Prince Edward Island ADAPT Council

Telephone: (902) 368-2005
Fax: (902) 368-2520
Email: adapt@pei.aibn.com

Farm Centre
420 University Avenue Room 103
Charlottetown, Prince Edward Island C1A 7Z5

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Report on Canadian Society of Agronomy (CSA) Biofuels Symposium
August 4, 2006; Halifax, Nova Scotia

Rising energy prices are adding to the hardships of Canadian farmers. However, according to the presenters at the CSA Biofuels Symposium held in Halifax, Nova Scotia on August 4, 2006. There is a silver lining in this critical and emerging issue.

Agricultural bioenergy is any energy or fuel derived from plant or animal matter produced on farms – for example, grass fuel pellets, manure biogas, and grain and/straw burning furnaces, oil seed biodiesel and cellulosic ethanol. A well planned renewable energy sector which develops small scale, regional energy systems from multiple feedstock resources can mean fresh opportunity for Canadian agriculture and rural communities.

The symposium explored the current and potential roles of agricultural bioenergy in the Canadian energy supply. Specific crops and technologies relevant to Canada were examined– biomass energy feedstocks based on perennial forage grasses and other productive woody plants, biodiesel from oilseed crops, and bioethanol from grains or crop residues. The expected fuel energy yields versus energy inputs for a variety of bioenergy pathways were examined. The role of bio-refining and value added bioproducts was considered. In the closing panel discussion, the overall feasibility of agricultural bioenergy in Canada, based on economic and environmental considerations, were discussed. Below is a summary of the lessons learned.

U.S. Sun Grant Program to Begin New "Bioenergy" Era

Oregon State University will help lead a major national effort to reduce America's reliance upon imported fossil fuels, enhance energy security and revitalize rural economies as part of the new Sun Grant Initiative.

OSU was named one of five centers of excellence that will conduct research, education and outreach programs in the evolving field of "bioenergy," which uses sustainable and renewable

agricultural products based on energy from the sun - instead of petroleum - for the direct production of fuels and a myriad of consumer products.

By 2007, plans call for up to $75 million a year to fund this ambitious new program.

The initiative taps into the existing scientific expertise and outreach concepts pioneered by the nation's land grant college system, and organizers say the new Sun Grant program can make a significant contribution towards America's energy crisis while providing a beacon of hope to farm families across the country who face sagging prices, uncertain demand for their crops and economic hardships.

Agrotechnological Research Institute
In the Netherlands, Wolter Elbersen, Programme Manager for Bio-energy and Biomass Conversion ATO B.V. (E-mail: wolter.elbersen@wur.nl
ATO-DLO is an organisation for fundamental and applied-scientific research for agriculture and horticulture, trade and export and for the industries manufacturing food and non-food products on the basis of vegetable and animal raw materials. With approximately 600 personnel ATO-DLO is one of the largest of the 12 agricultural research institutes of DLO (Directorate for Agricultural Research), the research organization of the Dutch Ministry of Agriculture.

From Perennial Grass to Biofuel
Ontario and Western USA States are growing switchgrass for biofuel production.

> *A grandiose scheme is proposed to replant 35 million acres of tallgrass prairie to be used for ethanol. It would: replace all of Canada's gasoline requirements; reduce government subsidies to both the agriculture and energy sectors; not only save farms but create rural employment opportunities; prevent Canada from becoming a net oil importing nation; rehabilitate prairie soils and wildlife populations; and reduce Canadian CO2 emissions by 15%. It sounds all too good to be true; can it be?*
> *See: Switchgrass : a living solar battery for the praires by Roger Samson at: http://www.eap.mcgill.ca/MagRack/SF/Fall%2091%20L.htm*

Switchgrass is slow to get established and has not been proven to be reliably hardy in Atlantic Canada. Other perennial grasses that may be more suitable include alfalfa and reed canary grass.

Oil and Carbohydrate Crops
Most crop land in western Canada returns about $400/acre. There is a need to make agriculture more profitable.

Need to think in terms of “miles per hectare” rather than “$ per hectare” or “miles per gallon”
Turning wheat into ethanol provides energy conversion of approximately 10,000 Km/ha.
Turning canola into bio-diesel is 50% more efficient. Biodiesel has more energy per litre.
1.8 million tonnes of canola exported /year to Japan and China. Much of the meal produced there is then shipped to California. So, the product crosses the ocean twice before being consumed. If canola were turned into bio-diesel in Canada, the meal could be consumed in N. Am.

The new standards for petroleum diesel which require low sulfur also causes more scarring of the motors. Canola based bio-diesel has good fuel properties, less scarring, burns clean and good lubricity.

In order to be economically viable in Eastern Canada, a biodiesel refinery of a scale that would be feasible, given the projected capacity to supply feedstock, would have to produce high-end by-products in addition to the fuel.

Canola Bio-Diesel By-Products:
Lecithin (digestive aid) , Phytosterol *(sp?)* (lowers cholesterol), Tocopherol (Vitamin E) Carotenoids (anti-oxident), Glucosinolate (a bio-pesticide)

The Canadian Biomass Innovation Network

The Canadian Biomass Innovation Network (CBIN) has been formed to coordinate the Federal Government's research and development activities in the area of bioenergy, biofuels and industrial biotechnology.

Their website is meant to create a public forum that can be used by the communities involved in delivering the R&D and moving it along the innovation chain. The program has been divided into 4 areas of activity:

* New and Existing Biomass Supply
* Biomass Conversion & Utilization Technologies
* Integrated Bio Applications
* Cross-Cutting Activities (strategy, policy, regulations, assessment, dissemination, etc).

Each of these activities consists of a number of long term research themes that are managed by a chosen Federal Government lead.

For more information see: http://www.cbin.gc.ca/index-e.html

Energy Analysis
80% of Canadian energy comes from fossil fuels
Only 10 % our energy is currently bio-based
We need to substantially increase the efficiency of the conversion from plant to bio-fuel before liquid fuel conversion is economically viable.

'More fossil fuels can be replaced by using solid fuel for heating and electrical generation than by producing liquid biofuels."

Cellulosic Ethanol Conversion

The production of ethanol from corn is a mature technology that is not likely to see significant reductions in production costs. The ability to produce ethanol from low-cost biomass will be key to making it competitive as a gasoline additive. The cost of producing ethanol could be reduced

by as much as 60 cents per gallon by 2015 with cellulosic conversion technology.

An overview of cellulose conversion technology and various feedstock options and a brief history of ethanol usage in the United States can be found at:
http://www.eia.doe.gov/oiaf/analysispaper/biomass.html

Also, From Wikipedia, the free Internet encyclopedia.....

> *Cellulosic ethanol is a blend of normal ethanol that can be produced from a great diversity of biomass including waste from urban, agricultural, and forestry sources. Unlike normal ethanol, which is made from sugars and starches, cellulosic ethanol is produced from cellulose. There are at least two methods of production of cellulosic ethanol—enzymatic hydrolysis and synthesis gas fermentation. Neither process generates toxic emissions when it produces ethanol. The technology is very new and exists in pilot configurations where testing is ongoing.*
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> *According to US Department of Energy studies conducted by the Argonne Laboratories of the University of Chicago, one of the benefits of cellulosic ethanol is that it reduces greenhouse gas emissions (GHG) by 85% over reformulated gasoline. By contrast, sugar-fermented ethanol reduces GHG emissions by 18% to 29% over gasoline.*
>
> *In April 2004, Iogen Corporation, a Canadian biotechnology firm, became the first business to commercially sell cellulosic ethanol. The primary consumer thus far has been the Canadian government, which, along with the United States government (particularly the Department of Energy's National Renewable Energy Laboratory), has invested millions of dollars into assisting the commercialization of cellulosic ethanol.*
>
> *SunOpta's BioProcess Group is supplying the biomass pretreatment process system for Abengoa's wheat straw to ethanol plant in Babilafuente (Salamanca), Spain. This facility will be the first commercial cellulosic ethanol production plant in the world. SunOpta's BioProcess Group is a world leader in the field of preparation, pretreatment and processing of biomass for the production of cellulosic ethanol and other renewable fuels. The SunOpta Process is based on proprietary and patented technologies and is the only industrially proven continuous process in the world for biomass conversion to value added products such as cellulosic ethanol.*
>
> *Genencor and Novozymes are two other companies that have received United States government Department of Energy funding for research into reducing the cost of cellulase, a key enzyme in the production cellulosic ethanol by enzymatic hydrolysis.*
>
> *Other enzyme companies, such as Dyadic International, Inc. (AMEX: DIL), have*

been using fungi to develop and manufacture cellulases in 150,000 liter industrial fermenters. Genencor and Novozymes are developing and manufacturing better performing enzyme mixtures, based on Dyadic's technology, to make the production of cellulosic ethanol more economical.

BRI Energy, LLC is a company whose pilot plant in Fayetteville, Arkansas is currently using synthesis gas fermentation to convert a variety of waste into ethanol. After gasification, anaerobic bacteria (Clostridium ljungdahlii) are used to convert the syngas (CO, CO2, and H2) into ethanol. The heat generated by gasification is also used to co-generate excess electricity.

Proven Viable Bio-based Resources

	Whole Plant	**Seed Harvest**
Stationary Fuel	Grass, Willow Coppice, Residues (For heating and Electric Generation)	Grains to Burn (For heating and Electric Generation)
Liquid Fuel	Cellulosic Ethanol	Bio-Diesel

In Western Canada the most viable resources are: wheat, wheatgrass, switchgrass and canola
In Eastern Canada the most viable resources are corn, reed canary grass, canola/grain and willow coppice.

Energy gains from solid fuel can be had for heat and electricity from willow coppice (low N demands and high yields), reed canary grass, wheatgrass/switchgrass

Liquid fuels are better to wait for development of new cellulosic ethanol technologies. Bio-diesel is a better, short-term, liquid energy solution.

There are a multitude of opportunities for grass and forest products which can lead to farm diversification and stimulate the rural economy.

Atlantic BioVenture Centre
Richard Ablett
Phone: (902) 893-4152
E-mail: rablett@nsac.ca

Bio-refinery/Co-product development can enhance the viability of ethanol production in Atlantic Canada.

Conventional Agriculture = monocrops
New Model:

- Health (Probiotics, Antioxidents, Ommega fats) 8-10% annual growth
- Bio-products (fibre, building materials, manufactured ingredients)
- Energy

In N. America the ethanol plants are primarily based on one feedstock (corn). The Asian model is a better model to adopt in the Atlantic region. It relies upon multi feedstocks to produce multiple products.

Next Steps

- Need to attract greater federal government buy-in for developing bio-fuels industry
- Connect wider range of value-added products to fuel feedstock.
- In 20-30 years there will be a serious energy crisis with supplies. Government needs to invest now. Most business' will be unwilling to invest until ecomonic viability improves.
- Cases for socio-economic benefits need to be documented in order to encourage government investment..
- Need to develop regional bio-fuel infrastructure or it will continue to come from somewhere else.

District Heating Systems from solid fuels have significant opportunity.

Sweden plans to be petroleum free by 2025.
Denmark produces 50% of the world's windmills.
PEI, as a model farm/province, can be a leader in multi-feedstock bio-refinery value added production.

Conclusions

There is lots of push from oil companies for developing liquid fuels (ethanol and biodiesel)from farm products for petroleum-based fuel additives. But if it is our desire to reduce our dependence upon petroleum, then burning, solid, farm based fuel feedstocks for heat and electrical generation makes more financial sense than turning those feedstocks into liquid fuel.

Developing cellulosic ethanol (fuel from cellulose instead of sugar) technologies is necessary in order to make ethanol fuel production financially viable.

In the short-term bio diesel is a more efficient solution for liquid fuel production than ethanol.