STRATEGIC MARKET MANAGEMENT SYSTEM

BIODIESEL FUEL/ADDITIVES

June 25, 2002

Prepared for:
Agriculture and Agri-Food Canada

TABLE OF CONTENTS

This is one of 15 companion documents to an AAFC-funded study, *Non-food/Non-feed Industrial Uses for Agricultural Products.* In most cases, information contained in each companion document was obtained with the assistance of a Sector Advisor who is considered to be a leader in that particular technical field.

1.0 Market analysis

1.1 Review of Ashmead's report

At the time Ralph Ashmead conducted his study (1997), Canada did not produce any biodiesel fuel, and he did not predict any growth in the Canadian market by 2005. Although he reported interest in Europe and the US in the environmental benefits of biodiesel fuel, he felt there was little market opportunity because of the higher cost of biodiesel fuel.

Ashmead believed the key to overcoming the market weakness for biodiesel was to:

- develop technology that could bring down the fuel price to levels approaching petroleum diesel
- overcome the market resistance from existing fuel suppliers
- find access to pools of investment capital to build a biodiesel infrastructure.

1.2 Response to Ashmead's report

The cost of pure biodiesel (B100) in the US has fallen from US$4.50 per gallon in 1997 to US$1.00 per gallon in 2001.[1] The noncompetitive price of biodiesel fuel becomes even less of an issue when it is used as a blend of 20% (B20) or less and becomes largely irrelevant when used as a fuel additive at 0.5 to 2.0%.

Original equipment manufacturers now support the use of biodiesel as a lubricant additive, provided it meets industry standards (i.e., American Society for Testing Materials provisional standard PS 121, and those of original equipment manufacturers).[2]

---

1 K. S. Tyson, J. Brown and M. Moora. Industrial Mustard Crops for Biodiesel and Biopesticides. National Renewable Energy Laboratory.

2 The New Diesel Fuels: They Are In Your Future for Nonroad Equipment. Equipment Manufacturers Institute. November, 2001.

Other barriers to market growth, like system inertia and access to capital, will be overcome as regulations mandating low sulphur and renewable fuel standards are enacted.[3]

If other tax incentives (similar to the excise tax incentives for ethanol) are extended to biodiesel, many of the impediments to growth will have been removed.

The size of the biodiesel market in Canada will depend largely on the new sulphur reduction standards and whether Canada chooses to implement a renewable fuel standard. Extending an excise tax exemption to biodiesel, similar to the approach to ethanol, would also be a key factor.

Assuming a renewable fuel standard starting at 0.8% and rising to 2.0% in 2010, the market demand for biodiesel in Canada could start at 170 million litres and rise to 424 million litres by 2010. Using canola as an example, it would increase canola seed sales in 2010 by 879,800 tonnes or 10.2% of the 8,798,000 tonnes produced in 1999.[4]

If the renewable fuel standard is set at 5% (the level being proposed in both Europe and the US), the market demand would be 1,060,000 litres of biodiesel, or 2,199,500 tonnes of canola seed, which is 25.5% of the canola crop production in 1999.

The huge projected demand for biodiesel opens up tremendous market opportunities for oil seed crops like soybean and canola. In fact, the demand is so great that domestication of other specialty oil seed crops, like industrial mustard,[5] should be examined closely. Research on edible mustard is well developed in western Canada and could form an important research base for investigating industrial varieties.

1.3 The US biodiesel industry

The US is the largest soybean producer in the world. It produces an annual crop of 2.7 billion bushels, the equivalent of about 4 billion gallons of oil.[6] Almost 1 billion bushels are surplus and are carried over into the next year.

---

3 Providing Cleaner Air to Canadians. Environment Canada. February, 2001.

4 Uses figures from SARD Report #4 that calculated market demand based on a 0.5% additive to all highway diesel fuel sold in Canada.

5 See the recent report by K. S. Tyson, J. Brown and M. Moora. Industrial Mustard Crops for Biodiesel and Biopesticides. National Renewable Energy Laboratory.

6 Soy Lubricants Technical Background. United Soybean Board. February 2000.

Thirty-five (35) million gallons of biodiesel were produced in the US in 2001.[7] Over 100 major US vehicle fleets are using biodiesel blended fuel. In addition, biodiesel is being used by boaters in Florida and California where B100 is being used to protect the marine environment, reduce the noxious smell of diesel fuel, and prevent black exhaust residue from forming at the stern of the boat.[8]

Biodiesel producers and marketers include:

- Ag Environmental Products (Lenexa, KS)
- American Biofuels, Inc. (Bonita, CA)
- Biodiesel Industries (Marathon, FL)
- Columbus Foods (Chicago, IL)
- Griffin Industries (Cold Spring, KY)
- Ocean Air Environmental (Lakeland, FL)
- Peter Cremer N.A. (Cincinnati, OH)
- Southern States Power (Ontario, CA)
- Stepan Company (Northfield, IL)
- West Central Soy (Ralston, IA)
- World Energy Alternatives (Chelsea, MA and Half Moon Bay, CA)
- Imperial Western Products (Indio, CA).

If just 1% biodiesel were blended with highway diesel fuel, over 300 million gallons of biodiesel production would be required. To produce 300 million gallons of biodiesel fuel would take approximately 194 million bushels of soybeans. This figure is based on the assumptions that 7.3 pounds of soybean oil are required to produce one gallon of biodiesel and that there are 11.3 pounds of soybean oil in one bushel of soybeans.[9]

According to the Renewable Fuels Association, a renewable fuel standard could increase US biodiesel production to 809 million gallons by 2016.[10]

---

[7] Establishing a Renewable Fuels Standard as Part of A National Energy Policy. Renewable Fuels Association.

[8] Southern California Harbor Makes Biodiesel Available to Mariners. National Biodiesel Board news release, May 2, 2002.

[9] The New Diesel Fuels: They Are In Your Future for Non Nonroad Equipment. Equipment Manufacturers Institute. November 2001.

[10] Establishing a Renewable Fuels Standard as Part of A National Energy Policy. Renewable Fuels Association.

According to the American Biofuels Association, biodiesel sales could reach about 2 billion gallons per year, or about 8% of highway diesel consumption, with government incentives comparable to those provided for ethanol.[11]

1.4 Potential biodiesel industry in Canada

Canada grows canola in the west (Alberta, Saskatchewan, Manitoba)[12] and soybeans in the east (Ontario and Quebec). In 1995, canola was planted on 3.3 million hectares and produced 6.4 million tonnes of oil, of which about 45% was exported. In the same year, soybeans were planted on 500,000 acres and produced 2.2 million tonnes of oil.

Despite the large canola oil output, the use of canola biodiesel as a total fuel replacement is not practical. It would require 11 times the acreage of all the canola grown in Canada to replace the diesel fuel used to satisfy current highway transport diesel fuel requirements.[13]

If a biodiesel industry develops in Canada, it will likely focus on B20 blends and on fuel additives of less then 2%. Canada may have an advantage in the fuel additive market. Research conducted in Saskatchewan using canola oil has found that small amounts of canola biodiesel, typically less than 1% (i.e., 0.1 to 0.5%), can be used successfully as a lubricant additive, particularly in winter diesel fuel. Even these small amounts of biodiesel have resulted in substantial improvements to fuel efficiency (2 to 13%) and reduction in engine wear (9 to 57%). What's more, economic modelling based on the findings of laboratory studies have found that a large diesel truck running 250,000 km per year using a 0.5% canola biodiesel lubricant additive would result in almost $4,000 per year in net economic savings for the owner, based on a 4% improvement in fuel economy and reduced engine wear of 50%.[14]

Biodiesel using canola, therefore, seems to have considerable potential in Canada:[15]

- < There could be widespread application of biodiesel, particularly in winter, when diesel fuel quality is low.

[11] Reported by the Alternative Fuels Data Center, http://www.afdc.doe.gov/altfuel/bio_general.html#market

[12] The actual breakdown, on average over the long term, is 40% Alberta, 40% Saskatchewan, and 20% Manitoba. Personal communication from Zenneth Faye.

[13] Barry Hertz et al. SARD Report #4, March 2001.

[14] Barry Hertz et al. SARD Report #4, March 2001.

[15] SARD Report #4.

- The fuel efficiency gains could result in substantial reductions in green house gas emissions from diesel engines, if used widely.[16]
- Use as a lubricant appears to be cost-effective, particularly when improvements in both fuel conservation and engine wear reduction are taken into account.

- Only a small fraction of the total Canadian oilseed production (in the range of 3%) would be needed to supply enough vegetable oil for conversion to biodiesel lubricant to add 0.5% (for example) to all diesel fuel used in Canada.

The total Canadian diesel fuel market in 1999 was 22,171 million litres. If canola biodiesel were used as a lubricant at 0.5%, it would require 106 million litres of biodiesel, the equivalent of 219,950 tonnes of seed or 2.55% of the 8,798,000 tonnes produced in Canada in 1999.[17]

[16] Barry Hertz et al., in SARD Report #4, report a net savings in GHG emissions of 4.13%.

[17] SARD Report #4.

2.0 Public policy

2.1 Biodiesel and sustainable development

Biodiesel is the name for a variety of ester-based oxygenated fuels made from vegetable oils like soybean and canola oil, animal fats, and recycled waste cooking oils. As a result of the new ASTM standard, these feedstocks can be used individually or blended together to produce biodiesel fuel, so long as the blend meets the ASTM performance standard.

2.1.1 Environment

Biodiesel has been called a "liquid solar energy" because it is produced from renewable oilseed crops that are grown and harvested repeatedly in what experts call a "closed loop carbon cycle." As they grow, the crops take up carbon dioxide and then release it back into the air when biodiesel is burned.[18]

A US government study by the Departments of Energy and Agriculture found biodiesel reduced CO_2 emissions by 78% over its life cycle compared to petroleum diesel, and it had a positive energy balance of 3.2 to 1 compared to diesel fuel's 0.83 to 1.[19]

2.1.2 Energy security

Unlike Canada, both Europe and the US import most of their oil. The US currently imports 57% of its oil and this is forecast to rise to 65% by 2020.[20]

This trend and the growing market influence of the OPEC cartel, which controls about 50% of the market, have raised grave concerns in the US about their energy and economic security. Recent studies by the US Department of Energy have pointed to the serious macroeconomic impacts on the US economy from monopoly oil pricing.[21]

Biodiesel (along with ethanol) offers a means of reducing that dependency by substituting imported oil with domestic production.

---

[18] See http://www.mnsoybean.org/showpages.cfm?pageid=575

[19] Reported in The New Diesel Fuels: They Are In Your Future for Nonroad Equipment. Equipment Manufacturers Institute. November 2001.

[20] David L. Greene et al. The Outlook for US Oil Dependence. Oakridge National Laboratory. May 11, 1995. Also see Paul Leiby et al. Oil Imports: An Assessment of Benefits and Costs. Oakridge National Laboratory. November 1997.

[21] David L. Greene et al. The Outlook for US Oil Dependence. Oakridge National Laboratory. May 11, 1995. Also see Paul Leiby et al. Oil Imports: An Assessment of Benefits and Costs. Oakridge National Laboratory. November 1997.

2.1.3 Health and safety

This summer Ontario had the largest number of smog warnings in the province's history. There is growing concern among health professionals that air pollution is a serious health hazard contributing to respiratory illnesses and premature deaths, especially among the young, the elderly, and those with respiratory and cardiac conditions. Environment Canada reports that federal studies show that 5,000 deaths can be attributed each year to air pollution.[22] The Toronto Public Health Department believes air pollution claims 1,000 lives each year in the city and causes numerous health-related problems.[23]

The health impacts are also placing a burden on an already stretched public health care system. The Ontario Medical Association claims that air pollution costs citizens of Ontario more than $1 billion annually in hospital admissions, emergency room visits, and absenteeism.[24]

Increased use of biodiesel (along with ethanol) would help to address this important health and safety issue. According to the National Biodiesel Board, biodiesel *"reduces carcinogenic air toxics by 75-90% compared to diesel fuel. Pure biodiesel (B100) is also non-toxic, biodegradable, and essentially sulphur free."*[25]

2.2 Regulatory change is now the main market driver

All three sustainable development issues have led to ongoing discussions about regulatory reform, particularly in the transportation fuels sector.

2.2.1 Transition to low sulphur transportation diesel fuels in the US and Canada

Diesel fuel in the US typically contains sulphur levels of about 350 ppm in on road fuel and 3,500 ppm in off road fuel. Sulphur has been found to reduce engine life and pollute the air.

The US Environmental Protection Agency (EPA) intends to reduce the sulphur content in on road diesel fuel to 15 ppm starting in June 2006. The sulphur content for off road diesel transportation fuels will be lowered to less than 500 ppm starting with the 2006 model year, and it intends to lower the standard further, to 15 ppm beginning in 2009 or 2010.

---

22 "Clean Air," Green Land, Environment Canada web site.

23 "Clean Air," Green Land, Environment Canada web site.

24 "Clean Air," Green Land, Environment Canada web site.

25 Referenced in ASTM Issues Biodiesel Fuel Standard. National Biodiesel Board news release, May 3, 2002. Use of biodiesel in enclosed spaces like underground mines has been suggested in some studies. See, for example, Biodiesel Use in Underground Metal and Non-metal Mines. National Biodiesel Board.

Reducing sulphur levels affects lubricity and can result in high rates of fuel injection component wear and potential premature failure. Field experience with these fuels has led to widespread use of fuel additives. The use of biodiesel as a lubricity additive for solving the problems of low sulphur content has been supported by the Fuel Injection Equipment industry.

Under Canada's Clean Air Campaign, launched in May 2000, Canada is now committed to aligning its regulatory controls to the more stringent air quality standards of the US.[26] The US regulations requiring low sulphur content will therefore also apply to Canada.

2.2.2 Renewable fuel standards in the EU and the US

For all of the environmental, economic, and social reasons discussed above, the European Union's (EU) Directorate for General Transport and Energy has drafted a proposed rule that would require each member state to use a minimum of 2% biofuels in their transportation fuels by 2005 and increase to 5.75% by 2010. Each member state must approve the rule before it goes to the EU Council of Minister and the EU Parliament for final approval. This is a process that can take several years.

The US is also considering legislating renewable fuel standards for the same environmental and energy security concerns. The US Congress has introduced legislation calling for the mandatory use of renewable fuels like biodiesel, ethanol, or biogas in motor vehicle fuels sold in the US. One of the proposed bills calls for a refiner, blender, or fuel importer to ensure that motor vehicle fuels contain not less than 0.8% renewable fuel beginning the calendar year of 2002 and then increase in percentage every year until it reaches 5.0% in 2016.

Canada's decision to align its air quality regulations with the US will create pressure on Canada to adopt similar renewable fuel standards.

2.2.3 US Senate Energy Bill

The US Senate Energy Bill (S517) approved in 2002 contains various provisions that will help promote biodiesel markets in the US:

- **biodiesel excise tax incentive** — blender will receive a one-cent reduction in excise tax for every 1% of biodiesel blend made from virgin vegetable oil up to 20% of the total content
- **blenders tax credit** — one half cent per percent up to 20% tax credit for biodiesel made from reccycled oils and animal fats
- **renewable fuel standard** — biodiesel eligible to meet five billion gallon renewable fuel standard

---

[26] Providing Cleaner Air to Canadians. Environment Canada. February 2001.

- **federal fleet use** — requires federal government fleets to use ethanol or biodiesel when they are cost competitive.

None of these provisions supporting biodiesel were included in the House of Representatives Energy Bill (HR 4) which passed the House in 2001. The differences will be reconciled shortly in a joint House/Senate Conference Committee.[27]

The US Senate farm bill also calls for a four-year $20 million biodiesel education program.[28]

2.2.4 State legislation

Minnesota passed a bill on March 15, 2002 requiring the majority of the state's diesel fleet to use B2 no later than June 30, 2005. The requirement could also be implemented within 18 months following the construction of a biodiesel plant with an eight million gallon capacity and after the federal government enacts a two-cent per litre excise tax exemption for B2. This is the first state in the US to mandate B2. The law is expected to create a demand for 11 million bushels of soybeans.[29]

2.2.5 Market impacts from US regulatory reform

The US Department of Agriculture has tried to estimate the industrial uses markets for soybeans through to the year 2010 using two scenarios.[30] The low scenario depends on implementing current policies and programs while the high scenario includes additional regulatory intervention in the market place. The two scenarios are summarized below.

Low scenario—assumes:

- USDA bioenergy program ($300 million in cash payments over two years to bioenergy companies to encourage plant expansion)
- federal, state, and local alternative fuel procurement programs
- 10% annual growth in demand for soybean-based lubricants and hydraulic fluids, adhesives, and coatings (based on effects of President's Executive Order and increasing interest by private sector in biobased products).

---

[27] Senate-Approved Energy Bill Offers Significant Boost to Biodiesel Industry. National Biodiesel Board news release, April 26, 2002.

[28] Farm Bill Includes Biodiesel Education Program. National Biodiesel Board news release, February 14, 2002.

[29] Landmark Biodiesel Legislation Passes Minnesota. National Biodiesel Board press release, March 15, 2002.

[30] Economic Analysis of Increasing Soybean Oil Demand Through The Development of New Products. United States Department of Agriculture.

High scenario—assumes:

- current policy and programs
- a minimum renewable fuel requirement of 1.5% by 2011
- the introduction of low sulphur content regulations for highway fuels.

The low scenario boosted markets from 183 million pounds in 2001 to 514 million pounds in 2010. The study estimated that biodiesel accounted for 462 million pounds and lubricants, hydraulic fluids, adhesives, and coatings accounted for the balance (52 million pounds).

The high scenario pushed the markets to almost 3 billion pounds by 2010. Biodiesel accounted for 1.9 billion pounds with the balance of 1.04 billion pounds coming from increased markets for lubricants, hydraulic fluids, adhesives, and coatings.

The economic impacts from implementing a low sulphur content and a renewable fuel standard (1.5%) was estimated to:

- increase the price of a bushel of soybeans by 17 cents annually during the 10-year period
- increase the annual price of soybean oil by 22%
- boost total crop cash receipts by $5.2 billion cumulatively by 2010
- increase average net farm income by $300 million per year
- add 13,000 jobs in the farm, food processing, and manufacturing and service sectors
- lower the trade balance by an accumulative $1.55 billion over the 10-year period.

The Senator Charles Grassley, Republican for Iowa, has been quoted as saying *"This report is very good news for soybean producers. Their commodity is the basis for value-added products that increase farm income, enhance rural communities, make America more energy independent, and clean up the environment."*[31]

[31] Washington DC press release. Posted on National Biodiesel Board web site. July 17, 2001.

3.0 Science and technology

3.1 Biodiesel research in Canada

Biodiesel processing technology is well advanced in Europe and could easily be licensed and applied to Canada. However, several Canadian technologies are near commercialization.

Milligan BioTech Inc. has been operating a biodiesel pilot plant in Saskatchewan since March 2001. The biodiesel is being used as a fuel conditioner and they are test marketing it across Canada. The plant capacity is approximately 450,000 – 500,000 litres per year.[32]

BIOX Corporation in southern Ontario has patented a technology that it claims can dramatically reduce the costs of biodiesel production. By the fall of 2002, the company intends to build a biodiesel plant in Ontario using soybean oil, animal fats, and recycled cooking oil. BIOX claims they can build one of the world's largest biodiesel plants if an excise tax exemption can be extended to biodiesel fuels and access to capital financing can be secured.[33]

3.2 Other relevant technologies

Another potential source of diesel fuel is yellow grease and tallow (and possibly poultry fat and waste water plant-generated lipids), which can be converted to a low sulphur, high cetane premium diesel blending stock called AGTANE (AGricultural ceTANE)[34] *"When AGTANE is blended with regular diesels, the resulting fuel burns more efficiently and with cleaner emissions. Particulate matter and NO_x emissions are significantly lowered."*[35]

A second technology worth monitoring is the Thermal Depolymerization and Chemical Reforming (TDP) process, which converts organic wastes (like manure, slaughterhouse wastes, and food processing wastes) into oils, gases and carbon using water, pressure and temperature. A $15 million, 200 ton per day demonstration plant is being built in Carthage, Missouri, next to ConAgra's Butterball turkey processing plant. The US Environmental Protection Agency has provided a $5 million grant, and ConAgra Foods Inc. has entered into partnership with Changing World Technologies to commercialize the technology. The US oil industry is reported to be

[32] **Personal communication from Zenneth Faye, March 17, 2002.**

[33] http://www.bioxcorp.com/

[34] A. Spartaru, J. Monnier, AGTANE (AGricultural ceTANE): An economically viable bioenergy product for compression ignited engines. CANMET Energy Technology Centre.

[35] Ibid.

supportive of the technology because they can take the crude oil from the TDP process and refine it into gasoline and other products.[36]

Finally, DynaMotive (Vancouver, BC) has a patented pyrolysis system that transforms forest and crop residues into BioOil. The company has a 10 tonne per day pilot plant at BC Research Inc. in Vancouver that has been operating since March 8, 2001. The first commercial application will produce electricity in the UK from forest residue to power Orenda gas turbines. A second commercial application will use forest waste to power industrial boilers, kilns, and engines at a saw mill site. The company's partners include Canadian Forest Products (Canfor), Resource Transforms International, Orenda Turbines / Maggellan Areopsace (Canada), Eco-Securities, Cosan Bon Jesus, Tecna Engineering Argentina, China Energy Holdings Limited, Technology Partnerships Canada, Natural Resources Canada, and the Department of Trade and Industry (UK).[37]

Neither AGTANE, nor the crude oil from the TDP process, nor DynaMotives BioOil are biodiesel fuels, but they may impinge upon the biodiesel market or compete with biodiesel technologies (e.g., BIOX) for the same organic waste streams.

3.3 Industrial standards have been established

Automotive industry acceptance of biodiesel fuel is critical for future market expansion. Original equipment manufacturers now support the use of biodiesel as a lubricant additive, provided it meets industry standards (i.e., American Society for Testing and Materials (ASTM) provisional standard PS 121 and those of original equipment manufacturers).[38] The Canadian General Standards Board has also announced that it will approve in principle the adoption of the ASTM standard for biodiesel.[39] On May 3, 2002, ASTM announced release of the final specification (D6751).[40]

[36]"ConAgra Signs Environmental Technology Agreement with Changing World Technologies." ConAgra news release, Dec. 5, 2000. Also see Oil from offal...a poultry plus. *Kansas City Star*, July 28, 2001.

[37]Communication from DynaMotive, May 2, 2002.

[38]The New Diesel Fuels: They Are In Your Future for Nonroad Equipment. Equipment Manufacturers Institute. November 2001.

[39]Reported in the Canadian Renewable Fuel Association newsletter, January 2002.

[40]Referenced in ASTM Issues Biodiesel Fuel Standard. National Biodiesel Board news release, May 3, 2002.

John Deere announced on December 3, 2001, that it approved the use of soy diesel in all its diesel-powered products.[41] Caterpillar, Cummins, Detroit Diesel, and International have also approved biodiesel for use in their engines.

3.4 Municipalities in Canada are piloting biodiesel blends

The largest municipal biodiesel project in North America is being undertaken by the City of Montreal, which is testing a range of biodiesel fuels (from B5 to B20) in a fleet of 140 buses. Partners in the project are Montreal Transit, Sine Nominee Marketing, Environment Canada, and TWD Technologies.[42]

The City of Brampton is also conducting a three-month field test of a soy diesel blend in 16 trucks. If successful, it will be expanded to include Brampton's 130 public transit buses and the entire 415 vehicle municipal fleet. This pilot could lead to other cities in the Greater Toronto Area following suit in an effort to reduce smog in the region. The fuel is being supplied by Big K Fuels Inc. in Etobicoke.[43]

More than 100 major vehicle fleets in the US are currently using B20 including the US Postal Service, the City of Philadelphia, USDA, several public transit systems, national parks, school districts, and NASA.[44]

3.5 Field testing by private companies.

One hundred of Toronto Hydro's cars, vans, and trucks will begin using B20 through the winter of 2001/2002. If testing is successful, Toronto Hydro wants to use vegetable oil fuel in all its vehicles.[45]

---

[41] John Deere Approves Eco-Friendly Biodiesel Fuel for its Products. John Deere press release, December 3, 2001.

[42] Reported in the Canadian Renewable Fuel Association newsletter, January 2002.

[43] Call it tofu for your truck's engine. *Toronto Star*, May 21, 2002.

[44] Referenced in ASTM Issues Biodiesel Fuel Standard. National Biodiesel Board news release, May 3, 2002.

[45] Toronto Hydro press release, October 15, 2000.

3.6 Industrial mustard—a new crop for biodiesel and biopesticides

If a renewable fuel standard is adopted in Canada, the demand for biodiesel fuel and lubricant additives could rise exponentially. Biodiesel feedstock resources are limited. Recycled greases and animal fats produce an inexpensive biodiesel fuel, but their supply is limited, and there are concerns being expressed in Europe that recycled cooking oils may adversely impact the quality of biodiesel and damage the industry's reputation. Consideration should also be given to the cultivation of additional oilseed crops so that demands on canola and soybean do not disrupt existing markets for animal feed.

The Office of Fuels Development at the US National Renewable Energy Laboratory (NREL) is currently searching for a crop that could produce 6-12 billion gallons per year at 10 cents a pound. At that level, biodiesel could supply 10-20% of the total diesel market at under $1.00 per gallon.

NREL is currently in the middle of a three-year study of the potential use of industrial mustard as a source of biodiesel and biopesticides. So far their research is very promising:

- The defatted meal (after the oil is removed) can be used as a pesticide without further processing.
- In vitro breeding can improve the glucosinolate concentration in the meal to reduce costs.
- Specific varieties can be bred to act as fungicides, insecticides, herbicides, or nemcides.
- Oil content varies between 25 to 40%.
- Depending on the variety, the oil is 90% monosaturated or more in some cases.
- The oil is inedible and not suitable for high value industrial purposes, so its market price will not be tied to increases in food crop prices or other markets.
- Crop yields of two tons per acre of seed appear to be achievable in rotation with dry land wheat production without irrigation.
- Wheat yields have increased as much as 20% when grown in rotation with industrial mustard.
- The mustard crop can be planted and harvested with existing wheat equipment.
- The mustard crop appears to be resistant to many of the pests common to canola.
- Application trials with mustard meal have shown to be highly effective with fungus, nematodes, cut worms, wire worms, crab grass and other agricultural pests.
- Mustard meal can be used directly on soils as a substitute for methyl bromide fumigation.

The use of industrial mustard as a biopesticide could provide an alleopathic benefit to subsequent crops, and offer great value to organic farmers and urban residents who are anxious to reduce the use of chemical pesticides.

Western Canada is currently growing edible varieties of mustard as a specialty crop. This experience and research base could be used to develop industrial varieties. Genetic markers would have to be developed to help ensure identity preservation.

4.0 Conclusions

Biodiesel fuel, particularly when used as a 2% fuel additive, offers an enormous market opportunity for Canadian agriculture. However, for these markets to expand, the same proactive public policy initiatives currently being discussed for ethanol (i.e., a renewable fuel standard, tax incentives, etc.) must be extended to biodiesel fuel production.

Canada already owns several technology patents that have commercial potential. One biodiesel pilot plant already exists in Saskatchewan, and a large commercial-scale biodiesel plant is being proposed in Ontario.