Ontario's Agricultural Bioeconomy: Research and Innovation, and Biomass Crops

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Ontario Ministry of Agriculture, Food and Rural Affairs
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Ontario's Agricultural Bioeconomy: Research and Innovation

Outline of Rajib's presentation:

- Why **agricultural bioeconomy** in Ontario?
- Current status, progress and challenges
- What have we learned from **OMAFRA** research programs?





Agricultural Bioeconomy in Ontario - Why?



39% of population and GDP of Canada
>Half of class 1 soil

Agricultural biomass, soil rehabilitation, Biotechnologies: biopesticides, biofertilizers, biopharma, biosensor, animal feed additives.

Packaging, biosensors, nutraceuticals, food additives, Food waste

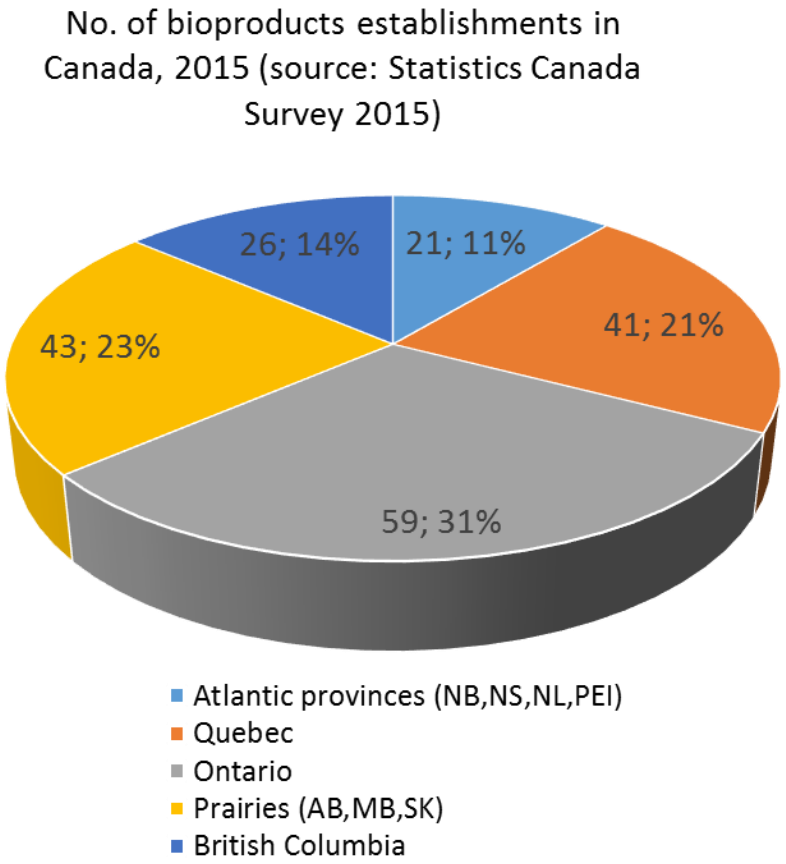


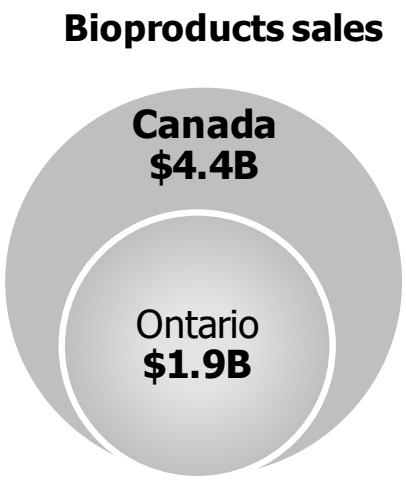
Biomass Bioenergy & Biofuel Biomaterial Biochemical & biotech products

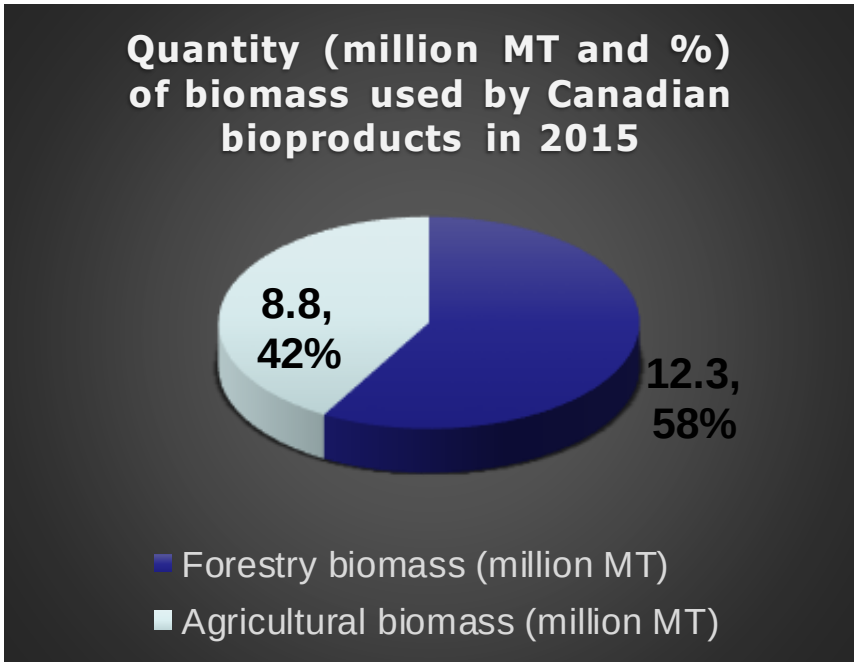
Plant pots and accessories, greenhouse biomass, wastewater treatment

Sources: Ontario Fact sheet June 2018; http://www.omafra.gov.on.ca/; , *2015 Statics Canada bioproducts Survey; http://www.omafra.gov.on.ca

Canadian Bioproduct Industry (Ag & Forestry) Survey

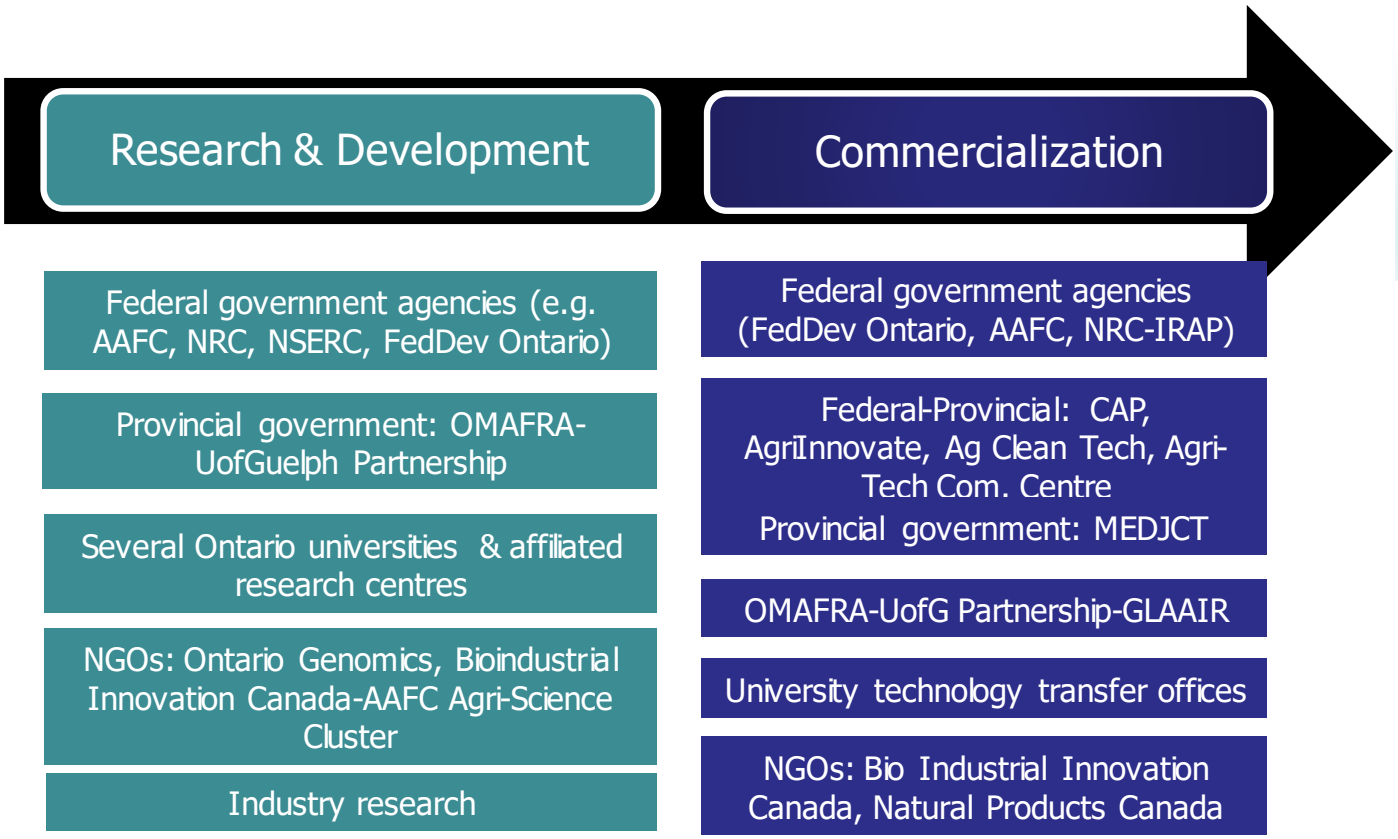






(Source: Statistics Canada, Bioproducts Production and Development Survey 2015)

Bioproducts Research & Innovation Partners & Programs in Ontario: Examples



Vital for Bioproducts Sector's success

AAFC: Agriculture and Agri-Food Canada; NRC: National Research Council Canada; IRAP: Industrial Research Assistance Program; CAP: Canadian Agricultural Partnership; MEDJCT: Ontario Ministry of Economic Development, Job Creation and Trade; NGOs: non-governmental Organizations; GLAAIR: Gryphon's Leading to Accelerated Adoption of Innovative Research

Advancing Agri-food Sector's Innovation and Competitiveness in Ontario

OMAFRA-UofGuelph Agreement Renewed in 2018 with provincial funding up to $713M for 10 years

Canadian Agricultural Partnership renewed in 2018; $1.5B for 5 years

Ontario Food Exports

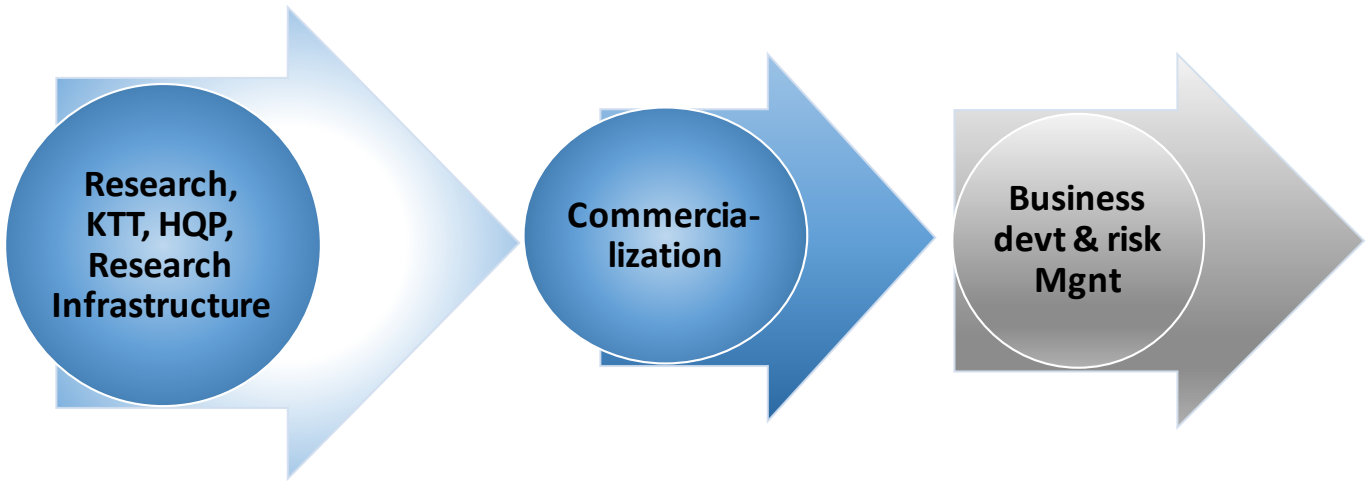


Competitive agri-food & agri-products sectors





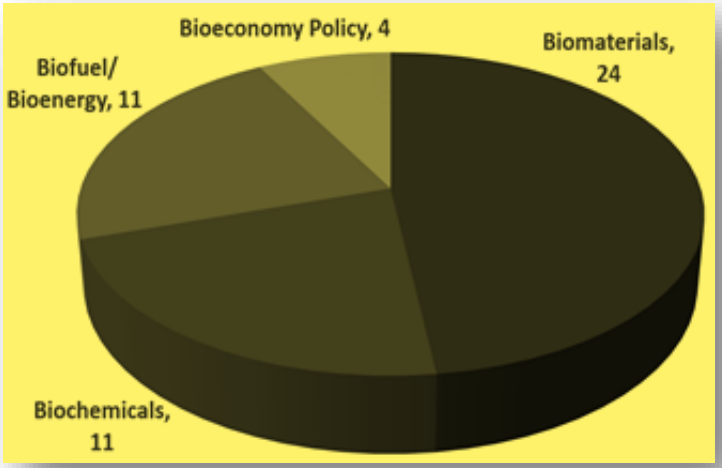




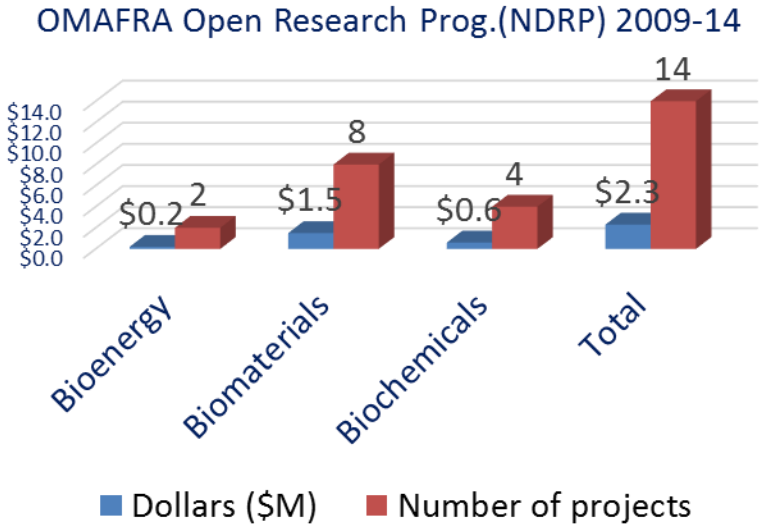
Sources: http://www.omafra.gov.on.ca/english/cap/index.htm; https://news.uoguelph.ca/2018/02/omafra-u-of-g-agreement/

OMAFRA Support to Agricultural Bioeconomy : Past 10 Years

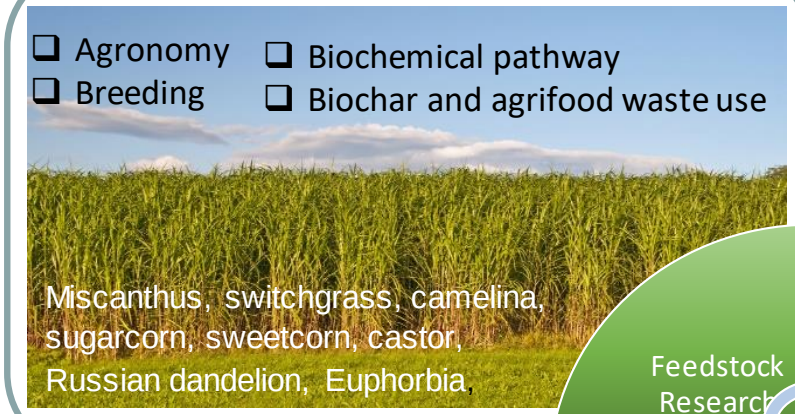
OMAFRA-U of Guelph Agreement Research Program *: 50 research projects, $7.3M OMAFRA fund, Collaboration and Partnerships*



OMAFRA Open (New Directions) Research Program *: 14 research projects, $2.2 M OMAFRA fund, Collaboration and Partnerships*



Examples of OMAFRA–Funded Bioproducts R&D Projects: Outcomes



- Agronomy
- Breeding
- Biochemical pathway
- Biochar and agrifood waste use

Feedstock Research

Processing Tech. Research

- Thermal conversion of biomass
- Yeast Fermentation
- Anaerobic Digestion
- Nanocomposite production
- Chemical modification (starch nanoparticles, biocomposite, catalysis)
- Extrusion melt processing and injection/compression molding
- Genetic modification
- Novel method for bio-based PU rigid foam

Bioeconomy Policy Research

- Biomass availability
- Value chain database
- Business models
- Life cycle analysis
- Biomaterials sector competitiveness

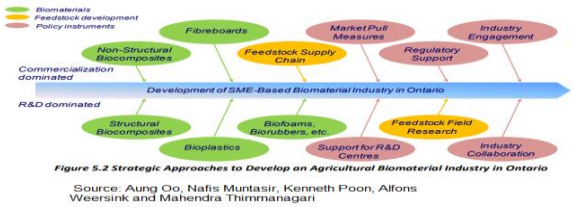


Figure 5.2 Strategic Approaches to Develop an Agricultural Biomaterial Industry in Ontario

Source: Aung Oo, Nafis Muntasir, Kenneth Poon, Alfons Weersink and Mahendra Thimmanagari

Bioproducts Devt Research

- Biomaterials for automotive & food packaging
- Bioblack R (CGT)- biocarbon
- Compostable SS coffee pods
- Biocomposite clips for greenhouse industry
- Starch branching enzymes for Industrial processing
- Bioadhesives and natural binders for landscaping industry
- Biogas
- Metagenomics
- Starch nanoparticles for cosmetics (Mirexus)
- Tobacco antibody (PlantForm) for human medicine

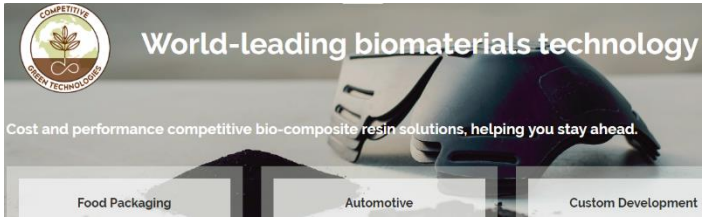
General Observations from OMAFRA-funded Bioeconomy Research

- Agri-bioproducts science capacity for innovation and manpower training
- Multi-disciplinary research and innovation culture
- Purposeful and strategic partnerships are key
- Bioproducts innovation and discoveries are heading to market
- Time from research to commercialization may vary
- Infrastructure, regulatory, sustained R&D with policy support are critical
- Multiple benefits/co-benefits of bioproducts/process needs to be measured/demonstrated
- Bioeconomy concept is dynamic and evolving; ready for new tools and concepts
- Integration of multiple processing technologies for biorefinery







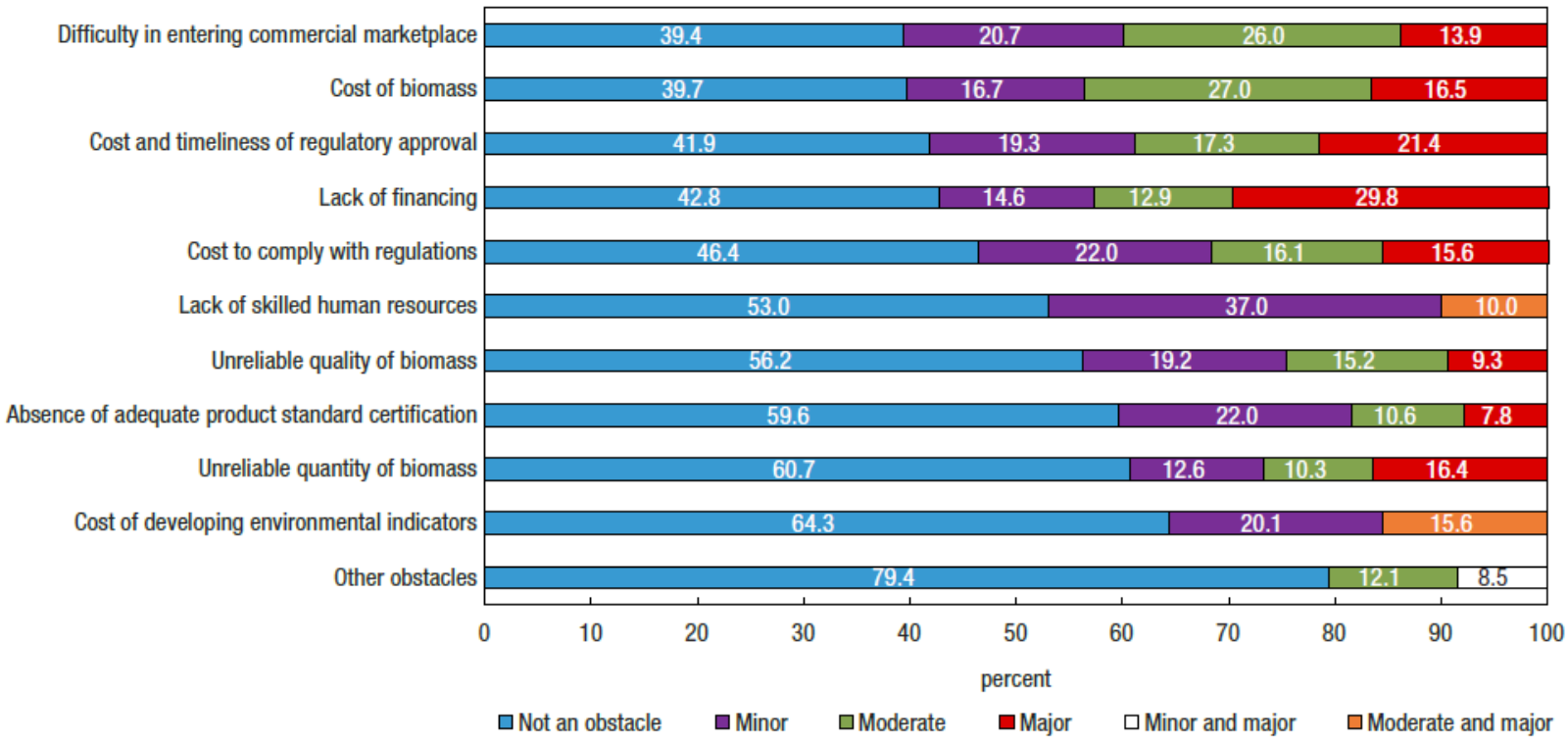




Sources: www. mirexusbiotech.com/; www.plantformcorp.com/; www.competitivegreentechnologies.com; www. prolongmug.com/; www.purpod100.com/

Challenges

Obstacles faced by bioproduct establishments, 2015



Source: Statistics Canada, 2015 Bioproducts Production and Development Survey, Table A.24.1.

Bioproducts Industry Priorities in Canada:
2017 IBVC Roundtable

"*Canada's strength in natural resources management and applied innovation make it well positioned to transition to a clean growth economy and become a global leader in the rapidly growing bioproducts industry.*"

- Feedstock development.
- Data-driven management practices focused on improving environmental performance.
- Building market awareness through the development of a BioContent Canada Program.
- Providing incentives and rewards for both domestic and international commercial innovation and market adoption.
- Establish regulations and policy to ensure safe, sustainable commercial demand and that supports Canada's bioproducts industry to grow both domestically and internationally.
- Providing enterprise support to accelerate commercial success and economic development.

Source: A paper prepared by the Industry Members of the Industrial Bioproducts Value Chain Roundtable September 2017

Ontario Biomass Crops for Bioeconomy

15th International Symposium on Bioplastics, Biocomposites and Biorefining (ISBBB 2018) || July 24-27,2018 || Guelph

Mahendra Thimmanagari
Bioproducts Specialist
Ontario Ministry of Agriculture, Food and Rural Affairs

Presentation Outline

Highlights from two OMAFRA biomass projects

- Growing the Biomass Marketplace: Agronomy, and Livestock Bedding Knowledge and Application
- Development of Agricultural Biomaterial Industry in Ontario

Background

- Miscanthus and Switchgrass, perennial biomass crops commercially grown in Ontario, can likely be the potential feedstocks for bioeconomy.

- Ontario's agricultural producers will have diverse markets for their feedstocks, and will be able to participate in higher value chains in the biomaterials industry.
- A vibrant biomaterials sector could:
  - ❖ Increase demand for crops in Ontario
  - ❖ Revitalize manufacturing industries
  - ❖ Create rural development opportunities
  - ❖ Reduce the environmental footprint of industry
- Clear market pathways for switchgrass and miscanthus are developing. The projects outcomes would further enhance for farmers and industry knowledge on biomass crops and markets.

Project 1

Growing the Biomass Marketplace: Agronomy, and Livestock Bedding Knowledge and Application

(Knowledge Translation and Transfer- KTT)

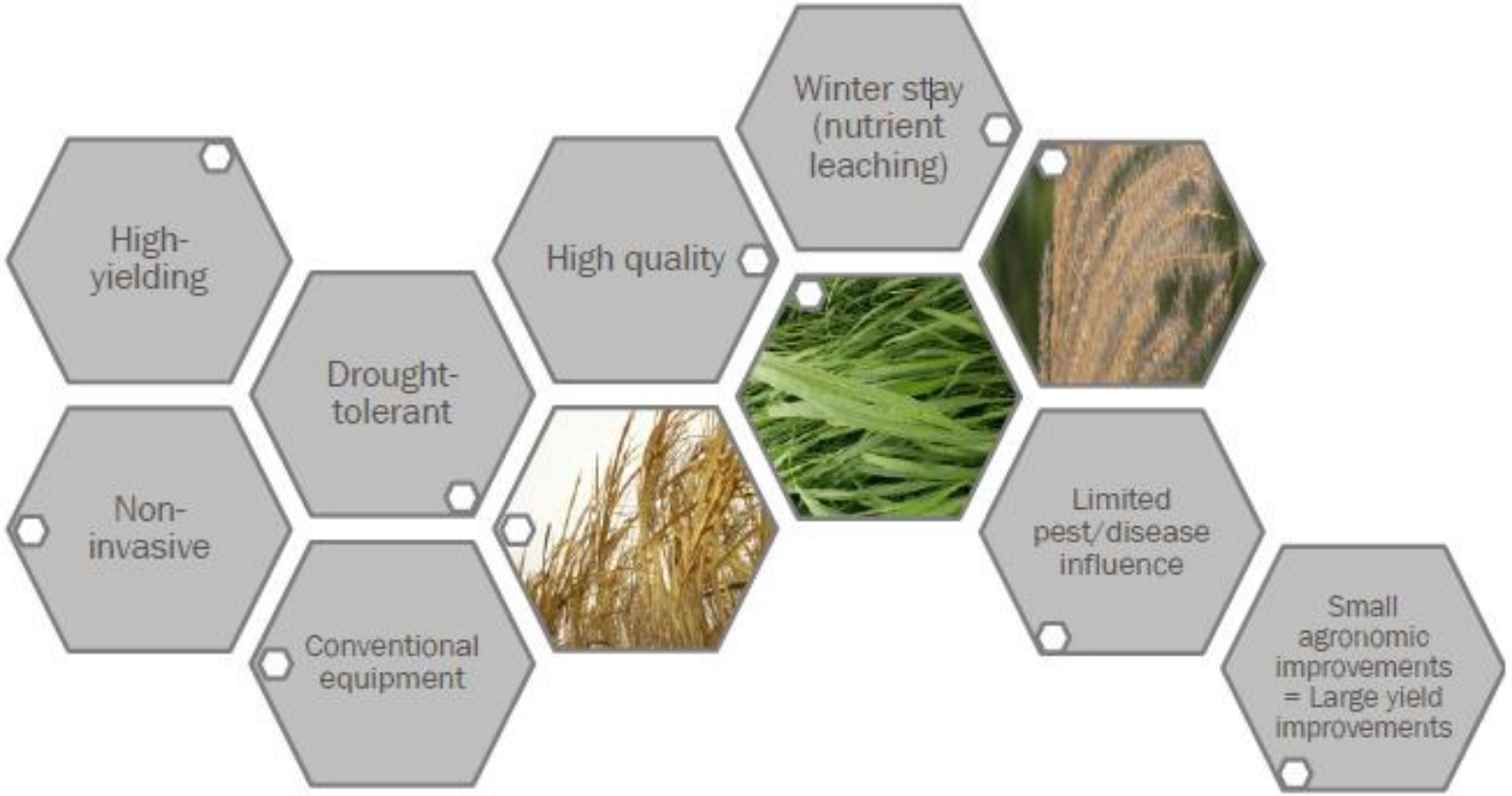
Developing the Biomass Marketplace

Principal Investigator: Dr. Bill Deen, U of Guelph

Background:

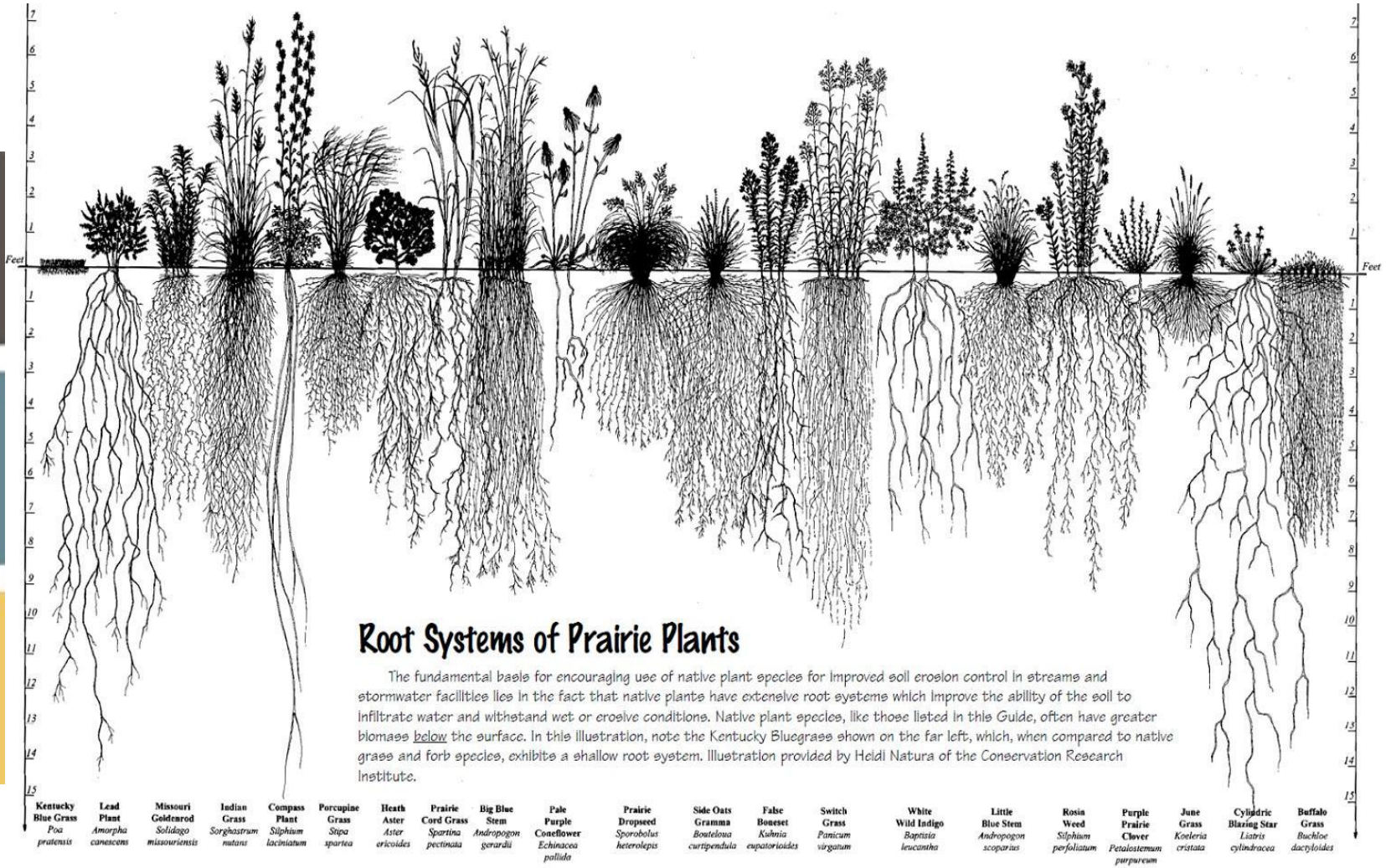
- The project, to synthesize multiple research studies, consultant reports, and on-farm knowledge on biomass crops:
  - into user friendly best management documents, videos for farmers
  - to enable broader uptake of biomass crops, and
  - to develop new high value markets.

Rationale for switchgrass & miscanthus for bioeconomy crops in Ontario



Source: Jake DeBruyn, OMAFRA

Root Systems of Grasses



https://www.oakgov.com/water/Documents/environmental_unit/native_plant_root_system_schematic.pdf

Switchgrass: Why is switchgrass a promising biomass crop?









- North American native perennial warm-season grass
- Inexpensive to establish from seed
- Low nutrient requirements
- Can be grown on both prime and lower quality class 3 and 4 soils
- Ontario farmers are achieving annual dry matter yields of 7-12 t/ha (3 to 5 t/acre)
- Current markets, premium livestock bedding, feed, composting, mulch
  - Bioeconomy, biogas, biocomposites, sugars
- Environmental benefits, carbon in roots, erosion control, bird and pollinator habitat

http://www.ontariobiomass.com/resources/Documents/KTT%20Projects/KTT%20Documents%20and%20Videos/SwitchgrassFinal.pdf

Miscanthus:
Why is miscanthus a promising biomass crop?





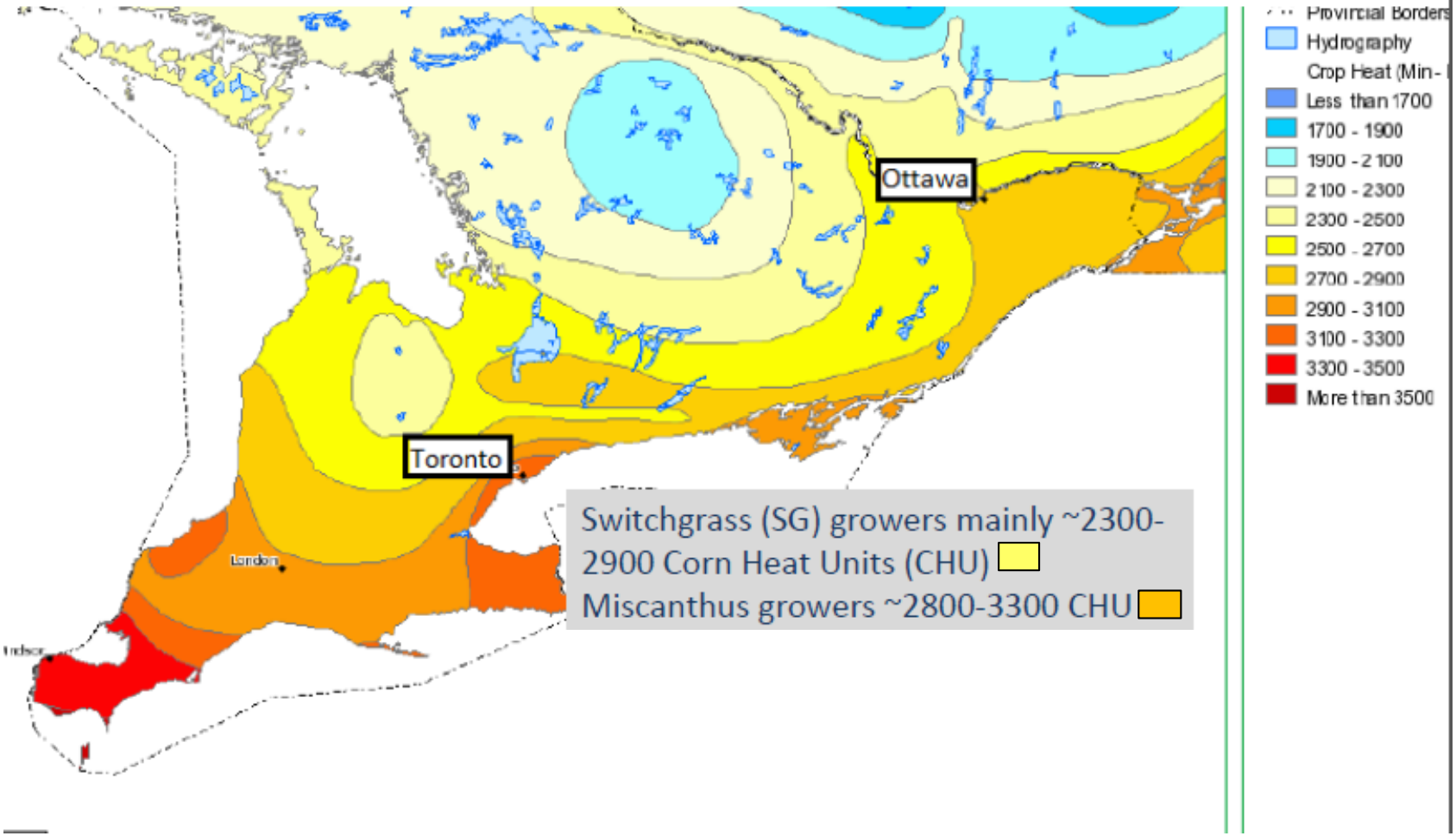




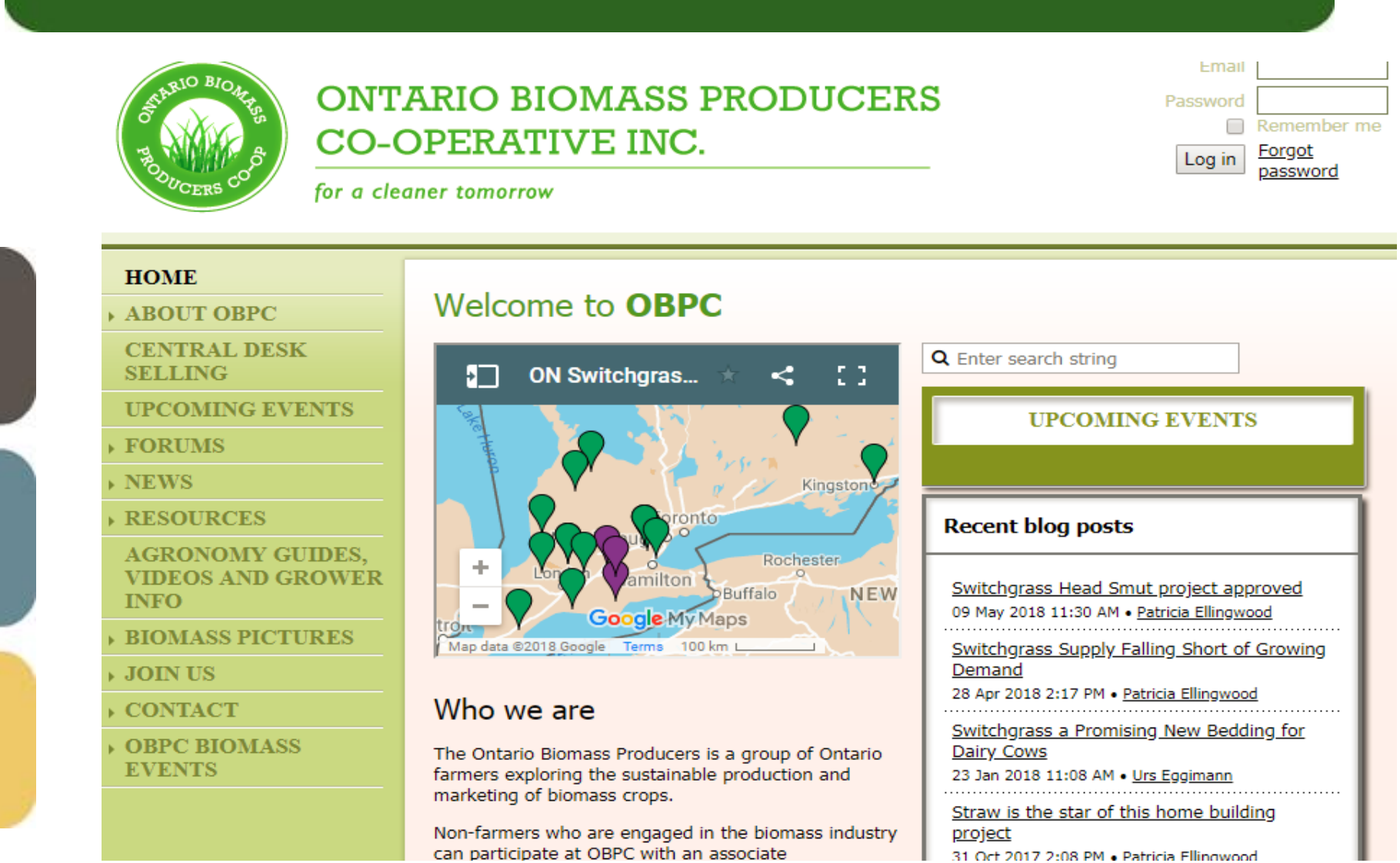
- Tall, warm-season, perennial grass native to Asia
- Established from rhizomes (root material)
- High Yield: Ontario growers have reported spring-harvested, dry biomass yields in the 17–26 t/ha (8–12 t/acre)
- Longevity and perennial (some plots 20yrs old)
- Current markets, premium livestock bedding, feed, composting, mulch
  - bioeconomy- sugars, fibre, lignin, chemicals
- Environmental benefits: large root mass, carbon in roots, erosion control

http://www.ontariobiomass.com/resources/Documents/KTT%20Projects/KTT%20Documents%20and%20Videos/MISCANTHUS%20Agronomy%202016%20FINAL.PDF

Land Base: Miscanthus and Switchgrass Growers tend to separate based on Corn Heat Units in Ontario



Source: Roger Samson, REAP Canada

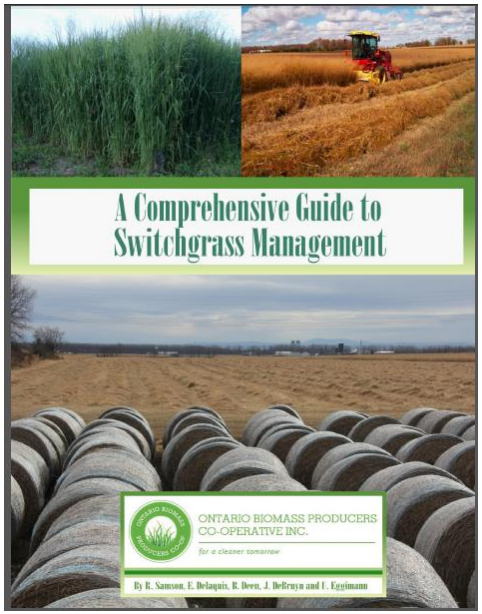


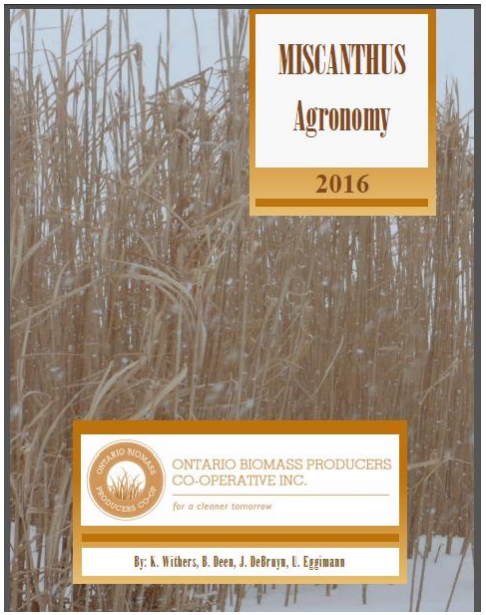
Switchgrass & Miscanthus grown in approximately 2,500 -3,000 acres in Ontario

http://www.ontariobiomass.com/

KTT Project Outcomes

- Switchgrass & miscanthus production guides
- Detailed manual on poultry and livestock bedding from warm season grasses
- Manual on mulch applications of warm season grasses
- 6 videos on switchgrass and miscanthus growing and use: livestock and poultry bedding; feeding to dairy cows; and mulch on ginseng
- All documents and videos at www.ontariobiomass.com





Project 2

Development of the Agricultural Biomaterials Industry in Ontario

Development of the Agricultural Biomaterials Industry in Ontario

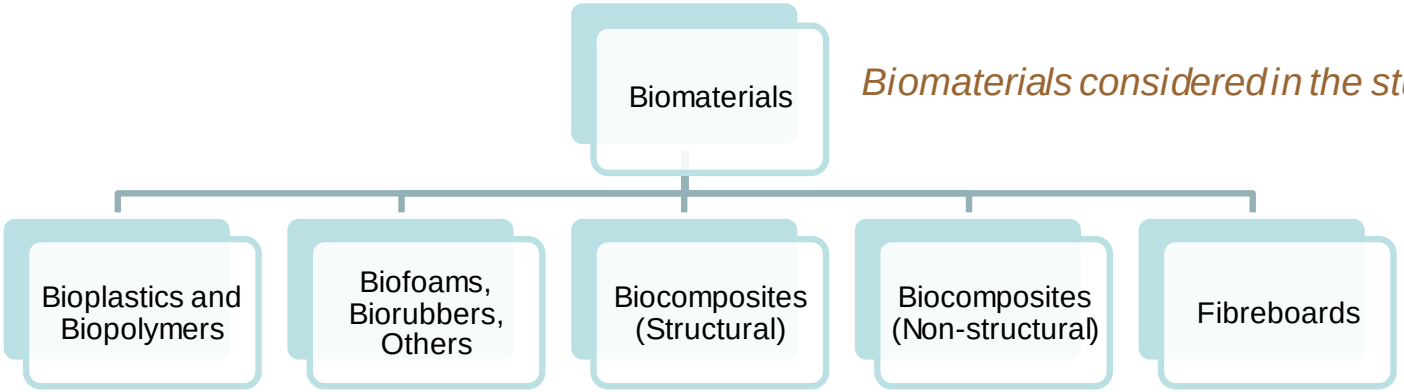
Principal Investigator: Dr. Alfons Weersink, U of Guelph

Purpose:

Identify the agricultural biomaterials with the most promising commercialization potential in Ontario

Scope limited to

- A set of biomaterials
- Biomass sources from Ontario
- Auto, construction and consumer product sectors



Biomaterials considered in the study

Development of an Agricultural Biomaterial Industry in Ontario

Aung Oo[1], Nafis Muntasir[2], Kenneth Poon[2], Alfons Weersink[2], and Mahendra Thimmanagari[3]

April 2016

Department of Food, Agricultural and Resource Economics

Institute for the Advanced Study of Food and Agricultural Policy

University of Guelph

Institute White Paper - 2016.1

[1]Western Sarnia-Lambton Research Park, [2]Dept of Food, Agricultural and Resource Economics, University of Guelph, [3]Ontario Ministry of Agriculture, Food and Rural Affairs

The authors gratefully acknowledge the financial support provided by the Ontario Ministry of Agriculture, Food and Rural Affairs

http://ageconsearch.umn.edu/record/241708/files/Biomaterial%20Industry%20-%20OMAF%20Report%20-%20April%202016.pdf

Bioeconomy

Biomaterial industry growth can be supported by agricultural sector

"Entrepreneurs in Ontario's agricultural sector are the potential manufacturers of biomaterials." – Prof. Alfons Weersink

Ontario's agricultural sector can easily meet the plant fibre needs of the emerging biomaterial industry, researchers have found.

The global biomaterial industry – based on products manufactured from renewable, biologically based resources – is expected to grow by more than 15 per cent in the next few years. This growth is primarily fuelled by consumer demand for greener products.

"Entrepreneurs in Ontario's agricultural sector are the potential manufacturers of biomaterials, and they should be provided with necessary assistance so the industry is able to take root and grow," says Prof. Alfons Weersink of the Department of Food, Agricultural and Resource Economics (FARE).

"Ontario has sufficient biomass along with the other resources necessary to supply the most optimistic projected needs of a future biomaterials sector."

Led by Weersink, a research team has been looking at policies and strategies to hasten the development of an agriculture-based biomaterial industry in Ontario.

Miscanthus and switchgrass – perennial grass crops already grown in Ontario on commercial scales – have been identified as the primary biomass raw materials for the emerging biomaterials industry.

Knowing Ontario can produce enough biomass resources, the next step toward developing a functioning local biomaterials economy includes establishing agricultural biomaterial manufacturing firms to supply local markets.



Collaborators for this research include Aung Oo, Sarnia Lambton Research Park; Mahendra Thimmanagari, OMAFRA; and Ken Poon and Nafis Muntasir, FARE.

Funding for this project is provided by the OMAFRA–U of G Partnership.

https://www.uoguelph.ca/research/sites/default/files/public/UofG_Research_Yearbook_Web.pdf

Development Potential of Biomaterial Sector for Ontario

Biomaterials	Technology Development Status	Market Development Status	Competitive Edge of Manufacturing in Ontario	Total Score
Bioplastics & Biopolymers	3	2	1	6
Biofoams & Biorubbers	3	2	2	7
Biocomposites (Structural)	2	1	1	4
Biocomposites (Non-Structural)	4	2	3	9
Fibreboards	4	2	3	9

1-least favourable, 5-most favourable

Factors Affecting Commercialization of Biomaterials

1. Feedstock Compatibility
2. Technology Maturity
3. Profitability
4. Economic Development Potential
5. Substitute Availability
6. Niche Market Potential
7. Regulatory & Institutional Support
8. Existing Value Chain/ Infrastructure

Summary

- Switchgrass and miscanthus hold significant economic and environmental promise for Ontario.
- Approximately 3 million tonnes of purpose-grown biomass (Miscanthus and switchgrass) can be sustainably produced from 0.5 million acres, less than 6% of total cropland in Ontario.
- Miscanthus and switchgrass – perennial grass crops already grown in Ontario on commercial scales has potential as the primary biomass raw materials for the emerging biomaterials industry.
- Non-structural biocomposites and fibreboards are biomaterials for near term commercial establishment in Ontario.
- Construction/building is the most promising target sector due to its market size followed by transportation/automotive sector and household/consumer sector.



Thank You

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