Development and Sustainability of the Biofuel Industry in Canada

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The production and use of first-generation biofuels (ethanol from cereal grains, biodiesel and biogas) has been increasing rapidly throughout the world. In 2000, total world production of ethanol for fuel was less than 20 billion liters and by 2005, production had more than doubled to over 45 billion liters (IEA 2004; RFA 2007). This provided about 3% of the motor gasoline use in the world, with a slightly smaller percentage in North America (IEA, 2004). In a review of recent policy initiatives, the International Energy Agency projected that total ethanol production in the world will rise to 65 billion liters by 2010 (and account for about 4% of motor gasoline use) and to 120 billion liters by 2020 (and account for about 6% of motor gasoline use) (IEA, 2004). However, rapid increases in several countries, especially in the United States may result in even greater increases in ethanol production in the next several years.

The rapid expansion of production of ethanol in the United States and of biodiesel (and to a lesser extent, biogas) in Germany, and other countries in Western Europe, has created a boom with far-reaching effects on the global demand for grains and oilseeds. World consumption of cereals grains has exceeded production for 6 of the last 7 years (Brown 2006) with the result that world-grain carryover stocks have shrunk to the equivalent of only 57 days of consumption, the lowest level since 1974.

The effects of the boom have extended into Canada, not only as a consequence of rapidly changing global supply-demand balances for grains and oilseeds, but as a result of domestic policies to assist the rapid expansion of biofuel production. As in other countries, governments in Canada have implemented measures to stimulate production and consumption of biofuels, including, among others, preferential taxation, subsidies, import tariffs and consumption mandates. The purpose of this paper is to describe the main policies guiding the development of the Canadian industry and to discuss economic and environmental implications.

Policies Guiding Industry Development

Ethanol, the predominant biofuel in Canada, has been used for some time as a gasoline oxygenate. Ethanol has been produced commercially in small quantities in Ontario and Québec since the mid 1970s and in the prairie provinces more recently. Among first-generation biofuels, ethanol can most easily (*i.e.*, physically and economically) be substituted or combined with traditional fossil fuels and used to power internal combustion engines. Widespread use of biodiesel in Canada, in comparison, faces additional challenges due to an absence of pre-existing commercial capacity and because of a warm cloud point, which can create significant cold-flow problems. At present, electricity generated from biogas in Canada is not competitive with traditional alternatives. To displace even a small proportion of domestic consumption, electricity generated using biogas will require relatively more government intervention than currently necessary for ethanol or biodiesel. The upshot is that ethanol is the major opportunity for mass-market biofuel in Canada.

Energy security is not propelling the political demand for ethanol in Canada, as it is in the United States. Figure 1 illustrates that Canada is a net exporter of all kinds of energy: oil, coal, natural gas, uranium, hydro-electricity and others. Instead, the policy objectives from expanding the biofuel industry in Canada are:

- to reduce greenhouse gas emissions,
- to increase and stabilize farm incomes by increasing the demand for farm commodities; and
- to promote rural development and diversification by encouraging biofuel plants in rural communities.

Ethanol development in Canada has been much slower than in the United States for reasons of grain supply and government policy. However, the federal and provincial governments are adopting some of the same means of promoting ethanol as in the United States. For example, there is an exemption of excise tax for ethanol. In Canada, the exemption is C$0.10 per liter.

Domestic ethanol suppliers have received and continue to receive production incentives in the form of subsidies. For example, in August 2003, the Ethanol Expansion Program provided C$250 million in grants toward capital costs of new or expanded ethanol plants. A Biomass Ethanol Program, also dating from the same time, provides C$140 million in lines of credit to ethanol plants if the excise tax is ever re-imposed.

On December 20, 2006, the federal government announced C$345 million in taxpayer transfers for two agriculture programs to subsidize the development of a biofuel industry. To encourage more farmer participation, C$200 million is to be made available through the Capital Formation Assistance Program (now called the EcoAgriculture Biofuels Capital Initiative). The remaining C$145 million is to be directed through the Agricultural Bioproducts Innovation Program to promote R&D.

The 2007 federal budget (presented in the House of Commons on March 19, 2007) offers C$1.5 billion in subsidies over 7 years for producers of ethanol and biodiesel. Government assistance will be up to C$0.10 per liter for renewable alternatives to gasoline

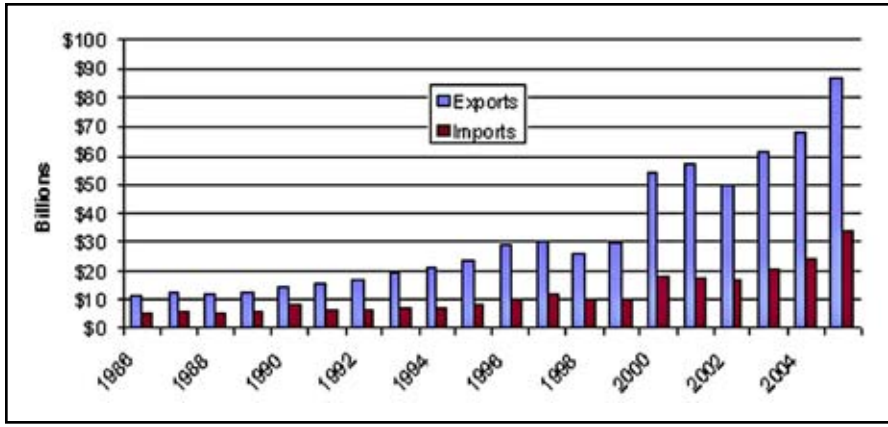

Figure 1. Canada's energy trade balance, 1986–2005 (Statistics Canada, 2007).

and up to C$0.20 per liter for renewable alternatives to diesel for the first 3 years, after which point the subsidies are then to decline. In addition, transfers totalling C$500 million over 7 years will be made to producers of next-generation renewable fuels, such as ethanol from agricultural and wood waste products (wheat straw, corn stover, wood residue, switchgrass, *etc*.).

Several provinces announced major biofuel incentive programs in 2006. The Ontario Ethanol Growth Fund makes up to $520 million available over the next 12 years to ethanol producers. The Alberta government announced a 4-year, $209-million Renewable Energy Producer Credit program that will offer tax credits to ethanol and biodiesel producers and distributors. The rate of subsidy will be reviewed annually to ensure it is competitive with other jurisdictions. The Québec government announced a twenty-four-point action plan to help realize some objectives of the Kyoto Protocol. Part of the plan involves a tax on producers of hydrocarbon energy during each of the next 6 years. The government expects to collect $200 million per year from the carbon tax, which will be transferred to a Green Fund.

On top of the taxes, tax credits and subsidies, most provincial governments have implemented mandates of renewable fuel consumption. The Ontario government has a policy that requires all the gasoline sold in the province contain 5% ethanol as of 2007. The governments of Manitoba and Saskatchewan will require a proportion of ethanol in all the gasoline sold to be a minimum of 5% to 10% starting when local production is sufficient. The plan of the Québec government is that before the end of 2012, all of the gasoline sold in the province will contain a minimum of 5% ethanol.

The federal government also has mandated an annual average renewable content of 5% in gasoline by 2010. In addition, there is a 2% renewable content requirement for diesel fuel and heating oil by 2012. The idea is similar to the renewable fuel mandates implemented by some state governments (*e.g.*, Minnesota, Montana and Hawaii).

Canadian Ethanol Production

Corn and wheat are used to meet the demand for ethanol in Canada. Eastern Canada is a net importer of increasingly expensive corn from the United States. In western Canada, the only viable feedstock for cereal-based ethanol is feed wheat, the supply of which is variable and usually unpredictable. The ethanol yields per tonne of corn and wheat are similar, but corn historically has been less expensive.

Currently, there are eleven ethanol plants operating across Canada, most of which are located in the central provinces of Ontario and Québec. These plants, excluding Iogen Corporation's cellulosic ethanol demonstration plant in Ottawa, have an annual production capacity of 764 million liters. In addition, eight plants are under construction or expansion. When completed, these plants will add more than 1.2 billion liters of production capacity annually, an increase over current capacity of 161%.

Based on total use projections in Canada, however, the renewable fuel mandate will create a minimum demand for 3.1 billion liters of ethanol by 2010 (Canada Gazette, 2006). To meet the renewable fuel standard without imported ethanol, an additional capacity of 1.11 billion liters needs to be built in the next 3 years. This would require an increase over existing capacity and that under construction of almost 56%.

Only four ethanol plants in Canada produce more than 100 million liters of ethanol annually. Despite the recognized cost advantages from larger-scale production of ethanol (Government of Manitoba, 2002; Whims, 2002; Tiffany and Eidman, 2003; Shapouri and Gallagher, 2005; Gallagher *et al.*, 2007), smaller plants are being promoted in some parts of Canada. There may be some opportunities for these small enterprises if they were integrated with a feedlot or food manufacturer that can profitably use the distillers' dry grains (DDGs), carbon dioxide (CO_2) and other co-products from ethanol production. If small plants require government incentives to be built or operated, the significant advantages of large-scale low-cost plants may render the small plants uneconomic.

The heterogeneity of the provincial tax exemptions (amounts, eligibility and duration) is creating an unusual pattern of trade within Canada. Until recently, almost all of the ethanol produced in Alberta was exported to the United States because Saskatchewan's tax exemption applies only to provincially produced ethanol. Meanwhile some ethanol produced in Saskatchewan was sold to buyers in Alberta where the provincial tax exemption does not place restrictions on the source of the ethanol. The impact of these interprovincial trade barriers is not well understood and more study is required.

Implications for Farm Incomes

One of the driving forces behind attempts to establish a successful biofuels industry in Canada is to improve farmer incomes. Certainly, grain and oilseed producers struggle financially in Canada and much of the rural infrastructure is running down as a result. Net farm incomes across Canada have stagnated (AAFC, 2005). An increase in the number of ethanol and biodiesel plants across the country that use cereal grains and oilseeds (and eventually plant residues) will increase demands for these feedstocks providing opportunities for growers to get higher prices for their products.

Table 1 shows that within the past year, the prices of all major feed-grain prices have risen in Canada: corn by 54%, soybeans 24%, oats 35%, barley 51%, and feed wheat 36%, much of it due to the extra demand for producing biofuels.

Table 1. Prices of cereal grains and oilseeds, in Canada, 2006–07 (Agriweek, 2007).

Commodity	May 2006	May 2007
Corn, CBOT future, next-nearest month, C$*/bu	C$2.63	C$4.05 (↑54%)
Soybean, CBOT future, next-nearest month, C$*/bu	C$6.66	C$8.27 (↑24%)
Oats, CBOT future, next-nearest month, C$*/bu	C$2.08	C$2.82 (↑35%)
Feed barley, WCE future, next-nearest month, C$/tonne	C$120.00	C$181.00 (↑51%)
Feed wheat, WCE future, next-nearest month, C$/tonne	C$116.00	C$158.00 (↑36%)

*Spot exchange rate C$/US$: 2007 (0.9044); 2006 (0.9095).

Although prices of grain and oilseed have increased (and, indeed, show signs of increasing further due to the strong expansion of the biofuel industry across North America), this does not necessarily imply that net farm incomes will increase. Net income is the critical factor, *i.e.*, gross income minus total cost of production. In anticipation of higher returns from corn, land prices and rents have risen rapidly in the United States and are rising in Canada as well. However, because of increased demand for inputs to produce the higher priced grains and oilseeds, prices also are rising for all necessary inputs to produce these crops, such as fertilizer, equipment and storage. So as grain prices are increasing, market processes are rationing the demand for inputs by way of higher prices. As individuals adjust to new price information, the transition will be profitable for some but costly to others.

Sustained higher prices for grains and oilseeds encourage farmers to bid up land prices. The capitalization of higher farm revenues into land prices also extends to other farm assets such as equipment and buildings. Under these circumstances, higher revenues do not yield higher net farm incomes. On the contrary, they boost the demand for farm assets and increase the cost structure of the entire industry. While increased asset values improve the equity position of property owners, tenants and farm workers are likely to receive little benefit and aspiring farmers will face higher entry costs.

An inevitable and undesirable result of rapidly expanding ethanol production is that livestock producers incur much higher costs of their major input: feed grain. Beef, hogs and poultry have been hardest hit. Feed represents more than 80% of the costs of production in a western Canadian beef feedlot. Feed can represent as much as 65% to 75% of the costs of hog and poultry production. Many livestock farms in Canada are small-margin, large-scale enterprises. The ethanol frenzy is placing them under a tremendous cost-price squeeze. Higher feed prices are providing an incentive for some producers to substitute towards alternative feeds, to move their operations closer to sources of lower-priced inputs, and for others to exit the industry.

Higher feeding costs for livestock will have three major effects (though the extent of these effects has not been studied thoroughly). First, some part of the increased feed costs inevitably will be borne by producers of calves and weanling pigs. To offset higher feed costs, feedlot enterprises will bid lower for feeder animals, which not only reduces the quantity of feeders offered for sale, but also the weight at which fed animals are sold. Second, in response to the potential decrease in supply of meat due to higher production costs, consumers will face higher prices for meat products. This will reduce consumption of meats both domestically and abroad. Third, higher costs will be faced by canola crushers, flour millers, and other users of grains and oilseeds.

To counteract the rise in feed prices, farmers may be able to substitute DDGs as part of their livestock rations. While DDGs contain a high percentage of protein and may be used successfully in some rations, especially for beef cattle, they also present several challenges.

First, DDGs create flow problems for handlers, particularly if the moisture content is 12% or more. DDGs tend to bind to the interior walls of hopper cars, which makes them difficult to unload.

Second, pork producers may be able to feed low levels of DDGs in grower-finisher diets, but higher levels of DDGs can cause significant problems. Feeding high levels in the diets (*e.g.*, at 20% and 30%) may result in lower average daily gains and dressing percentages (Lawrence, 2006).

Third, depending on the feedstock used to make ethanol, the resulting co-products are nutritionally different and have different economic values in various types of animal feeds. The nutrient content of DDGs can vary across plant species and has been shown to vary over time even within species (Spiehs *et al.*, 2002). In addition to consistency issues, there also are concerns about deficiencies in lysine digestibility in rations with a high proportion to DDGs and the amount of by-pass protein in ruminants. As nutrients in the DDGs become concentrated through the process of fermentation, the same is true for substances that are harmful to livestock, such as mycotoxin, which also appear in increased concentration.

Implications For Natural Capital

The fundamental justification for expanding biofuels in Canada is the reduction in CO_2 emissions that results from the displacement of petroleum-based energy. Though a lot of fossil fuels are used in the production of first-generation biofuels, life-cycle analysis generally reveals a reduction in greenhouse gases, carbon monoxide and other undesirable compounds. According to the government of Canada (2006), consumption mandates are anticipated to lead to reductions in greenhouse-gas emissions of 2.7 million tonnes per year on a life-cycle basis. There is a greater reduction in greenhouse-gas emissions from production and use of ethanol produced from cellulosic feedstocks than from cereal-based ethanol.

The desired environmental benefits do not come without environmental costs. Expanding ethanol production in the United States has worried some that cropland will be shifted from the Conservation Reserve Program to provide more land on which to plant corn (Shapouri, 2007). This could happen in Canada as well. Following the end in 1995

of the Western Grain Transportation Act (which subsidized the freight rates to transport grains from the prairies provinces to export terminals and, therefore, artificially increased feed-grain prices on the prairies), some land around the fringes of the main crop-growing areas were taken out of crop production and planted to grasses and other perennials. This was a more sustainable use of fragile soil resources in these regions. However, the rapid rise in grain prices (and the subsequent economic stress this places on the livestock industry) threatens to reverse this activity. It seems likely that marginal quality land (*i.e.*, land that is easily erodable, has higher salt content, or other characteristics that make it environmentally sensitive) will again be converted to crop production to take advantage of the higher prices for grains and oilseeds.

It is anticipated that growers will use more fertilizers and chemicals to increase yields in response to the much higher prices for cereals and oilseeds. This could lead to additional leaching of nutrients into ground water and run-off into drainage systems. Increased intensity of crop production could lead to more monoculture and increased soil erosion, not to mention the greater need for fossil fuels to power the more intense farming practices.

The economic incentive to import biofuels—especially biodiesel—from tropical countries, threatens the rain forests that provide enormous climate-moderating and habitat resources for all citizens in the world. More than 85% of the global supply of palm oil comes from two countries: Malaysia and Indonesia (Blumenthal, 2007). Existing biodiesel plants and those under construction have greatly increased demand for palm oil. Logging and burning of some of the most biologically diverse forests is well under way to plant more palm trees. Reductions in their habitats could endanger orangutans, Sumatran tigers, elephants, rhinoceroses, and the world's largest butterflies (Blumenthal, 2007).

There also is the issue of water use to produce biofuels. Production of one liter of ethanol requires between four and eight liters of water, depending on the process. The 130 million-liter ethanol plant recently opened in Lloydminster, Saskatchewan, will likely require more than 500 million liters of water per year for its production process (or about 1.5 million liters per day). Most of the water must come from underground sources, which could reduce water tables in the aquifer. Increased demands for water resources by industry, agriculture, municipalities and for recreation, combined with melt of existing glaciers, are threatening this already scarce resource. Widespread use of water to produce transportation biofuels could further threaten its sustainability.

Concluding Remarks

The markets for commodities like corn, wheat, gasoline and ethanol are global. The exportable supply of grains in the United States has a strong influence on world prices. Canada is much less important in world markets for grains and oilseeds, though still a large exporter. Renewable energy policies in the United States will likely have greater economic impacts on Canadian agriculture than will domestic biofuel policies. The policy effects in both countries have benefited landowners by way of sharp gains in land prices. Following a short period of adjustment, however, there will be little gain in net farm incomes. The long-term impact on natural capital is mixed with perhaps as many (or more) negative environmental consequences as there are positive results.

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