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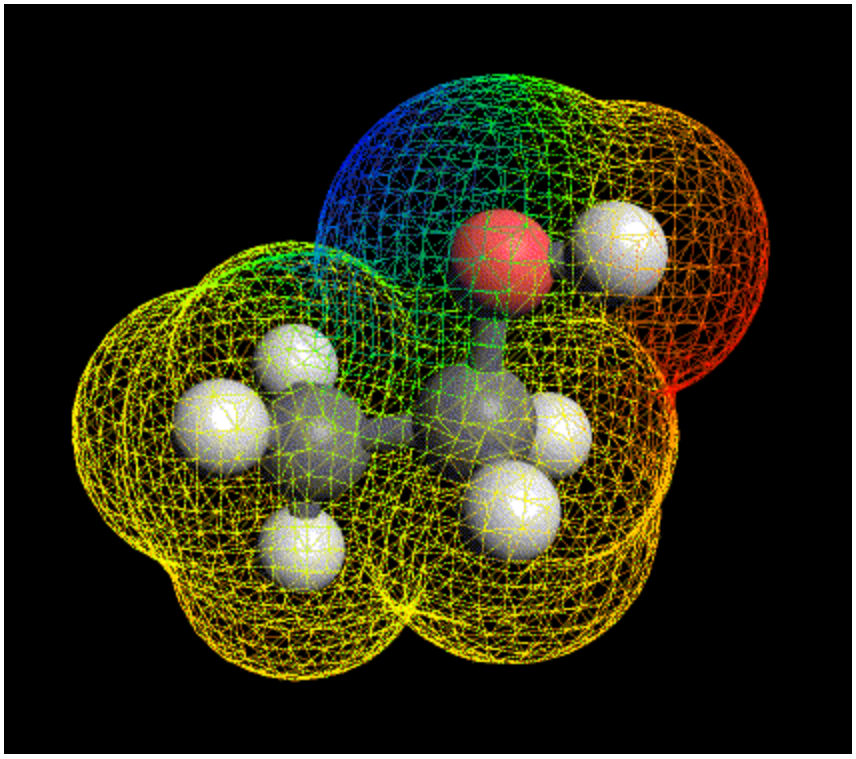
ETHANOL: THE PROMISE AND THE PERIL

A CRITICAL ANALYSIS OF THE CASE FOR SUBSIDIZING ETHANOL PRODUCTION IN MANITOBA



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By Robert D. Sopuck

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ETHANOL: THE PROMISE AND THE PERIL – SHOULD MANITOBA EXPAND ETHANOL SUBSIDIES?

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About the Author

Robert D. Sopuck is director of the Rural Renaissance Project at the Frontier Centre for Public Policy. He is a natural resource policy consultant with a special interest in rural issues who lives at Lake Audy near Riding Mountain National Park in Manitoba. He received his B.Sc. from the University of Manitoba and Masters from Cornell University. His first career was in fisheries management. He later coordinated the sustainable development initiative for the province of Manitoba and was on the Canadian delegation to the Earth Summit in Rio de Janeiro in 1992. He was Manitoba's observer on the Board of the International Institute for Sustainable Development. He carried out a major project for Canada's National Round Table on the Environment and Economy dealing with agriculture and trade policy. He was Environment Director with the Pine Falls Paper Company. He is an Adjunct Professor in the Department of Rural Development at Brandon University.

ETHANOL: THE PROMISE AND THE PERIL

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SHOULD MANITOBA EXPAND ETHANOL SUBSIDIES?

Executive Summary

Manitoba has an established ethanol industry, and the Government of Manitoba is exploring whether to expand it. Ethanol is produced from wheat, in Manitoba, by means of fermentation. The ethanol is then blended with gasoline to produce ethanol-blended gasoline (EBG).

About 90 million litres of EBG are consumed a year in Manitoba. Other products produced at Manitoba's ethanol facility include "distillers dry grain," used as a high protein cattle feed.

Both the economics and the environmental benefits and impacts of the ethanol industry are controversial issues. Some have contested the economic efficiency of producing ethanol, that the process requires more energy than the final product contains. More recent studies have shown that there is indeed a small gain. The environmental effects, both positive and negative, are difficult to calculate and to quantify. But Manitoba's gasoline market is so small in relation to the whole world that no matter happens here, it will have little or no significant effect either way.

There are three models for producing ethanol:

1. Stand alone ethanol production facilities, which are the most risky and expensive
2. Integrated facilities that produce other products. Examples include "wet mash", which can be fed to cattle in adjacent feedlots, or "nutraceuticals," starch or other products from grain that can be sold separately.
3. Integrated facilities that produce "dry mash" which can be exported as a high protein feed.

Clearly, ethanol facilities should be designed to produce a wide range of products, rather than ethanol alone.

The main risks of expanding ethanol production are price collapse and the capitalizing of subsidies into prices. Direct subsidies and price supports should be avoided. Subsidies will spur the conversion of more feed grain into ethanol. Since Manitoba does not produce enough feed for its growing livestock industry, subsidies will exacerbate the feed shortage.

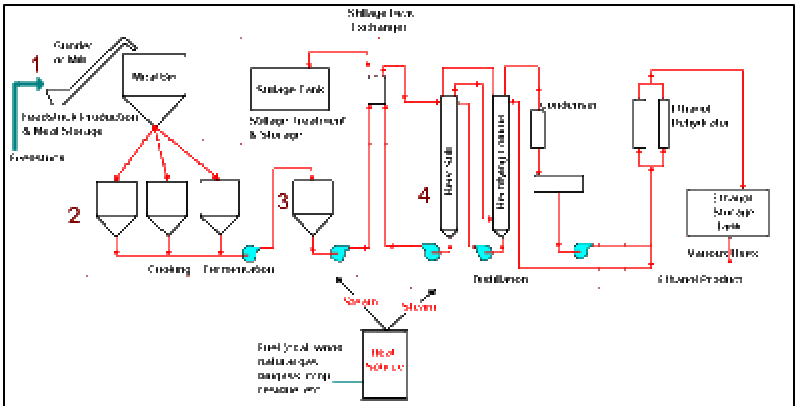
Mandating EBG use in Manitoba and supporting this industry with increasing subsidies would be counter-productive and should not be considered.

Background

All life and all societies require energy in order to function. Humans use energy directly for heat and transportation, and the products and by-products of energy production and consumption are used in a myriad of ways to improve the quality of life. Energy production and consumption can have negative environmental consequences in regard to air quality and waste generation. Energy sources can be divided into two broad categories, non-renewable and renewable. Non-renewable energy, which cannot be replaced, includes fossil fuels and nuclear energy, which consumes finite metallic resources. Renewable energy comes from sources which, theoretically at least, constantly renew themselves and hence

should last indefinitely. These include hydro-electricity, wind, geothermal and solar heat and the general group known as biomass fuels.

Biomass energy is derived from biological sources other than fossil fuel. Fossil fuels are, of course, derived from biological sources, but little if any are being formed presently, while other biological fuels are constantly being renewed in real time. Biomass involves the extraction of energy from wood, wood waste, wood liquors, peat, railway ties, wood sludge, spent sulfite liquors, agricultural waste, straw, tires, fish oils, sludge waste, waste alcohol, municipal solid waste, landfill gases and other waste. Ethanol blended into motor gasoline is also considered a biomass fuel.



The Process of Producing Ethanol

Renewable energy sources, as defined above, constitute only 13.1% of global energy production with hydropower and wood burned for heat making up most of that, fully 12% of global energy use. Biomass fuel other than wood accounts for a mere 0.4% of total global energy use.[1] In the United States, ethanol provides less than 1% of the energy consumed by automobiles ,[2] although ethanol use is increasing.

This paper analyzes the environmental and economic implications of current and expanded utilization of ethanol biomass fuel with a focus on Manitoba. The Government of Manitoba is investigating the potential for this industry through its Manitoba Ethanol Initiative. The Province's web site (www.gov.mb.ca) provides further details on this effort.

The Production of EBG in Manitoba

The conversion of corn, wheat and some other food and feed crops into ethanol by fermentation is a well-known and established technology. In a large and efficient plant with economies of scale, the yield from a bushel of corn, for example, is about 2.5 gallons of ethanol.[3]

Manitoba's ethanol fuel industry is centred around the Mohawk plant located in Minnedosa. As the province's only large-scale producer of ethanol, the plant produces on average about 10 million litres of ethanol per year. One million is sold for industrial purposes and the remainder, nine million litres, is blended with gasoline, at a ratio of 10 parts gasoline to one part ethanol, to produce about 90 million litres of EBG. The output from the Minnedosa plant serves the EBG needs for all of Manitoba.

[1] *The Skeptical Environmentalist: Measuring the Real State of the World*. by Bjorn Lomborg, Cambridge University Press. 2001, p .515.

[2] *Energy and Dollar Costs of Ethanol Production*, by D. Pimental, Hubbert Center Newsletter, Volume 2, 1998.
[3] Ibid.

This plant is an important component of Minnedosa's economy. It creates thirty direct, full-time jobs and the plant purchases varying amounts of grain from about 150 farmers every year. The plant uses approximately 27,000 metric tonnes of grain per year, or about one million bushels. The plant consumes mostly wheat but some corn is purchased when required.

Dairy farmers buy a by-product of the ethanol production process, distillers dry grain, for its high protein content, which can range from 35-40%. The byproduct is shipped as far as Quebec, which reveals the value dairy producers place on it. Plant officials note that it is economic to produce and market distillers dry grain, which indicates that any analysis of the ethanol industry must take into account all of the products these facilities manufacture.

The other Prairie ethanol plant, located in Lanigan, Saskatchewan, is also in the livestock business. In fact, a livestock feeding facility, built in 1969, preceded the ethanol plant, which started production in 1991. The ethanol output from Lanigan is purchased by Mohawk and marketed west of Manitoba. Between 60 and 70 people work at this facility.

In Manitoba, the production of EBG is supported by a 2.5 cents per litre tax rebate on the final product. The roughly 90 million litres of EBG produced in Manitoba thus reflects a subsidy of $2.25 million a year in foregone tax revenue by the government. This means that each job created costs the public purse about $75,000 in subsidy.

The Pros and Cons of Ethanol Fuels

Environmental

The main environmental case for producing and utilizing EBG holds that replacing some of the fossil fuel in gasoline by ethanol decreases air pollution. EBG produces less carbon monoxide than regular gasoline.[4] Presumably EBG also puts less carbon dioxide, the most important greenhouse gas, into the atmosphere than regular gasoline, thus contributing less to global warming and climate change than the burning of fossil fuels. The carbon in the ethanol portion of EBG comes from the atmosphere, extracted by the crops during photosynthesis. Fossil fuel carbons come from sources that have been sequestered underground and not normally available in the atmosphere. The burning of fossil fuels therefore adds "new" carbon dioxide to the atmosphere while biomass fuels use carbon that was already there.

Ethanol has also been used to replace potentially harmful fuel additives. In California, for example, the government has mandated that the fuel additive MTBE, which is considered a groundwater contaminant, be phased out over the next two years. According to a June, 2002, press release from the U.S.-based Renewable Fuels Association (www.ethanolrfa.org), Shell Oil, the second largest gasoline marketer in California, has decided to replace MTBE with ethanol to boost engine performance without environmental risk

In terms of negative environmental impact, David Pimentel of Cornell University notes:[5]

"Ethanol produces less carbon monoxide than gasoline, but it produces just as much nitrous oxides as gasoline. In addition, ethanol adds aldehydes and alcohol to the atmosphere, all of which are carcinogenic. When all air pollutants associated with the entire ethanol system are

[4] Ibid.
[5] Ibid.

measured, ethanol production is found to contribute to major air pollution problems. The 129,600 BTU of fossil fuel including coal, oil, and natural gas, which are expended in corn production and subsequently burned in the ethanol plant release significant amounts of pollutants into the atmosphere."

These conclusions would not entirely apply to Manitoba's situation, given that hydro-electricity and natural gas are the main energy sources for ethanol production at our plant, not coal. Manitoba's energy mix is much cleaner and adds less carbon dioxide into the atmosphere than the coal burned at American ethanol plants. The energy inputs for Manitoba's grain production are similar to those for corn.

Pimentel also tries to make the case that it is "immoral" to produce crops to burn in cars when so many people in the world are without adequate food supplies. This argument is problematic. We grow many non-food crops, like industrial rapeseed, flax for the linseed oil in paints or corn for biodegradable plastic. Secondly, people starve for political reasons, like incompetent governance, not because there is a worldwide shortage of food. The prices of most raw food commodities are as low as they have ever been and supplies are more than adequate. Farmers have an obligation to grow what will provide the greatest return, regardless of end use. And they do.

Energy Balance

Energy balance refers to the amount of energy consumed in the production of certain types of energy versus the amount of energy contained in the final product. The principles of thermodynamics state that energy is always lost during each transformation. In the case of fossil fuels, this balance is achieved because since the final products contain much more energy per unit than processing absorbs. Ethanol production has more steps than fossil fuel production, in that crops must be grown and the starch in the grain transformed into ethanol via the process of fermentation.

David Pimentel has analyzed the energy and dollar costs of ethanol production using corn and has concluded that the industry has a negative energy balance. Even though his work deals with corn, it is assumed that most of the conclusions would apply to all grains despite slight differences in ethanol outputs and costs from different raw products.

Pimentel notes:[6]

"The production of corn in the United States requires significant energy and dollar inputs. Indeed, growing corn is a major energy and dollar cost of producing ethanol. For example, to produce an average of 120 bushels of corn per acre using conventional production technology requires more than 140 gallons of gasoline equivalents and costs about $280. The major energy inputs in U.S. corn production are oil, natural gas, and/or other high-grade fuels. Fertilizer production and fuels for mechanization account for about two-thirds of these energy inputs for corn production."

Corn will produce about 2.5 U.S gallons of ethanol per bushel in a plant with appropriate technology and economies of scale.[7] In the case of the feedstock for the Minnedosa plant, the one million bushels of wheat and corn purchased generate about the same amount of ethanol per bushel. This last calculation is based on the estimated purchases of one million

[6] Ibid
[7] Ibid

bushels of wheat and corn in Minnedosa and the output of 10 million litres of ethanol. The inputs for wheat production are lower than for corn but so are the yields per acre.

Pimentel makes a negative case for the energy balance in ethanol production.[8] He notes that although 120 bushels per acre of corn yield 300 gallons of ethanol, its energy equivalent to gasoline is only 190 gallons because ethanol has a much lower BTU content than gasoline (76,000 BTU versus 120,000 BTU for gasoline per gallon). Furthermore, there is a significant net energy loss in producing ethanol when the fermentation and distillation process is taken into account. However, even assuming zero or no energy charge for the fermentation and distillation processes and charging only for the energy required to produce corn, the net ethanol energy yield from one acre of corn is only 50 gallons (190 gallons minus 140 gallons).

Other studies have reached far different conclusions. The table below summarizes other studies of the energy balance of ethanol production from corn in the United States.[9]

Table 1 -- Energy input assumptions of corn-ethanol studies

Study/year	Corn yield	Nitrogen fertilizer application rate	Nitrogen fertilizer production	Corn ethanol conversion rate	Ethanol conversion process	Total[1] energy use	Coproducts[1] energy credits	Net[1] energy value
	Bu/acre	lb/acre	Btu/lb	gal/bu	Btu/gal	Btu/gal	Btu/gal	Btu/gal
Pimentel (1991)	110	136	37,551	2.50	73,687	131,017 (LHV)	21,500	-33,517
Pimentel (2001)	127	129	33,547	2.50	75,118	131,062 (LHV)	21,500	-33,562
Keeney and DeLuca (1992)	119	135	37,958	2.56	48,470	91,196 (LHV)	8,078	-8,438
Marland and Turhollow (1990)	119	127	31,135	2.50	50,105	73,934 (HHV)	8,127	18,154
Lorenz and Morris (1995)	120	123	27,605	2.55	53,956	81,090 (HHV)	27,579	30,589
Ho (19891)	90	NR	NR	NR	57,000	90,000 (LHV)	10,500	-4,000
Wang, et al.(1999)	125	131	21,092	2.55	40,850	68,450 (LHV)	14,950	22,500
Agri. and Agri-Food Canada (1999)	116	125	NR	2.69	50,415	68,190 (HHV)	14,055	29,826
Shapouri et al. (1995)	122	125	22,159	2.53	53,277	82,824 (HHV)	15,056	16,193
This study (2002)	125	129	18,392	2.66	51,779	77,228 (HHV)	14,372	21,105

NR: Not reported
LHV: Low heat value = 76,000 Btu per gallon of ethanol. Keeney and DeLuca used 74,680 Btu per gallon of ethanol.

[8] Ibid
[9] Grant MacVicar, Manitoba Department of Energy.

HHV: High heat value = 83,961 Btu per gallon of ethanol. Lorenz and Morris used 84,100 Btu per gallon of ethanol.
[1] The midpoint or average is used when studies report a range of values.

As can be seen from the table, the net energy value ranges from a low of –33,562Btu/gal to a high of +29,826 Btu/gal. These discrepancies can be explained by the variables used in the studies and the economies of scale for the various ethanol facilities. The last study in the table was conducted by the United States Departments of Agriculture and Energy and is considered the most credible.[10] If production facilities have large enough scale, it appears that there is a net gain of energy in ethanol production. Pimentel's work is evidently somewhat out of date, because of technological improvements in ethanol production and the construction of large-scale plants. Pimentel's analysis may also be far too broad as well. The corn will be produced regardless, so it may not appropriate to include the actual production of corn in his analysis.

Even if it is accepted that minor energy gains are possible, the question remains whether it is economically useful to support the industry. Further work is required to prove this definitively.

Economics

The production and consumption of ethanol is another "value-added" enterprise that processes raw agricultural products, grains in this case, into a higher valued product. The promotion of value-added enterprises is an important component of most rural development strategies. Examples of value added agricultural industries include potato processing, oat milling, and forage compacting. In most cases, the creation of value-added industries is a sound economic strategy for rural communities. This is especially true if it can be done without subsidies. Subsidized value-added businesses are vulnerable to changes in government policy, budgetary constraints, and can be blindsided by price declines often brought about by over-supply.

Western Canadian agriculture is more dependent on international trade than any other region in Canada. Free and open access to world markets is vital, but western agriculture is vulnerable to trade actions by other countries. Whether these actions are fair or desirable is irrelevant for this discussion. They distort the market and create uncertainty, even if Canadian interests eventually prevail. In the case of ethanol production in Manitoba, all of it is consumed locally. A portion of Manitoba's grain crop, by being outside the system of international trade, may ostensibly have a more secure market. Diversifying markets and outlets for grain, whether for international or domestic markets, makes grain production more feasible. The problem with subsidies is that they distort the marketplace, raising input prices and creating more supply and lower prices.

Pimentel writes:[11]

"A recent report by the U.S. General Accounting Office which analyzed tax costs and federal farm program expenditures associated with projected increased ethanol production has added to our understanding of the complexities of ethanol production. The 1990 report concluded that: (1) increasing ethanol production would greatly increase tax-subsidy expenditures; (2) no projections could be made concerning any net federal budget savings from increasing ethanol production; and (3) an estimate of any overall federal budget

[10] MacVicar
[11] *Energy and Dollar Costs of Ethanol Production*, op. cit

impact was precluded because of the uncertainties about production economics for both ethanol and gasoline (GAO, 1990). In addition the report indicated that it was impossible to calculate how much higher the subsidies might have to be increased to encourage a measured expansion of ethanol production, if the expansion were needed at all."

Pimentel cites old studies from 1990[12], and it is evident that ethanol technology has improved since then.

In the case of Manitoba, as noted above, the production of EBG is supported by a 2.5 cents/litre road tax rebate on the final product. Thus the roughly 90 million litres of EBG produced in Manitoba represents a subsidy of $2.25 million per year in foregone tax revenue away from the Manitoba government. Expanded ethanol production would clearly require expanded subsidies.

Further, Manitoba is in the middle of a market-driven expansion in livestock production. Manitoba cannot produce enough feed grains to support this expansion and hence feed imports are required to sustain Manitoba's livestock industry. Direct subsidies for ethanol production will attract more feed grains to be converted to ethanol and exacerbate the feed shortage. Manitoba and indeed western Canada is a net importer of feed grain to supply the growing livestock sector. The province in particular has been in a feed deficit situation since the subsidy on the transportation of feed grains was removed. Manitoba's barley and wheat production has decreased and the province has been importing feed from Saskatchewan since 1996. Alberta, with its large cattle feedlot industry, competes with Manitoba for Saskatchewan feed grain. As Manitoba's livestock industry continues to grow, so will Manitoba's reliance on imported grain, primarily corn from the United States.

Since Manitoba's petroleum reserves are quite small, almost all of Manitoba's gasoline must be imported. Manitoba's gasoline "bill", the annual value of our imports of fossil fuels, runs at about $430,000,000 per year[13]. One justification for expanded EBG production in Manitoba is import replacement, that burning ethanol, a homegrown fuel, will displace imported fuel. The current consumption of EBG in Manitoba displaces about $2,000,000 worth of imported fossil fuel energy, which is roughly equivalent to Manitoba's current subsidy to the EBG industry. Corn is a slightly better feedstock than wheat and produces about 3% more ethanol per tonne. In addition, the oil in corn acts as an anti-foaming agent which further enhances corn's effectiveness.

Although Manitoba's EBG industry will probably rely mostly on wheat for the foreseeable future, the combination of availability and technical merit will cause corn to become more widely used. In Manitoba the combination of tight feed grain supplies due to an expanded livestock industry and decreasing domestic feed production coupled with the EBG industry's natural bias and understandable bias in favour of corn will result in more corn imports from the United States. Thus it is not at all certain that the EBG industry will replace imported energy. The production of EBG using imported corn will merely replace one type of imported energy with another.

If the Manitoba government subsidizes a significant increase in EBG production the result will be even tighter feed grain supplies causing shortages that will harm Manitoba's expanding livestock industry. Ironically, the government also promotes this other industry.

[12] Ibid.
[13] MacVicar.

In the U.S., the use of ethanol fuels has been mandated on environmental grounds but it is very difficult to establish an economic value for these benefits. While Pimentel[14] argues that there are only environmental costs, he does not place any emphasis on the environmental benefits, because calculating the environmental costs and benefits in dollar terms is extremely difficult. It is nearly impossible to put a value on reduced greenhouse gas emissions or any improvements in air quality brought about by the use of ethanol. This is especially true for the Province of Manitoba, an exceedingly small "player" in an economic and environmental sense when compared with the rest of the world and the United States. Any environmental improvement produced by the use of ethanol is not only difficult to quantify in dollar terms but would be miniscule in a global sense.

National Energy Security

The production and consumption of EBG can be considered as a source of homegrown energy that is theoretically immune from oil embargoes and international price shocks. Energy security as a rationale for more EBG production is more prevalent in the United States, given their reliance on imported fossil fuels, but the argument is also used in Canada. Theoretically, every litre of ethanol that is produced reduces local fossil fuel use by an equivalent amount and allows Canada to export that much more oil to the United States.

This argument is simplistic, because the dynamics and ingenuity of market systems result in a "feedback" mechanism that responds to commodity prices and market conditions. When energy prices rise, this feedback takes the form of the development of alternate energy sources, improved energy efficiency or the increased exploitation of oilfields that were previous not economical. In other words, the supply of petroleum is elastic, not just a fixed amount.

There have been constant warnings about the world and the U.S. in particular "running out of oil." Citing a number of sources, Bjorn Lomborg[15] shows that the price of oil (in U.S.$ 2000), measured from 1870 to 2000 has not had any long-term upward trend. Lomborg reviewed the literature concerning authoritative statements made by various agencies over the years and he writes:[16]

" We have long been told that we were running out of oil. In 1914 the U.S. Bureau of Mines estimated that there would be oil left over for only ten years' consumption. In 1939 the Department of the Interior projected that oil would last only 13 more years and again in 1951 it was again projected that oil would run out 13 years later. As Professor Frank Notestein of Princeton University said in his later years, 'We've been running out of oil ever since I was a boy.' "

Citing various sources, Lomborg shows that the development of oil reserves around the world far outstrips the expansion in demand.

Discussion

Given all this, there is ample room for debate about the merits of the Province of Manitoba's initiative to encourage and expand local ethanol production. The variables and unknowns, both from the environmental and economic perspectives, indicate an understandable level of uncertainty.

[14] Energy and Dollar Costs of Ethanol Production, op. cit
[15] Lomborg, op. cit.
[16] Ibid

Negligible Impacts on Climate Change

One of the most touted rationales for expansion of the ethanol industry in Manitoba is that ethanol production and usage does not contribute to the emissions of carbon dioxide, a major GHG. The Government of Manitoba is committed to the Kyoto Protocol and is urging Canada and the other provinces to sign on. But no matter what Manitoba does or does not do it is completely of no consequence on a worldwide basis. Manitoba's production of GHG is 20-26 mega-tonnes per year which is about 3% of Canada's total emissions. Canada, although a high per capita emitter of carbon dioxide, contributes a corresponding small proportion of the world's GHG emissions. Thus a government-mandated expansion of EBG production will have a negligible effect on the issue of climate change.

In fact the Kyoto Protocol itself will have no effect. Bjorn Lomborg presents an analysis of the expected effect of Kyoto and concludes, "… it is clear that the reduction in temperature corresponds to a mere six year's difference – the temperature that we would have reached in 2094 without a deal, Kyoto has now postponed to 2100."[17] Jerry Taylor, the Cato Institute's Director of Natural Resource Studies, also points out that were the treaty passed today, temperatures would be be only .07 degree cooler by 2050 according to the best weather models.[18]

Smarter Ways to Help the Environment

The production of EBG in Manitoba could not exist without subsidies, currently at a level of $.25/litre of ethanol produced. Mandating EBG in Manitoba will require an annual subsidy of $35 million to support this industry. As discussed above, the environmental benefits of mandated EBG in Manitoba are negligible, insignificant, and basically non-measurable If environmental improvement is a public policy goal in Manitoba, then Manitoba would be far better off spending that $35 million on projects that directly improve the environment. An example would be to enhance the ability of farmers and ranchers to change land use so that the production of public benefits from private land, such as clean water and wildlife, would be increased. The environmental benefits from such an expanded program would be significant, measurable, and obvious.

A bushel of wheat, much like a barrel of oil, is a commodity that can be the source of a variety of products. Thus a "new generation" ethanol industry would extract a number of value-added products from wheat, including ethanol. It is a moot point whether these facilities should even be labeled ethanol plants. The diverse product mix is sold directly in the marketplace or further utilized on site, as in the case of cattle consuming distiller's grain at the Lanigan site, where it supports other local business opportunities. Another example is the facility at Red Deer, Alberta which extracts gluten from wheat as its main product and makes ethanol from the starch that remains.

Government Has a Role in R&D

The creation of multi-purpose facilities that produce many products in addition to ethanol seems to be the proper direction for this industry. Changes in the price of one commodity are buffered by the prices received for the other commodities. This can be viewed as a form of cross-subsidization but, as in any diversified economy, high prices for one commodity one year allow the entire operation to survive until prices return for the remaining products. This

[17] The Skeptical Environmentalist: Measuring the Real State of the World, op. cit

[18] Jerry Taylor, On Global Warming, Cato Audio September 2002.

obviously does not apply if the price for one of the products remains far below the cost of production.

There is a role for governments in further research and development. Despite the existence of established EBG companies, the industry is still very small and can be considered a work in progress. It is appropriate for the Manitoba Government to provide limited support to this industry and, more importantly, to support the appropriate research and development projects that will focus on new product development such as “nutraceuticals” that can be produced along with ethanol.

Direct Subsidies will Ultimately Harm Rural Diversification

However, given the economic and environmental uncertainties associated with EBG production and use, the Government of Manitoba should not mandate it. Nor should there be an expansion in the level of subsidy to the ethanol industry. Such actions may well be counter-productive, with negative environmental and economic consequences. Mandating and subsidizing EBG in Manitoba would have the perverse effect of harming rural economic diversification and development by exacerbating the feed grain shortage at a time when increasingly feed grains are required by an expanding livestock industry.