Agriculture & Agri-Food Canada’s Bioeconomy Research Initiatives

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### Bioproducts in STB Strategy Matrix – 9 X 4

<table>
<thead>
<tr>
<th>STRATEGIC OBJECTIVES</th>
<th>Cereals &amp; Pulses</th>
<th>Oilseeds</th>
<th>Horticulture</th>
<th>Forages &amp; Beef</th>
<th>Dairy, Pork, Poultry and Other Livestock</th>
<th>Agri-Food</th>
<th>Bioproducts</th>
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</thead>
<tbody>
<tr>
<td>Increase agricultural productivity</td>
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<td>Enhance environmental performance</td>
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<td>Improve attributes for food and non-food uses</td>
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<td>Address threats to the value chain</td>
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<td>Biodiversity and Bioresources</td>
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<td>Agro-Ecosystem Productivity and Health</td>
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</table>
AAFC’s Scientists Deliver on Nine Sectoral Science Strategies

Number of Scientists* by Strategy

- Biodiversity and Bioresources
- Agro-Ecosystem Productivity...
- Bioproducts
- Dairy, Pork and Other Livestock
- Agri-Food
- Forages and Beef
- Horticulture
- Oilseeds
- Cereals and Pulses

*Based on 385 scientists
Bioproducts Strategy Objectives and Projects

1. Increase biomass yields and improve feedstock productivity, quality & availability
   - Perennial forages (alfalfa, switchgrass and reed canary)
   - Oilseeds, flax, carinata and camelina, cereals, corn

2. Improve sustainability of feedstock production and develop quantitative measures to support the development of sustainability metrics
   - Agroforestry
   - Corn stover

3. Identify components and properties in existing crops and livestock for value added industrial applications, and develop new purpose grown biomass crops
   - Plant-made industrial, pharmaceutical and vaccine products
   - Biopesticides
   - Total plant utilization and co-products
   - Biodigestion

4. Mitigate emerging biotic and abiotic threats to bioproducts feedstock
World ethanol and biodiesel projections, 2005-2018

Source: FAO-OECD Outlook (2009)
Biomass Supply to Bio-products

Several Initiatives partially funded through the AAFC Agri-Innovation Program

• Regional Assessment of Supply
• Field Trials (Demonstration and Research)
• Laboratory Analysis (Stover)
• Economic assessment
• Sector Readiness
• Sustainability
### Project: Bioproduct Value Chain Analysis (M. Wellisch)

- **Define Status and Identify Gaps**

#### Agricultural Biomass suitable for bioproducts

<table>
<thead>
<tr>
<th>Type</th>
<th>Examples</th>
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<tbody>
<tr>
<td>New Crops (annual)</td>
<td>Carinata, Camelina</td>
</tr>
<tr>
<td>Crop Residues</td>
<td>Corn stover, Flax straw, Hemp stalks</td>
</tr>
<tr>
<td>Perennials</td>
<td>Switchgrass, Miscanthus, Jerusalem artichoke</td>
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<tr>
<td>Wastes (livestock)</td>
<td>Manure</td>
</tr>
<tr>
<td>Wastes (processing)</td>
<td>Screenings, off-spec</td>
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</table>

#### Value Chain

- Stover Production
- Conversion
- Product Use
  - C6
  - C5
  - Lignin
Corn (Canada)

Breeding

Agronomy

Corn Production

Silage Production

with Manure returned to field

Cobs + Stover Chopped/Soil

Partial Stover Removal

Cobs + Stover

Grain

Finely ground grain

Food Manufacturing (corn grits, hominy, corn meal, corn flour)

Wholesaler

Retailer

Ethanol Production

Food Manufacturing

Many applications

Stover to Sugar Production

C6 Chemical Production

C5, Lignin

Animal Feed

Starch

Protein

Corn Oil

Fibre

Industrial Manufacturing

Many applications

Animal Feed

cracked grain

Agronomy

Inputs (energy, fuel, chemicals, recycled materials, etc.)

Corn Milling (fractionation: bran, gluten, starch, and germ)

Stored Transported Cleaned

Stover to Sugar Production

Animal Feed

Many applications

Food Manufacturing

Many applications
Economic Assessment of Stover Harvesting & Removal

- 250,000 t per year bio-refinery model
- Cellulosic material converted to sugars for green chemistry products
- Value of corn stover based on cellulose, hemi cellulose and lignin
  - C6 sugar
  - C5 sugar and lignin as co-products
- Value of a tonne of stover $80/t
Corn Stover Harvest & Baling Demonstrations at the Outdoor Farm Show
Corn Stover Research Trials
Surface Residue – Mid Season
Stover Removal Project Research Design

**Objectives:**

To determine the optimal rate of corn stover removal that would be sustainable.

**Treatments:**

- Corn stover residue removal rates:
  - 0, 25, 50, 75 and 100% removal
- Conventional tillage and no-tillage

**Soils:**

- Brookston clay loam
- Fox sandy loam
Corn Emergence
Harrow sandy loam 2015

Conventional Tillage
No-Tillage

Days after planting
Corn Emergence (%)
Corn Grain Yields – 2015

Harrow sandy loam

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- Conventional Tillage
- No-Tillage

Brookston clay loam

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- Conventional Tillage
- No-Tillage
Highlights/Successes

- Preliminary results indicate that corn grain yields and corn stover biomass can increase with corn stover removal. This is due in part to the improved soil conditions in the spring especially for no-tillage treatments.
Highlights/Successes

- Soil microbial processes were impacted by stover removal and conservation tillage as demonstrated by the:
  
  - Stover removal was associated with a reduction in CO$_2$ emissions with conventional tillage whereas there was no effect with no-tillage
  
  - Stover removal increased POM at:
    - 0 to 50% removal rates for conventional tillage
    - 0 and 25% removal rates for no-tillage
Acknowledgements

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