



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada



Breaking Agricultural Barriers: The ABIP Canadian Cellulosic Biofuels Network

A multi-disciplinary and multi-institutional
research effort across Canada.

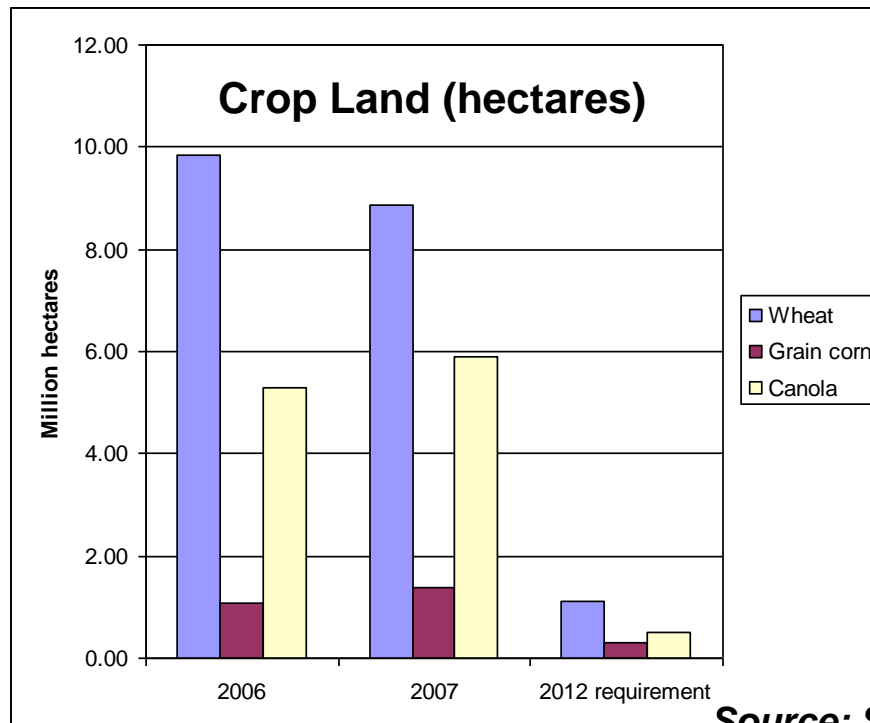
by Gruber MY, Laberge S, Tsang A, and Bellavance F
Soils & Crops Research & Development Centre, AAFC, Quebec City,
Saskatoon Research Centre, AAFC, Saskatoon,
Centre Structural & Functional Genomics, Concordia University, Montreal

Canada

Canadian Renewable Fuels Strategy.....

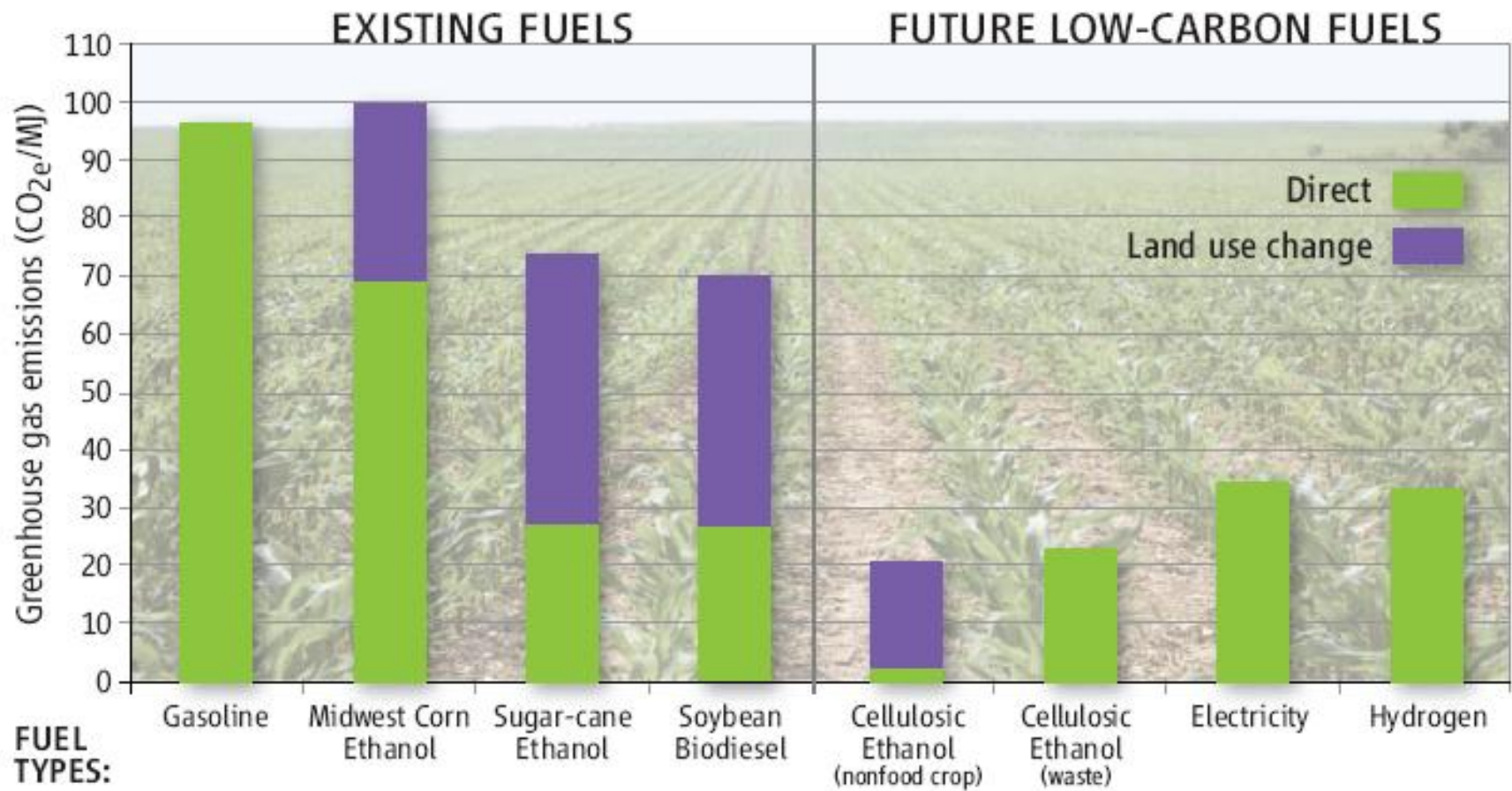
Impact on land and production

- approximately 17M hectares in crops at present
- CRFS will require 5% additional land into crops by 2012.
- extension beyond 2012 requires Next Generation technologies, such as cellulose-derived biofuels.



Source: Statistics Canada

Low Greenhouse Gas Emission from Cellulosic Biofuel...



Cellulosic Biofuel Network (Agricultural Bioproducts Innovation Fund)

10 GOVERNMENT INSTITUTIONS:

AAFC: SCRDC (Quebec, PQ), ECORC (Ottawa, ON), SCPFRC (London, ON), SRC (Saskatoon, SK), SPARC (Swift Current, SK), LRC (Lethbridge, AB), PARC (Agassiz and Summerland, BC), PFRA (Saskatoon, SK)
NRC: IBS (Ottawa, ON), **PBI (Saskatoon, SK)**.
Sask Ministry of Agriculture (Regina, SK)

13 UNIVERSITIES:

Nova Scotia: Agriculture College (AAFC @ Truro)
Quebec: Concordia, Montreal
Ontario: Ryerson, Toronto, UOIT, Ottawa, **Waterloo**
Manitoba: Manitoba
Saskatchewan: Saskatchewan, Regina
Alberta: Alberta
British Columbia: UBC

3 Not-for-profit OTHER INSTITUTIONS:

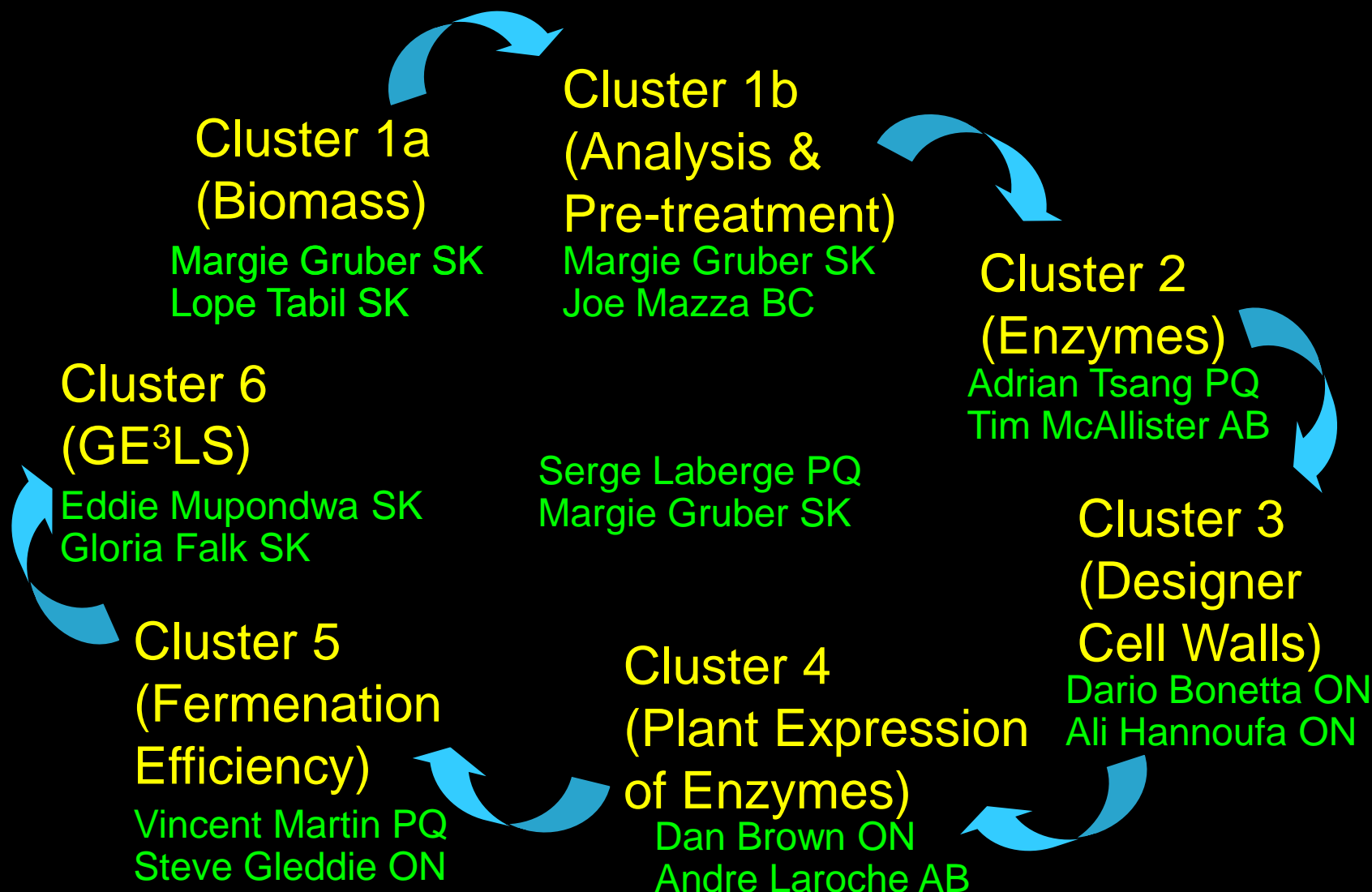
FPIInnovations (Quebec and Vancouver), **PAMI, SRC**

BUDGET: \$19.8M over 2.5 years, funded by AAFC ABIP - Applying for national environment funds, genome funds, provincial & international funds, industrial partners)

R&D POWER:

>50 scientists plus associated staff (Visiting Fellows, Bioinformaticians, PhD students, technicians, summer students)

Organized along the barriers to cellulosic biofuel.....



Cluster 1a.....Plant evaluation, genomics & germplasm development, biomass enhancement, nutrient recycling

Margie Gruber / Bruce Coulman

AAFC Lethbridge
Surya Acharya

U. Saskatchewan
Bruce Coulman

AAFC Agazzi
Shaptai Bitman

AAFC Saskatoon
Margie Gruber
Kevin Falk
Isobel Parkin
Matt Links
Stu Brandt

U. Alberta
David Wishart

AAFC/NSAC – Nova Scotia
Yousef Papadopoulos

AAFC Quebec
Yves Castonguay
Real Michaud

PBI Saskatoon
Andy Sharpe

AAFC Swift Current
Mark Stumborg
Harold Stepphun

U. Waterloo
Trevor Charles
Bernie Glick

Cluster 1a: Evaluating Major Annual Crop Residues

Canola
Residues



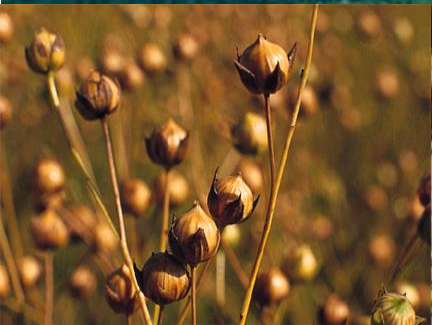
Corn stover



Wheat, barley,
oat straws



Flax and field pea residues



Cluster 1a: Evaluating/Enhancing low-input Biofuel Crops for sustainable growth – genomics, modification, nutrient recycling



Issues and Opportunities under consideration.....

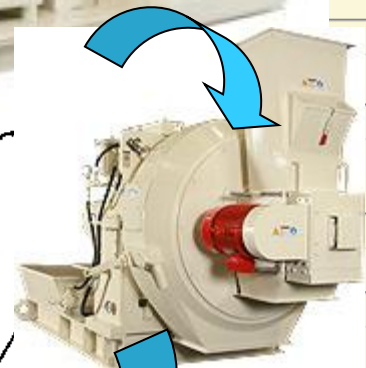
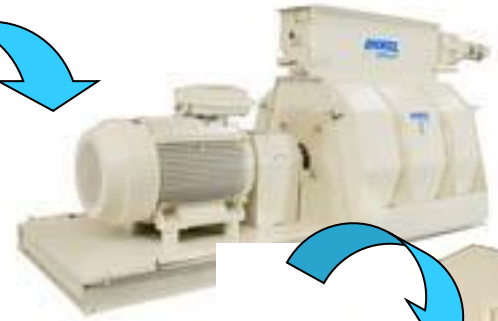
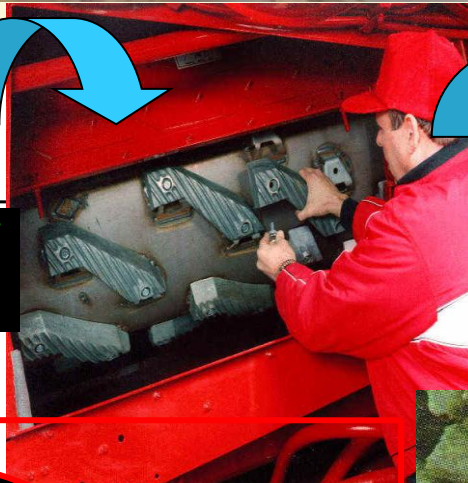
- Invasive Species and GMOs growing on deficient lands
- Nutrient Recycling, PGPRs
- Deficient lands (saline, acidic, water-saturated, unfertile, contaminated)
- Roadside land diversity and breadth (eg. 250,000 km in Saskatchewan)
- Engaging Aboriginal Nations



Cluster 1a: Biomass Mapping and Availability, Harvesting Methods and Equipment, Densification, Transport



Margie Gruber /
Lope Tabil



U. Saskatchewan
Lope Tabil
Vankatesh Meda
Satya Panigrahi

AAFC & PFRA
Swift Current
Mark Stumborg
Laurence Townley-Smith

Prairie
Agricultural
Machine
Institute



Cluster 1b: Physico-chemical Pre-treatment & Characterization

....cost reduction and suitability for biomass and environment....

Margie Gruber / Joe Mazza

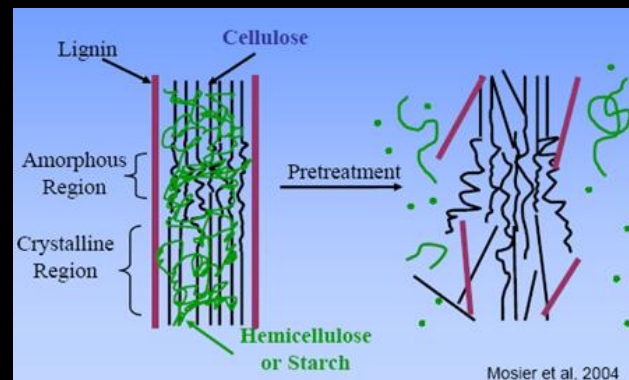
Chemical Characterization

Margie Gruber AAFC Saskatoon
Rong Zhou AAFC Saskatoon
Joe Mazza AAFC Summerland
Jack Saddler U. British Columbia
Annik Bertrand AAFC Quebec

Ammonia Fibre
Explosion, Mild acid
Ryerson U.
Ginette Turcotte

Microwaves
Synchrotron
U. Saskatchewan
Lope Tabil
Venkatesh Meda

PLPW, Ionic Liquids
Joe Mazza – AAFC
Summerland



Steam Explosion
Mild Solvents
UBC, FPInnovations
Jack Saddler
James Deng
Tony Zhang

Cluster 1b: Biomass Characterization

- **Total solids**
- **Molecular weight of celluloses, hemicelluloses and lignins by size exclusion chromatography**
- **Ion-moderated partition chromatography**
- **Thermal characterization**
- **Fourier transform infrared spectroscopy**
- **Scanning and transmission electron microscope**
- **Functional groups & monolignol analysis of lignin**
- **Physical properties of biomass samples**
- **Uronic acids, sugars, proteins, ash**
- **Degradation products and value-added extractives**

Cluster 2: Enzyme Hydrolysis – Cost reduction & suitability...

Adrian Tsang / Tim McAllister

AAFC-Lethbridge

Tim McAllister

Robert Forster

Ron Teether

Enzyme Prospecting

Anaerobic
microbes

U. Concordia

Adrian Tsang

Gregory Butler

Justin Powlowski

Aerobic fungi
bioinformatics

AAFC-Saskatoon

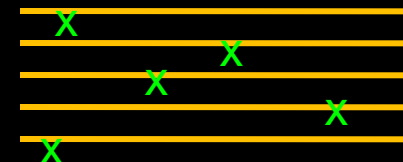
Tim Dumonceaux

Enzymatic
feedstock
pretreatment

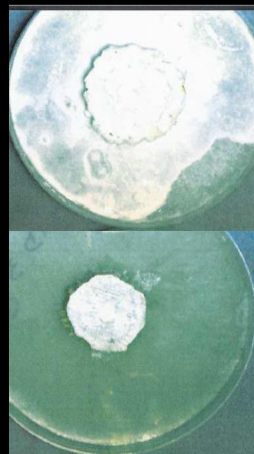
NRC-Ottawa

Wing Sung

Enzyme engineering



Library of
variants and /or
chimeras



Cluster 3: Cell Wall Biosynthesis and Modification

...designer biomass for easy degradation...

Adrian Tsang / Tim McAllister

AAFC-London
AAFC-Lethbridge
Andre Laroche
Ali Hannoufa
Serge Laberge

Lignin modification
- cereals and canola

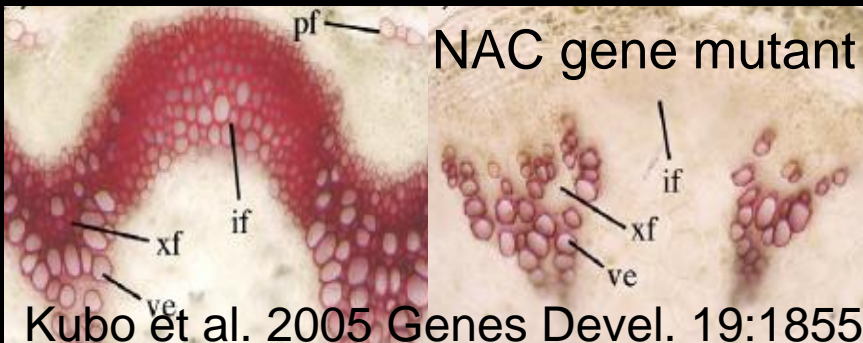
U. Ontario Inst.
Technology
Dario Bonetto

Cellulose mutants
in Arabidopsis

U. Toronto
Peter McCourt
David Guttman
Nic Provart

Cell wall transcriptomics in biofuel
species under nutrient stress

U. Alberta
Mike Deyholos

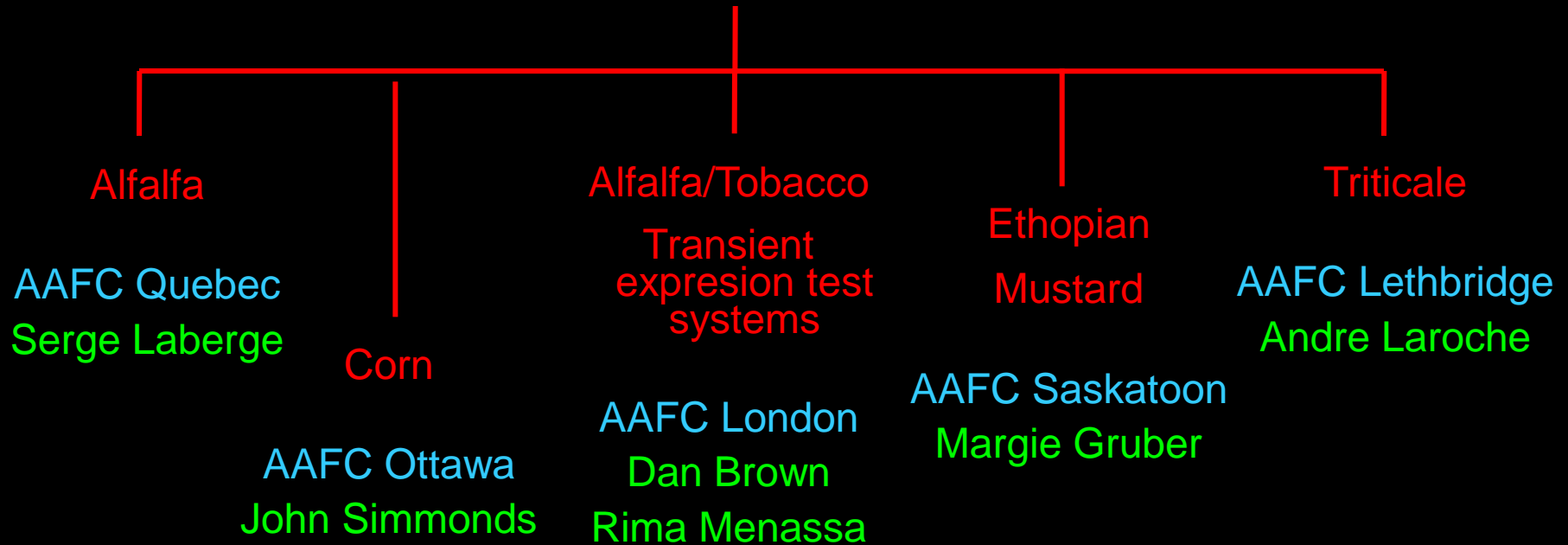


454 & Solexa
sequencing

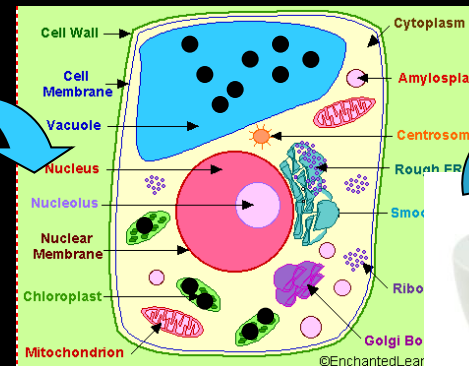
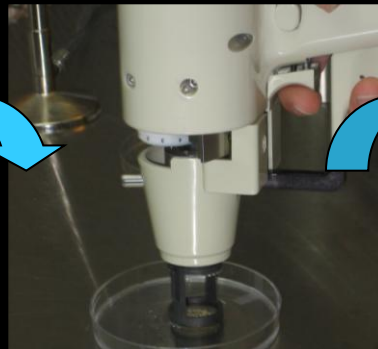
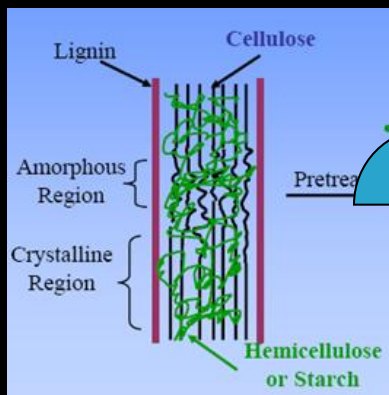


Cluster 4: Hydrolytic enzyme expression in plantsreducing the cost of enzymatic degradation.....

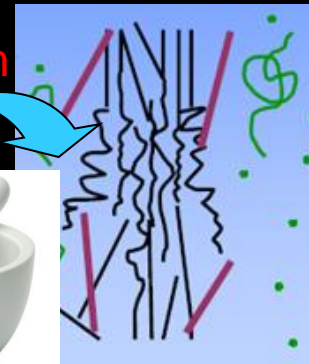
Dan Brown / Andre Laroche



Tissue/Subcellular targeting



crush



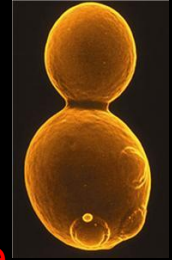
Cluster 5: Fermentation

...consolidated bioprocessing and reducing inhibition

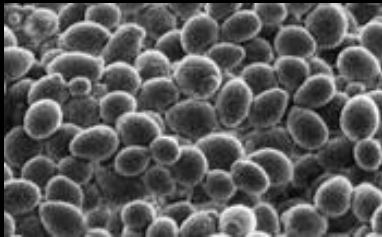
Victor Martin / Steve Gleddie

Consolidated
Bioprocessing
C5 sugar use

Systems Biology approach to reducing
fermentation inhibition – transcriptome,
proteome, metabolome, chemical genomics,
fermentation kinetics, yeast biology



Concordia U.
Victor Martin
Reginald Storms



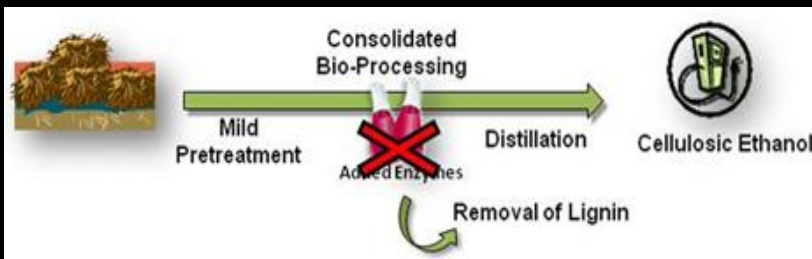
AAFC Ottawa
Steve Gleddie
Linda Harris



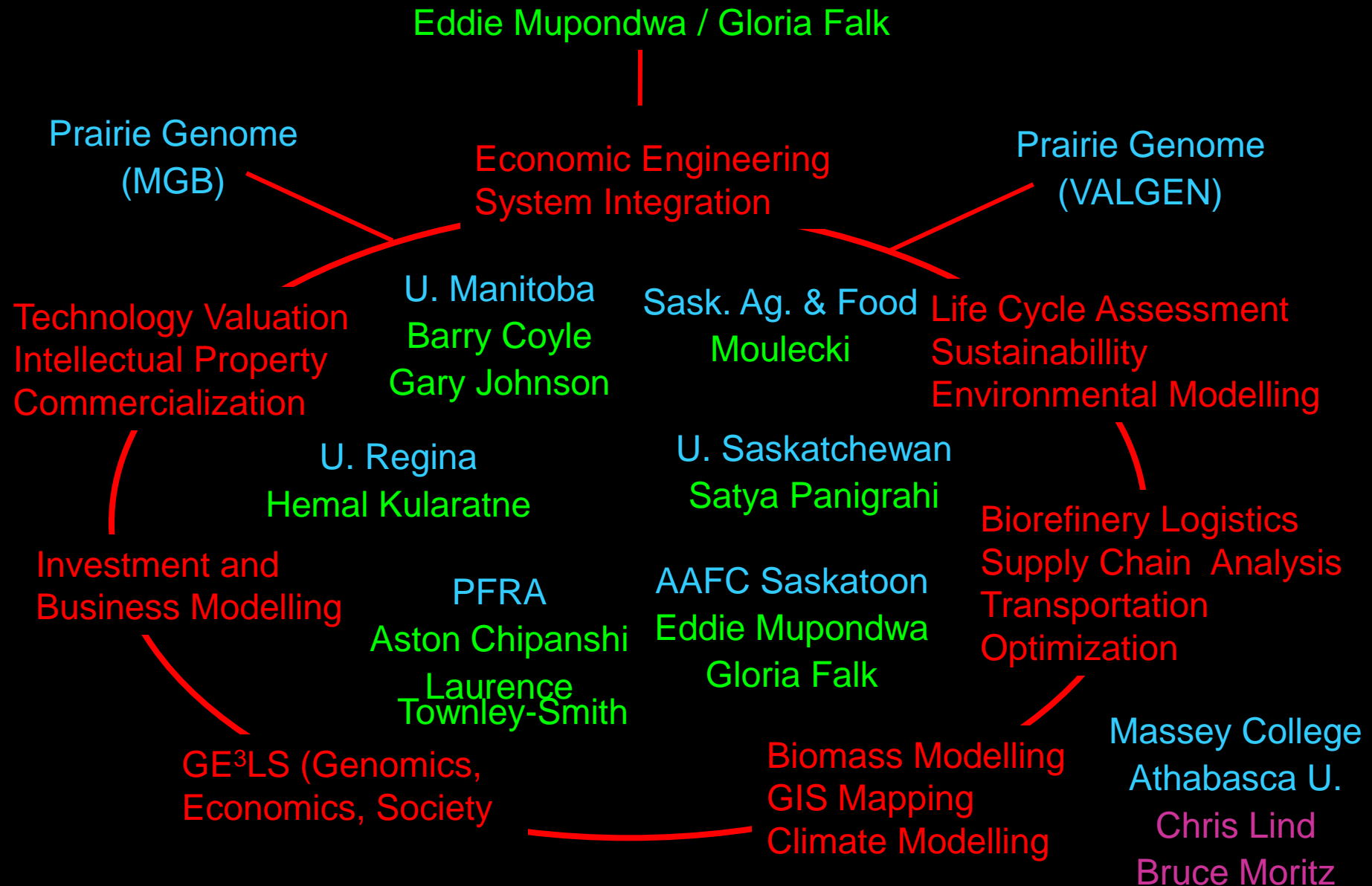
U. Toronto
Krishna
Mahadevan

Ottawa U.
Kristen Baetz
Mads Kaerns
David Bickel

U. Alberta
David Wishart
Liang Li



Cluster 6: Economic, Environmental, Ethical, Legal, Social Considerations



CBION Partnerships and Linkages

- Ag-West Biotech, Quebec Biotechnology Innovation Centre
- Greenfield Ethanol and Poundmaker AgVentures
- Pioneer Hi-Bred, Forage Genetics International, CalWest Feed
- Enzyme Companies – Adrian Tsang, W. Sung, J. Saddler
- Case New Holland – L. Tabil
- Feed Opportunities in the Biofuels Industry Network – C. Christiansen
- Agricultural Biorefinery Innovation Network – F. Berutti, Lope Tabil
- Canadian Biomass Innovation Network – M. Stumborg
- Genome Canada (Microbial Genomics for Biofuels) – D. Levin
- NCE CBBE Network – D. Smith
- International Energy Agency Task 39 – J. Saddler
- Indigenous Land Management Institute (University of Saskatchewan)

Contact us!

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- Patrice Audy (Manager) Patrice.Audy@agr.gc.ca
- Diane Ostiguy (University coordinator) dlostiguy@concordia.ca