRA Bioeconomy Resources

Multi Branch/Cross Division Teams
- Agriculture Development
- Business Development
- Client Service
- Economic Development Policy
- Environmental Management
- Food Safety and Environmental Policy
- Research and Innovation
- Rural Community Development
OMAFRA Bioeconomy Collaborators

Prov. Govt.
• Min. of Environment (MOE)
• Min of Research & Innovation (MRI)
• Min. of Energy & Infrastructure (MEI)
• Min. of Natural Resources (MNR)
• Others
OMAFRA BioEconomy Collaborators

Fed. Govt.
- Agri. and Agri-Food Can
- Agriculture Adaptation Council
- Natural Resources Can./Canmet
- Environment Canada
- others
OMAFRA BioEconomy Collaborators

Industry Partners
• OFA – Ontario Federation of Agriculture
• GFO – Grain Farmers of Ontario
• OSCIA – Ontario Soil and Crop Improv. Assoc.
• CFFO – Christian Farmers Federation of Ontario
• OFC – Ontario Forage Council
• Ag Energy Coop
• ALUS – Alternative Landuse System
• OGVG – Ontario Greenhouse Vegetable Growers
• OPVG – Ontario Processing Vegetable Growers
• OFVGA – Ontario Fruit and Vegetable Growers
• others
OMAFRA BioEconomy Collaborators

NGO’s:

• Bioenterprise
• Ontario Agri-Food Technologies
• REAP Canada
• others
OMAFRA BioEconomy Collaborators

**Academic:**
- Brock
- Laurentian
- Guelph
- Lakehead
- Queens
- Toronto
- Trent
- Waterloo
- Western
- Windsor

- Ohio State Univ.
- Univ. of Illinois
- others
OMAFRA BioEconomy Collaborators

Businesses:
- Ontario Power Generation (OPG)
- Greenfield Ethanol
- Lafarge Cement
- New Energy Farms
- Nott Farms
- Switchgreen
- Willowlee
- EcoSynthetix
- Cook Engineering
- Agri-Therm
- BioAuto Council
- Woodbridge Foam
- Many others
OMAFRA ADB Resources

Units
• Business Management (1)
• Livestock (2)
• Crops (4)
OMAFRA ADB Resources

Units

• Business Management (1)
• Livestock (2)
• Crops (4)

• ADB Bioeconomy Theme Team
The Bioeconomy System

Feedstock / Biomass

- Agricultural crop residues
- Agricultural crops
- Dedicated biomass crops
- Woody biomass

Process / Biorefinery

- Chemical and Biochemical
- Thermochemical (gasification, pyrolysis)
- Combustion
- Biodigestion
- Cogeneration

Market / Bioproduct

- Biofuels
- Bioenergy
- Biochemicals
- Bioplastics
- Biomaterials
Biomass Value Chain

Biomass-Derived Materials Flowchart

Source: Top Value-Added Chemicals Report
ADB Areas of Emphasis

Agronomics

Economics

Environment

Social/Policy
ADB Activities

Vehicles
• Awareness
• Education
• Research
• Demonstration
• Networking
• Funding
• Analysis
• Reporting
• Scientific review
ADB Activities

Sectors
• Biomass
• Biogas
• Solar
• Wind

For Production of:
• Power
• Electricity
• Heat
• Fuel
• Chemicals
• Materials
• Food Enhancement
• Fertilizers
• etc
ADB Activities

Sectors
• Biomass
• Biogas
• Solar
• Wind

For Production of:
• Power
• Electricity
• Heat
• Fuel
• Chemicals
• Materials
• Food Enhancement
• Fertilizers
• etc

How do these relate to new ventures and integrate with existing enterprises?
OMAFRA ADB Activity Involvement

- OPG-OMAFRA Biomass steering committee
- GTM/ FarmSmart / other conferences
- Collaborative research projects-OMAFRA- U of G/ OSCIA/ Env. Sust. Pgm
- Program delivery/ Tech. Transfer
  - (COP, fact sheets, bioproducts webpage, etc)
- Biomass heat/ biogas/ biofuels/ biomass crops & sustainability aspects
Specific Examples
Landuse
REQUEST FOR EXPRESSIONS OF INTEREST

In the future, we want to make electricity at our coal-fueled stations using fuel that’s clean, renewable and made in Ontario. As we continue to test biomass made from wood or non-food agricultural products, we are also seeking expressions of interest from companies that can supply and/or transport this greener fuel.

Using solid biomass as a replacement for coal beyond 2014, when coal will no longer be used for electricity production, helps move us toward a greener energy future. It will also reduce our contribution to global warming while making use of existing electricity generating assets owned by the people of Ontario.

If you wish to express your interest in supply and/or transportation of biomass visit: opg.com or email: biomass@opg.com

ONTARIO POWER GENERATION
Gross Supply Potential of Biomass

Fig. 2. Estimates of sustainable biomass energy potential in Canada and in Ontario compared to the total energy demand (all forms of energy) in Canada and Ontario.

- Municipal Wastes
- Agriculture
- Forestry

Canada’s Energy Use (2003) ~ 10.5 EJ/yr
Ontario’s Energy Use (2003) ~ 3.3 EJ/yr

Ag contribution estimates high relative to other sources

Exploring the Potential for Biomass Power in Ontario
BIOCAP Canada Foundation (www.biocap.ca) - Feb. 23, 2006
## Gross Supply Potential of Biomass

### Table 1: Summary Biomass Resources and Calculation of Potential for Power Generation

<table>
<thead>
<tr>
<th></th>
<th>Mt dry biomass/yr</th>
<th>Energy Content (GJ/t dry)</th>
<th>Thermal Energy (PJ/yr)</th>
<th>Power. (TWhr)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forestry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residues from Existing Forestry</td>
<td>2.5</td>
<td>16.9</td>
<td>42.3</td>
<td>4.11</td>
</tr>
<tr>
<td>Accessing unused annual allowable cut</td>
<td>4.0</td>
<td>16.9</td>
<td>67.8</td>
<td>6.57</td>
</tr>
<tr>
<td>Harvesting forests after disturbance</td>
<td>3.8</td>
<td>16.9</td>
<td>64.2</td>
<td>6.24</td>
</tr>
<tr>
<td>Silviculture</td>
<td>13.8</td>
<td>16.9</td>
<td>233.2</td>
<td>22.67</td>
</tr>
<tr>
<td>Dedicated harvest for energy</td>
<td>3.0</td>
<td>16.9</td>
<td>50.7</td>
<td>4.93</td>
</tr>
<tr>
<td><strong>TOTAL for Forestry:</strong></td>
<td><strong>27.1</strong></td>
<td><strong>458.0</strong></td>
<td><strong>44.52</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Agriculture</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop Residues</td>
<td>4.0</td>
<td>16.0</td>
<td>64.0</td>
<td>6.22</td>
</tr>
<tr>
<td>Animal Manure*</td>
<td>7.7</td>
<td>16.0</td>
<td>21.0</td>
<td>3.10</td>
</tr>
<tr>
<td>Biomass Crops</td>
<td>20.0</td>
<td>16.0</td>
<td>320.0</td>
<td>31.1</td>
</tr>
<tr>
<td><strong>TOTAL for Agriculture:</strong></td>
<td><strong>31.7</strong></td>
<td><strong>405.0</strong></td>
<td><strong>40.4</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Municipal Waste</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solid Waste*</td>
<td>3.7</td>
<td>16.0</td>
<td>10.2</td>
<td>1.48</td>
</tr>
<tr>
<td>Biosolids*</td>
<td>0.3</td>
<td>16.0</td>
<td>0.8</td>
<td>0.12</td>
</tr>
<tr>
<td><strong>TOTAL for Municipal &amp; Ind. waste:</strong></td>
<td><strong>4.0</strong></td>
<td><strong>11.0</strong></td>
<td><strong>1.60</strong></td>
<td></td>
</tr>
<tr>
<td><strong>GRAND TOTAL</strong></td>
<td>62.8</td>
<td>874.4</td>
<td>86.54</td>
<td></td>
</tr>
</tbody>
</table>


Exploring the Potential for Biomass Power in Ontario
BIOCAP Canada Foundation ([www.biocap.ca](http://www.biocap.ca)) - Feb. 23, 2006
Canada Land Inventory
Capability Classes for Agriculture
Class 1 & 2 Lands
Canada Land Inventory
Capability Classes for Agriculture
Class 3 Lands
Crop Residue Feedstocks
## Estimates of Accessible Residue Volumes

<table>
<thead>
<tr>
<th>Based on 2008 Harvest Numbers</th>
<th>Corn</th>
<th>Soybean</th>
<th>Wheat</th>
<th>Forages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residue Yield (0% mt/ac)</td>
<td>3.10</td>
<td>1.01</td>
<td>1.86</td>
<td>1.98</td>
</tr>
<tr>
<td>Total Residue (million mt)</td>
<td>5.37</td>
<td>2.12</td>
<td>2.24</td>
<td>5.16</td>
</tr>
<tr>
<td>Practically Available (%)</td>
<td>50</td>
<td>40</td>
<td>66</td>
<td>5-10</td>
</tr>
<tr>
<td>Sustainably Available (mt)</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

Stewart & McDonald, 2008

Estimates of residue volumes that can be practically removed

How much can be sustainably removed from the landscape?
Wheat all goes through combine and straw left in convenient windrow for pickup by baler.
Practical Implications of Residue Removal

Lots of residue left in field but harvest requires windrowing, baling, etc
Further Logistical Issues – Harvest Timelines

Best opportunity for residue harvest because of long period of good weather

Wheat Growing Season
Soybean Growing Season
Corn Growing Season

Wh. Harvest
Soy Harv.
Corn Harvest


Need to plant winter wheat
Racing against snow!
Residue Volume Obstacles

Competing Uses of Crop Residues!

- Livestock bedding
- Livestock feed
- Livestock pasture
- Mushroom production
- Ginseng, strawberry, other vegetables
- Building Materials
- Food vs. fuel debate
Future Competing Uses of Crop Residues!

- Cellulosic ethanol
- Industrial Uses (Biomaterials, Biochemicals, etc)
- Space and hot water heating
- Electrical generation
- Others?
Landscape Obstacles

**Sustainably Issues**

- Soil Organic Matter Levels
- Soil Erosion Protection
- Cost and Depletion of Nutrients
- Long term productivity
# Fertilizer, Harvest and Storage Costs

<table>
<thead>
<tr>
<th></th>
<th>Fert. Replacement Values (NPK)</th>
<th>22.00 – 37.00/t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvest</td>
<td>Cut/Windrow</td>
<td>$15/ac</td>
</tr>
<tr>
<td></td>
<td>Bale</td>
<td>$8.00/bale</td>
</tr>
<tr>
<td></td>
<td>Move</td>
<td>$2.00/bale</td>
</tr>
<tr>
<td>Wheat/Soybean</td>
<td></td>
<td>$27.55/t</td>
</tr>
<tr>
<td>Corn</td>
<td></td>
<td>$32.38/t</td>
</tr>
<tr>
<td>Storage</td>
<td></td>
<td>$4.00/t</td>
</tr>
<tr>
<td>Total Costs</td>
<td></td>
<td>= $ 53.55 – 73.38/t</td>
</tr>
</tbody>
</table>
Biomass Crop Feedstocks

- Energy Content of Crop per Hectare less Fossil-Fuel Energy Consumption
- Fossil Energy Consumption per Hectare Production
<table>
<thead>
<tr>
<th>Substrate</th>
<th>Yield (t/ha)</th>
<th>Methane Yield (m3/ha)</th>
<th>Pass Car Transport (1000 km/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereal Straw</td>
<td>2</td>
<td>600</td>
<td>7</td>
</tr>
<tr>
<td>timothy-clover forage</td>
<td>8-11</td>
<td>2900 – 4000</td>
<td>36 – 50</td>
</tr>
<tr>
<td>clover alone</td>
<td>5-7</td>
<td>1400 – 1900</td>
<td>17 – 24</td>
</tr>
<tr>
<td>Jeruselum artichoke</td>
<td>9-16</td>
<td>3100 – 5400</td>
<td>38 – 68</td>
</tr>
<tr>
<td>giant knotweed</td>
<td>15</td>
<td>3800</td>
<td>47</td>
</tr>
<tr>
<td>nettle</td>
<td>6-10</td>
<td>2200 – 3600</td>
<td>27 – 45</td>
</tr>
<tr>
<td>Rhubarb</td>
<td>2-4</td>
<td>800 - 1700</td>
<td>11 - 21</td>
</tr>
<tr>
<td>Switchgrass</td>
<td>8-12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscanthesus</td>
<td>30- 40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain Corn</td>
<td>8-10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silage Corn</td>
<td>16- 20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Perennial Grass Research Efforts

- Establishment
- Winter hardiness
- Weed control
- Variety differences
- Nutrient Requirements
- Harvest systems (equipment and timing)
- Feedstock quality (H$_2$O, minerals, etc)
- Landscape effects
OSCIA-OMAFRA Field Research of N Rates on Established Switchgrass

Application

N Response

Low N

High N
Late Sept 2009, 3rd year Switchgrass Growth, Quinte Region
## Field Trial Results – N on Established SG

<table>
<thead>
<tr>
<th>Nitrogen Rate (kg /ha)</th>
<th>Average Moisture %</th>
<th>Average Yield (mt/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>19.96</td>
<td>4.07a</td>
</tr>
<tr>
<td>50</td>
<td>17.51</td>
<td>4.73a</td>
</tr>
<tr>
<td>100</td>
<td>19.77</td>
<td>4.43a</td>
</tr>
<tr>
<td>150</td>
<td>17.09</td>
<td>4.18a</td>
</tr>
<tr>
<td>200</td>
<td>20.14</td>
<td>4.06a</td>
</tr>
</tbody>
</table>

OSCIA-OMAFRA, 2009, Quinte Partner Grant
Storage of fall cut, spring harvested switchgrass in Ag Bags
## Switchgrass COP

### Annual Costs

<table>
<thead>
<tr>
<th>Description</th>
<th>$ Per Acre</th>
<th>$ Per Tonne (3.1 tonne/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>establishment costs (amortized over 10 years @ 5%) (9)</td>
<td>50.46</td>
<td>16.28</td>
</tr>
<tr>
<td>N fertilizer (60 lbs/ac actual N @ 50¢/lb) (10)</td>
<td>30.00</td>
<td>9.68</td>
</tr>
<tr>
<td>P &amp; K removal rate fertility costs (@$3.80 / tonne) (12)</td>
<td>11.78</td>
<td>3.80</td>
</tr>
<tr>
<td>fertilizer spreading (3)</td>
<td>7.00</td>
<td>2.26</td>
</tr>
<tr>
<td>swathing (3)</td>
<td>17.00</td>
<td>5.48</td>
</tr>
<tr>
<td>baling ($8/bale) (3)</td>
<td>59.83</td>
<td>19.30</td>
</tr>
<tr>
<td>field removal &amp; storage ($6.60/ tonne) (13)</td>
<td>20.46</td>
<td>6.60</td>
</tr>
<tr>
<td>hauling (from storage to plant) (14)</td>
<td>30.00</td>
<td>9.68</td>
</tr>
<tr>
<td>land costs (8) (assumed rental rate)</td>
<td>226.53</td>
<td>73.07</td>
</tr>
</tbody>
</table>

**Total Annual Costs**: 226.53  73.07

OMAFRA, 2009

http://www.omafra.gov.on.ca/english/busdev/bear2000/Budgets/Crops/Forages/switchgrass_static.htm
OMAFRA specialists are searching out answers to:

What are the best energy biomass crops & production systems
- Feedstock options?
- Production Systems?
- Money/Value/Cost?
- Logistics?

- What conversion technology options will work for Ontario?
- Maintenance of Sustainable Agricultural Landscapes?
- Biomass Supply and Location?
- Is an Ontario biomass industry which uses agricultural feedstock's economically viable?
- And more…
The End!

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