Economic Feasibility of Biodiesel Production in North Dakota

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ABSTRACT

The U. S. biodiesel industry is rapidly expanding due to energy production concerns, environmental concerns, and recent legislation. The most common type of biodiesel in the United States is derived from soybean oil. Soybeans are a major crop in North Dakota and could easily supply a 5 million gallon per year biodiesel facility. Potential market segments of a biodiesel facility in North Dakota include agriculture, construction, and state fleet sectors based on current diesel use. However, with existing technology and no subsidy, biodiesel operation and investment costs for a North Dakota facility are not competitive with petroleum diesel. Using soybean oil prices of 17 cents to 25 cents per pound, the per gallon cost of producing diesel in southeastern North Dakota ranges between $2.02 and $2.64, while the wholesale price for regular diesel is $0.91. The cost of producing biodiesel is highly dependent on the price and availability of soybean oil. While biodiesel production technology is feasible and fairly simple, producing biodiesel in North Dakota is not economically feasible at least in the foreseeable future.

Key Words: biodiesel, soybeans, economic feasibility

ECONOMIC FEASIBILITY OF BIODIESEL PRODUCTION IN NORTH DAKOTA

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INTRODUCTION

This report evaluates the market feasibility of establishing a biodiesel production facility in North Dakota. The analysis reviews existing diesel market segments in the state, identifies the market potential for biodiesel in the state, determines economic profitability and investment costs, develops a strategic approach based on both existing and future competition in the region, and suggests important factors influencing site location. Finally, the economic impact of a biodiesel plant on total business activity, employment, and state tax revenues is determined. A companion report to this study reviewed the technical qualities of biodiesel (Independent Biodiesel Feasibility Group).

GROWING INTEREST IN BIODIESEL

Interest in biodiesel is growing for various reasons. United States energy production concerns are at the top of this list. Other reasons for the growing interest in this alternative fuel include environmental concerns and recent legislation.

Energy Production Concerns

The market for biodiesel developed gradually in the United States, but recently a number of factors have caused it to grow rapidly. One factor is energy production concerns. Energy consumption in the United States exceeds energy production, and this gap is forecasted to increase (Figure 1).

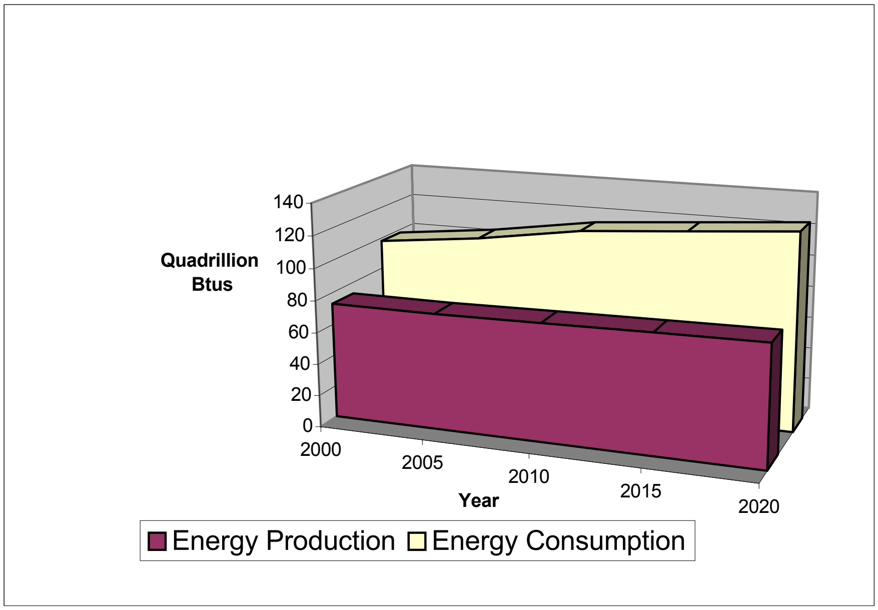

Figure 1. Energy Production Versus Consumption

The National Energy Policy Development Group's 2001 report examines the nation's current and future energy production and consumption. By the year 2020, energy consumption in the United States is forecasted to increase by 32 percent. More specifically, the report indicates U.S. oil production will decrease from 5.8 to 5.1 million barrels per day (bpd), while consumption will increase to 25.8 million bpd. This gap increase means more dependence on foreign sources for oil. In 2000, the U.S. supply of oil from imports was already 52 percent. This number is forecasted to increase to 64 percent by 2020.

Oil is the country's leading source of primary energy, making up about 40 percent of U.S. energy requirements. Transportation fuels account for approximately 67 percent of U.S. oil consumption. Transportation fuels are especially significant in certain parts of the country, like North Dakota. For example, the transportation sector makes up a large portion of oil consumption in the western states (National Energy Policy Development Group).

Average consumption of gasoline and diesel in OECD (Organization for Economic Co-operation and Development) countries was 900 million tonnes from 1996-1999 (Agriculture and Agri-food Canada). The United States accounted for the largest share (51 percent) followed by the European Union (EU) (26 percent). However, considerable differences exist between countries in their use of gasoline and diesel. In the United States and Canada, gasoline accounted for 77 percent and 72 percent of the total fuel demand, respectively. In the EU and Japan, gasoline accounted for only 48 percent and 57 percent, respectively. If U.S. energy policy and resulting diesel usage approaches that of the Europeans, dependence on diesel fuels will likely increase.

The energy supply and demand gap needs to be addressed. This obstacle can hopefully be overcome with technological innovations that help increase the country's energy supply. Although no easy answer exists, the production and use of renewable fuels like soy biodiesel could narrow this gap.

Environmental Concerns

Environmental concerns have also had a large impact on the increasing interest in biodiesel. High carbon dioxide and sulfur levels in the atmosphere, along with climate changes are major issues. Biodiesel has many environmental benefits that directly address these concerns. A 20 percent biodiesel blend can reduce particulate matter by 15 percent, carbon monoxide by 20 percent, and hydrocarbons by 30 percent (National Biodiesel Board). Pure biodiesel contains no sulfur, thus reduces sulfur dioxide exhaust. In addition, the potential for biodiesel to form ozone is half that of regular petroleum diesel. Another environmental benefit attributed to biodiesel is reduction of carbon dioxide in the atmosphere. The production and use of biodiesel from organic oils such as soybean, produces a closed carbon cycle, meaning a reduction in the net amount of carbon dioxide in the biosphere (National Biodiesel Board).

Feasibility of Production Technology Increasing

The EU chose biodiesel to be its main renewable liquid fuel. Fuel use of ethanol in the EU is much less important. Low European corn production and a high proportion of diesel engines compared to the United States make biodiesel a more attractive alternative in the EU. The primary organic oil used to make European biodiesel comes from rapeseed. Biodiesel use is particularly strong in Germany, where B100 (100 percent organic diesel) is untaxed. Biodiesel production expanded rapidly in the EU since 1992, and an estimated 1 million metric tons (300 million gallons) were produced in 2001, requiring the use of 1.5 million hectares (3.7 million acres) of land for oilseed production. Proposals from the EU Commission called for biofuels to account for 2 percent of fuel use in 2005 and 5.75 percent by 2010. Biodiesel is expected to make possible most of the increase, given the maturity of the biodiesel processing and distribution infrastructure.

Biodiesel Legislation

Another key factor in the expanding biodiesel market is recent legislation. The U.S. Senate approved Energy Bill, S. 517 on April 25, 2002, which includes provisions for biodiesel. These provisions contain a biodiesel excise tax incentive, renewable fuels standard, blenders tax credit, amendment of the EPAct, and federal fleet use requirement (S.517, H.R.4, *Biodiesel Bulletin*, May 1, 2002). The Biodiesel Excise Tax Incentive provides blenders of biodiesel with a 1-cent reduction in diesel excise tax for every percentage of biodiesel made from virgin vegetable oil, up to a 20 percent content. A Blender's Tax Credit also offers a 1/2-cent per percent up to a 20 percent tax credit for biodiesel made from recycled oils and animal fats. The

Renewable Fuels Standard specifies biodiesel as an eligible fuel that can help meet a 5 billion-gallon fuels standard. The EPAct amendment removes the 50 percent limit on biodiesel use for government fleets. Finally, the legislation requires the federal government to use biodiesel when cost competitive (*Biodiesel Bulletin*, May 1, 2002).

On March 15, 2002, Minnesota passed legislation creating a new law requiring a majority of the state's diesel to include 2 percent soy biodiesel. This law will be put into action no later than June 30 of 2005, and possibly could be implemented earlier if an 8 million gallon per year (MGY) biodiesel plant is constructed in Minnesota and the federal government provides a two-cent incentive for a B2 biodiesel blend (S.F.1495, *Biodiesel Bulletin*, March 29, 2002). Minnesota is the first state to require the use of biodiesel (*Biodiesel Bulletin*, March, 29, 2002).

Biodiesel Specification

In May of 2002 the American Society of Testing and Materials (ASTM) issued Specification D 6751 for biodiesel fuel. ASTM is the U.S. premier organization that sets standards for additives and fuels (National Biodiesel Board). Specification D 6751 covers all biodiesel fuel bought or sold within the United States that is blended with conventional diesel up to 20 percent (National Biodiesel Board). This standard protects people who purchase biodiesel which contains poor quality products. It will help decrease the cost of both buying and selling biodiesel. This specification also has warranty implications. Manufacturers of diesel equipment can now adopt this specification, indicating that use of biodiesel will not void engine warranties. The culmination of the events described has been a catalyst for biodiesel production.

Biodiesel Opportunities in North Dakota

Soybeans are a major crop in North Dakota, and therefore North Dakota has potential to play a vital role in the biodiesel market. Soybean oil is one of a number of feedstocks that can be used to make biodiesel. Construction and operation of a biodiesel plant could provide rural economic development opportunities by increasing demand for agricultural products and demand for labor.

Increasing interest in biodiesel is evident in North Dakota. Approximately 20 retailers are already selling biodiesel in the state (Table 1). Currently, biodiesel is primarily being used for agricultural purposes. Soybean producers are in favor of using products that may help add value to their crop. Since biodiesel can be used in existing diesel engines with little or no modification, it is a simple way to enhance North Dakota's soybean market.

Table 1. North Dakota Biodiesel Retailers

Company Name	Location
Anderson Service	Wyndmere
Cenex	Arthur
Cenex	Casselton
Cenex	Lisbon
Cenex	Litchville
Cenex	Fargo/Moorhead
Cenex	Valley City
Farmers Union Oil	Devils Lake
Farmers Union Oil of Southern Valley	Fairmount
Farmland Coop Inc.	Oakes
Farstad Oil	Fargo
Johnson Oil	Ayr
Maple Valley Oil Association Coop	Buffalo
Nash Grain and Trading	Grafton
Nelson Oil Company	Milnor
Northwood Cooperative Oil Company	Northwood
Rutland Oil	Rutland
Schlagel Oil Company	Casselton
Town & Country Oil	Fargo/Moorhead
Tri County Petroleum, Inc.	McVille

Source: National Biodiesel Board, http://www.biodiesel.org

OBJECTIVES

The objectives of this study are as follows:

1. Determine the economic feasibility of producing biodiesel in North Dakota.

2. Estimate biodiesel market impacts on soybean production.
3. Conduct strategic competitive analyses to determine investment actions.
4. Estimate regional economic impacts (direct, indirect, and induced).

BACKGROUND ON BIODIESEL

Biodiesel, or methyl esters, is an alternative fuel produced using renewable resources such as recycled cooking oils, animal fats, or vegetable oils. The chemical definition of biodiesel is mono alkyl esters of long chain fatty acids. This alternative diesel fuel can be used in pure form (B100) or blended with petroleum diesel at various ratios. The Environmental Protection Agency has registered biodiesel as a fuel additive or a pure fuel, and it is legal for commercial use. The physical and chemical operating characteristics of biodiesel are similar to those of petroleum diesel, and therefore it can be used in existing diesel engines with little or no modification (Howell and Weber).

Benefits

Many benefits are associated with the use of biodiesel. A major advantage for biodiesel use is increased lubricity. A fuel with low lubricity causes much corrosion to an engine, while high lubricity increases the life of an engine. An improvement in lubricity reduces engine wear and maintenance costs ("Biodiesel Promotion"). Tests have shown that only 2 percent or less biodiesel blend increases lubricity of D1 and D2 diesel fuels (Nelson et al.).

Biodiesel degrades four times faster than regular diesel fuel ("Just the Basics"). When compared to sugar, 100 percent biodiesel degrades at the same rate. A 20 percent biodiesel blend degrades at twice the pace of regular diesel. Thus, blending biodiesel with regular diesel speeds up degradation ("Biodiesel Use in Regulated Fleets").

Use of this fuel reduces unburned hydrocarbons, carbon monoxide, and particulate matter. Nitrogen oxide emissions can be slightly decreased or increased. In addition, this fuel contains little or no aromatics and no sulfur (Nelson et al.). Potential for biodiesel to form ozone is 50 percent less than petroleum diesel and reduces air toxins by up to 90 percent ("Biodiesel Promotion"). This fuel overall, burns cleaner than petroleum diesel and prevents water pollution ("Biodiesel Promotion"). Therefore, biodiesel is better for the environment and less toxic to the atmosphere.

With a flash point of more than 300 degrees Fahrenheit, pure biodiesel will not ignite as easily as regular diesel. Flash point is defined as the temperature at which a fuel must be heated to ignite when exposed to a flame or spark ("Biodiesel Use in Regulated Fleets"). Regular petroleum diesel has a flash point of approximately 125 degrees Fahrenheit, making pure biodiesel or biodiesel blends safer to transport and store ("Biodiesel Promotion"). Even with a high flash point, biodiesel still operates satisfactorily in diesel engines.

The energy content of biodiesel is 120,000 BTUs per gallon, which is the highest of all alternative fuels ("Biodiesel Promotion"). The energy profit ratio of biodiesel is approximately 3 to 4, which means for every one unit of energy used to produce this fuel, 3 to 4 units of useable energy are gained (Nelson et al.). It works in existing diesel engines with little or no modification. In addition, it is the only alternative fuel in the United States that has completed the EPA-required Tier I and II health effects tests, which are part of the Clean Air Act ("Benefits of Biodiesel"). With so many benefits, biodiesel production is increasing.

Disadvantages

Biodiesel does have several disadvantages. Biodiesel or biodiesel blends increase cold flow properties 3 to 5 degrees Fahrenheit (1 to 3 degrees Celsius). These properties include pour point, cloud point, and cold filter plugging point. This means that biodiesel will gel faster in cold weather than petroleum diesel. In addition, biodiesel will degrade certain elastomers and natural rubber compounds. Although most manufacturers do currently use components that are compatible with the use of biodiesel, precautions must be taken. Additionally, because biodiesel has good solvent properties, use of this fuel dissolves sediments left by petrodiesel. This may require changing filters more frequently when switching to biodiesel until the system is void of deposits ("Biodiesel Use in Regulated Fleets").

Production

Three methods are used to produce biodiesel from organic oils: 1) base catalyzed transesterification of oil with methanol or another alcohol, 2) conversion of oil to fatty acids, then to methyl esters with acid catalysts, and 3) direct acid catalyzed esterification of oil with methanol (MARC-IV). Most biodiesel is produced using the base catalyst method because it is generally the most economical.

Most kinds of oil contain esters and glycerin. The esters are the valuable component of oil since they are used for fuel. Glycerine is a waste product that can be used in producing soaps, skin oils, and lotions, among other products. Transesterification is the process used to separate esters and glycerine.

Oil reacts with methanol (or another alcohol), and a catalyst (such as sodium hydroxide) is used to separate these products. Excess methanol is removed, and the separated biodiesel and glycerine are left. In certain systems, the alcohol is removed before the separation step. In either case, the alcohol is removed and can be re-used. In the reaction process, if the free fatty acid level is too high or any water is present, soap will form and cause emulsions with the oil and methanol. This blocks the reaction, and the process is halted. Therefore, it is important to remove free fatty acids from the oil prior to the reaction process and ensure that no water is present in the process. The glycerine byproduct is neutralized with an acid in order to form salts to make crude glycerine, which can be sold. Salts formed during this process can be recovered and used for fertilizer, but usually are left in the glycerin. The recovered methyl esters are washed in order to remove residual catalysts or soaps, and then dried to achieve the highest possible purity. Using clean feedstock can eliminate this step. More simply, this process consists of a fat or oil reacting with some type of alcohol in the presence of a catalyst, which results in the production of biodiesel and glycerine (MARC-IV).

The oil content of soybeans is 18.7 percent (Scheithauer and Dripchak). One bushel or 60 pounds of soybeans produces 48 pounds of soybean meal and 11 pounds of oil, which upon processing, equals 1.5 gallons of biodiesel (Nelson et. al). One hundred pounds of oil, plus 10 pounds of methanol, produces 10 pounds of glycerine and 100 pounds of biodiesel (MARC-IV).

The cost of producing biodiesel varies with plant size, plant location, and technology used. The most prominent cost contributor is the price of feedstock used to produce biodiesel. Feedstocks used to produce biodiesel include canola oil, sunflower oil, soybean oil, and waste grease. Soybeans are a vital part of North Dakota's agricultural economy (Bangsund and Leistritz, 1999) and, therefore, are an excellent source of feedstock for this purpose. Figures 2 and 3 are pictures of West Central Soy's new 12 MGY soy biodiesel plant located in Ralston, Iowa.

Glycerine

Glycerine is the byproduct resulting from the production of biodiesel. It has over 1500 applications and end products. It is an odorless, colorless, clear liquid found in products such as toothpaste, paint, textiles, rubber, cosmetics, explosives, and pharmaceuticals. The average price of glycerine in the United States over the past 20 years is 74 cents per pound, but recently prices have been lower. The average 1999 price was 54 cents a pound (Heming). Potential profits from selling glycerine are left out of this feasibility study because of recent low prices and absence of buyers in close proximity to North Dakota. Approximately 3,800,000 pounds of glycerine would be produced annually at a 5 MGY biodiesel facility. Using the 1999 price of 54 cents, this could potentially bring in roughly 1.9 million dollars a year. Again, it should be noted that this potential income was not included in this study, but should be considered (net of transportation costs) if buyers can be located.

Figure 2. West Central Soy Biodiesel Plant

Figure 3. West Central Soy Biodiesel Plant

BIODIESEL POTENTIAL FOR NORTH DAKOTA

Diesel Market

Information from the North Dakota Office of State Tax Commissioner's Motor Fuel Tax Section indicates that 387 million gallons of diesel, kerosene, and compressed natural gas were used from July 2000 to June 2001. The amount of kerosene and compressed natural gas are minimal compared to the amount of diesel fuel sold. Utilization in the three previous years was 373,288,102 gallons (1999 to 2000), 395,195,176 gallons (1998 to 1999), and 415,182,790 gallons (1997 to 1998). The sales data are recorded and broken down into the following categories: 1) Highway, 2) Agriculture, 3) Railroad, 4) Industrial/ Construction, 5) Heating, and

6) Unidentified. The amounts for these categories are shown in Figure 4. Each of these categories represents a potential market segment for biodiesel in North Dakota.

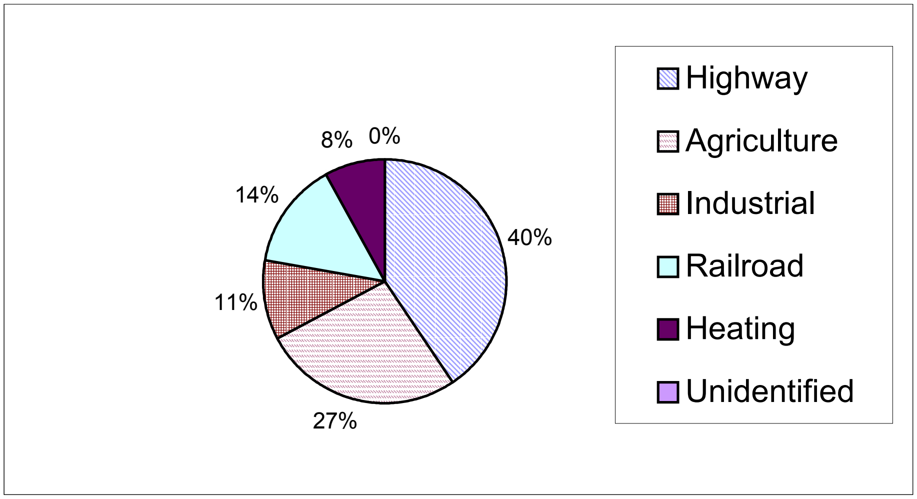

Figure 4. North Dakota Diesel Use July 2000 – June 2001

The wholesale market for diesel in North Dakota is highly concentrated. Diesel retailers in North Dakota obtain their supplies from one or a combination of four sources. The four diesel wholesalers for the state of North Dakota are: 1) Williams Pipeline, 2) Cenex, 3) Kaneb Pipeline, and 4) Tesoro Refinery. All four wholesalers provide diesel to eastern North Dakota, while only the Cenex and Tesoro Refineries provide the fuel to retailers in western North Dakota. Williams Pipeline starts in Tulsa, OK, and extends to Fargo and Grand Forks, ND. Cenex begins in Billings, MT, goes to Minot, ND, and then to Fargo, ND. The Kaneb Pipeline comes to Jamestown, ND, from Kansas. Finally, the Tesoro Refinery, located in Mandan, ND, has a pipeline to Jamestown, ND. A Cenex Refinery is located in Laurel, MT. This facility produces 20,000 barrels of diesel a day and 70 percent is shipped to North Dakota for highway consumption.

The wholesale diesel market is difficult to penetrate. Its structure is concentrated and competitive, which is an obstacle for a biodiesel plant located in the state. There are significant economies of operation scale in this industry. Handling biodiesel is more costly than petroleum diesel because existing retailers prefer to segregate the product, creating extra expenses. Also, due to existing low sales volume, biodiesel needs to be transported from wholesaler to retailer via truck, which is more expensive than pipeline transportation. Unfortunately, North Dakota's present diesel market structure impedes the forward movement of biodiesel.

Biodiesel Market

North Dakota has only two biodiesel wholesalers; Farstad Oil and Cenex (Kram). They obtain product from a variety of sources. Farstad Oil purchases biodiesel from World Energy, headquartered in Chelsea, Massachusetts. Farstad oil sells pure biodiesel for about $1.49 per gallon (Farstad Oil).

North Dakota has 15 retail biodiesel suppliers. These retailers get their biodiesel fuel from suppliers such as Farstad Oil or Cenex (Kram). North Dakota consumers of biodiesel are almost exclusively farmers who use various biodiesel blends for production purposes. The ratios used range from a 1 percent biodiesel blend to a 20 percent blend (B20). Prices charged by biodiesel suppliers in North Dakota vary. When the retailers mix pure biodiesel with petroleum based diesel, they charge a premium over regular diesel ranging from $0.00 to $0.14 per gallon.

The existing biodiesel market in North Dakota is almost exclusively farm-based. However, North Dakota has several potential new markets. For example, the City of Fargo's Division of Solid Waste started using biodiesel in May of 2001. A decision to test biodiesel use in landfill vehicles and equipment was successful. Use and performance of biodiesel was indistinguishable from petro diesel. Aside from some gelling problems during cold weather, the trial prompted the Solid Waste division to continue using 20 percent biodiesel in all of their vehicles and equipment (City of Fargo, Division of Solid Waste).

In addition, North Dakota's State Fleet has begun the process of using biodiesel. The State Fleet purchases about 1.2 million gallons of diesel fuel annually. In 2001, the State Fleet used 1,000 gallons of a 20 percent biodiesel blend in two NDSU trucks. NDSU and Fargo's Department of Transportation fuel sites were converted to B20 biodiesel starting the first of May 2002. The amount of biodiesel used from these two sites in 2002 will total approximately 50,000 gallons (Hanson).

Biodiesel Market Potential in North Dakota

Three immediate opportunities for biodiesel market growth in North Dakota are: 1) agriculture, 2) construction equipment/industrial, and 3) state fleet. Agriculture represents the largest market segment opportunity for biodiesel in North Dakota. Increasing numbers of farmers are becoming familiar with its technical properties and merits. The cold flow limitation of biodiesel is of minor consequence to farmers as the majority of their field operations are performed during the warm season. North Dakota farmers also have a strong commitment to adding value to their crops and strengthening rural economic development.

Construction is included as an immediate opportunity for biodiesel market growth. One reason is because of the seasonal nature of the work. Like agricultural crop production in North Dakota, construction is primarily done in the warmer months. Because of this, the reduced cold flow properties of biodiesel are not consequential. In addition, the engine size of construction equipment is similar to agricultural equipment. Since biodiesel has been used and tested successfully in agricultural equipment, using it in construction equipment should produce similar results.

The state fleet is the third category included in the potential biodiesel market for North Dakota. It is included because of past and current biodiesel use. As indicated previously, the City of Fargo's Division of Solid Waste started using biodiesel in May of 2001. They deemed the pilot program successful and will continue to use this alternative fuel. Also, North Dakota's State Fleet has begun using biodiesel. In addition, other successful state fleet pilot programs have been completed around the United States.

Transportation is not viewed as a viable market segment in the short run because of price conscious purchasing behavior exhibited by this sector. Transportation is price sensitive, so the lowest priced diesel is usually purchased for trucking purposes. Prevailing biodiesel prices would have to fall substantially or be heavily subsidized to become competitive. Railroad and heating are the other categories not included in the potential biodiesel market because the technical properties of biodiesel may not fit these applications. Diesel fuel used in railroad and heating is used year round. Use of biodiesel in cold months is often avoided because of gelling concerns.

To estimate total biodiesel market potential, this study assumed a majority of the diesel fuel sold for agriculture, construction, and state fleet uses would contain 2 percent biodiesel. This is similar to the biodiesel legislation passed in Minnesota in the spring of 2002, mandating 2 percent use. Another assumption is that all biodiesel produced in North Dakota would be sold in-state, the transportation costs to out-of-state regions being prohibitively expensive, and competition in nearby states may arise from other potential biodiesel production facilities.

To calculate potential biodiesel demand for North Dakota, the total volume of diesel used in agriculture, construction, and state fleet (145,533,380 gallons) is multiplied by 2 percent. The result is a state market potential of 2,910,667 gallons of biodiesel. This is assuming only a 2 percent blend of biodiesel. The demand could be higher with larger blends of biodiesel. Alternative demands for biodiesel are shown in Table 2. All calculations include the three categories of agriculture, construction, and state fleet.

Table 2. Potential North Dakota Demand for Biodiesel

Percent Biodiesel	Total Demand (gallons)
2%	2,910,667
3%	4,366,001
5%	7,276,669
10%	14,553,338
20%	29,106,676

Competition

Proposed biodiesel plants in Minnesota and South Dakota may be a source of competition for North Dakota. ADM was conducting a U.S. biodiesel feasibility study. The focal point of this study is their soybean crushing plant located in Mankato, MN (*Grainnet*, April 2, 2002). However, ADM recently decided against this project (http://www.soytech.com, 11/13/2002). Ag Processing Inc. (AGP) is also initiating a biodiesel feasibility study. More specifically, they are evaluating the viability of a 16 MGY facility in Minnesota. One of the possible plant locations is Dawson, MN, which already has an AGP soybean processing facility (*Grainnet*, March 22, 2002). Biodiesel plants constructed in Minnesota present competition for a North Dakota plant. South Dakota has one soybean processing plant, but no biodiesel plants. South Dakota Soybean

Processors is located in Volga, SD. There are currently no biodiesel plants in the state of South Dakota.

Competition from neighboring states creates likely hurdles. If a nearby plant began producing biodiesel, it may erode market potential in a North Dakota plant, jeopardizing feasibility. This would create a loss for North Dakota. These competitors also could deplete the available supply of crude soybean oil, leaving nothing for a North Dakota plant to use as a feedstock. In other words, competition from Minnesota or other neighboring states would create challenges that could adversely affect a biodiesel plant in North Dakota.

Feedstock Required

Approximately 7.3 pounds of soybean oil are needed for 1 gallon of soy biodiesel. One bushel of soybeans produces 11 pounds of soybean oil or 1.5 gallons of soy biodiesel (Agricultural Marketing Services Division). Using these numbers, a 5 MGY biodiesel plant would require 36.5 million pounds of soybean oil or 3.3 million bushels of soybeans per year. In 2001, 71.74 million bushels of soybeans were produced in North Dakota (National Agricultural Statistics Service). Only 4.64 percent of North Dakota's 2001 soybean production would be required to supply feedstock for a 5 MGY biodiesel plant.

Soybean Oil

Crude soybean oil is traded on the Chicago Board of Trade (CBOT). The price constantly fluctuates depending on numerous market conditions. Soybean oil prices are extremely important to biodiesel production because it makes up a vast majority of total production costs. Figures 5 and 6 illustrate historical soybean oil prices and baseline projection prices for the United States (*Agricultural Outlook*, USDA, Economics and Statistics System).

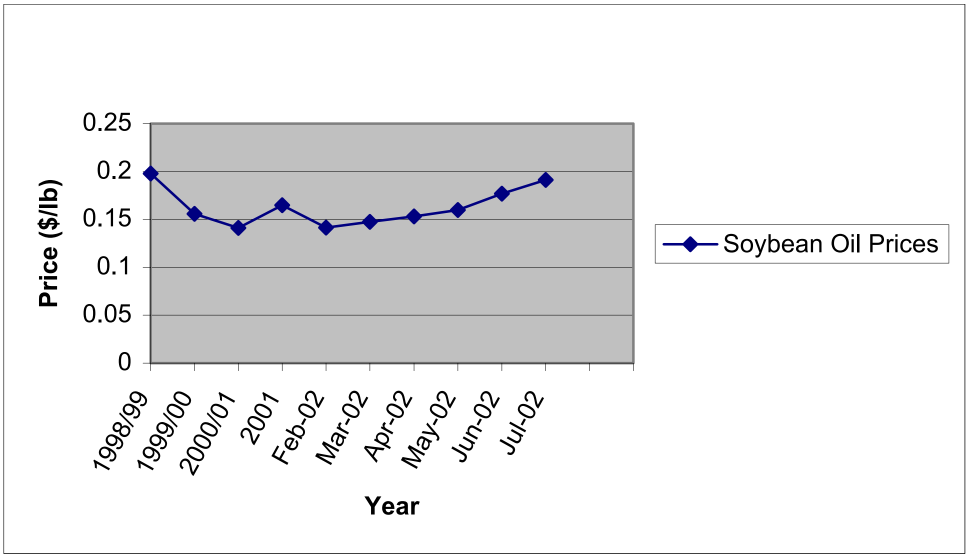

Figure 5. United States Soybean Oil Prices

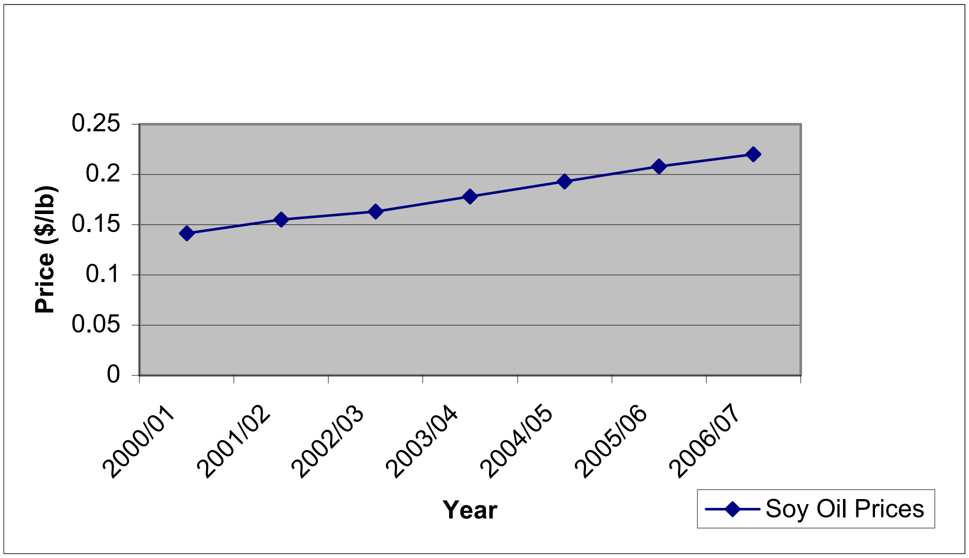

Figure 6. Soy Oil Baseline Projection Prices

The production of soy biodiesel in North Dakota has two options for obtaining soybean oil. The first option is to buy oil from soybean extraction facilities. The second option is to build an extraction facility in addition to a biodiesel plant. There are several types of soybean oil: 1) crude, 2) degummed, 3) refined and bleached, and 4) refined, bleached, and deodorized. Crude soybean oil has no impurities removed. Oil is degummed to remove phosphor and other materials that may have settled during transport or storage. Refined oil has had free fatty acids removed. Bleaching removes odor, color, and other impurities from the oil. The deodorization step is done to remove aromatic oils and more free fatty acids. The type of soybean oil most commonly used in the production of biodiesel is degummed. Therefore, crude, degummed soybean oil is assumed to be used for the remainder of this analysis.

The closest extraction plants to key soybean producing regions of North Dakota are in Enderlin, ND; Volga, SD; and Mankato, MN. The Northern Sun plant in Enderlin is an ADM facility. It crushes sunflowers and soybeans by means of solvent extraction. This facility refines sunflower oil, but sends its crude soybean oil to Mankato to be refined. They do supply crude, degummed soybean oil, which at this time sells for approximately 20 cents a pound. Although the soybean oil from this plant is committed to the Mankato refinery, it is not considered to be in long-term contracts because it is an internal agreement. Their own refinery is used mainly for sunflower and canola oil. This facility would possibly be able to supply some soybean oil for a North Dakota biodiesel plant in Marshall, MN.

The South Dakota Soybean Producer plant sells almost all oil in long-term contracts to refineries also. This refinery crushes 80,000 bushels of soybeans daily. They operate 24 hours a day, 12 months out of the year. This facility uses a hexane extraction technology and partially refines the oil. Almost all of the oil from this plant is committed in long-term agreements with refineries, such as the Mankato refinery. Most crushing plants that are currently under operation have their oil committed to refineries in long-term contracts (Kersting).

Harvest States, in Mankato, MN, has a crushing facility as well as a refinery. Since this facility can refine twice the amount of oil as the amount extracted, none of their crude oil is for sale. The Harvest States refinery is very large and annually can refine almost one billion pounds of oil, the equivalent to 90 million bushels of soybeans. However, their crushing plant capacity is only 35 million bushels of soybeans annually. A new crushing facility is currently under construction in Fairmont, MN. All the oil from this plant will also be refined at the Mankato location, and there will be no supply available for sale (Teters). Figures 7 and 8 are pictures of the Harvest States crushing plant in Mankato, MN.

Figure 7. Mankato, Minnesota, Crushing Plant

Figure 8. Mankato, Minnesota, Crushing Plant

The South Dakota Soybean Producers along with the Minnesota Soybean Producers are in the process of building a new soybean crushing plant in Brewster, MN. It is currently under construction and is expected to be operational by fall of 2003. Because this is a new plant, it would be a potential source of crude soybean oil for a new biodiesel plant. Another option would be to purchase oil from small expeller plants (Kersting).

As mentioned, building an extraction facility is another option. To get a rough cost estimate for constructing a soybean extraction facility, an industry rule is to multiply the cost of equipment by three (Teters). Using this estimation, a 5 MGY crushing plant for a 5 MGY biodiesel plant would cost approximately $30 to $36 million, plus $10 million for partial refining (degumming).

Production Costs

Production costs play a vital role in the feasibility of a North Dakota biodiesel plant. Especially critical is the cost of soybean oil since oil accounts for 75 to 80 percent of total production costs ("Biodiesel Use in Regulated Fleets"). Production costs for this industry are uncertain for several reasons. First, production costs are proprietary. Companies who produce biodiesel have exclusive rights to the technology and do not want to share this information with potential competitors. Second, biodiesel technology is evolving. As this evolution takes place, the cost of producing biodiesel should decrease similar to ethanol. Finally, production costs are incomplete. There have been a number of studies done on the feasibility of biodiesel plants, but certain elements remain unknown. Generally, absent from production costs are land costs, marketing expenses, administrative support salaries, and transportation costs.

Minnesota's Department of Agriculture examined Minnesota's potential to produce and use biodiesel as well as the effects a plant would have on the state's economy. They found that Minnesota's diesel fuel prices were higher than the national average, while soybean prices were lower. These two factors make production of soy biodiesel in Minnesota ideal. With annual diesel usage of 631 million gallons and assuming 2 to 5 percent biodiesel inclusion, 8.5 to 21 million bushels of Minnesota's soybeans could be utilized for producing biodiesel. This would increase the state's soybean processing capacity by 9 to 21 percent. In conclusion, soy biodiesel production has the potential to increase soybean demand in Minnesota from 3 to 7 percent, generate a total economic impact of $212 to $527 million annually, and create 1,128 to 2,798 jobs.

Tiffany also describes the potential for biodiesel in Minnesota. A mandate for 2 to 5 percent biodiesel blends will raise demand for soybean oil, thus increasing the price farmers receive for their soybean crops. A biodiesel mandate would create a need for 16 to 40 MGY of biodiesel for Minnesota. Because of the abundance of soybean oil at prices lower than the country's average and historically high diesel prices, Minnesota has the ideal climate for biodiesel production.

Nelson et al. estimated the impact of soybean crushing and biodiesel production on two specific Kansas counties as well as the entire state of Kansas. Ninety-six million gallons of soy biodiesel could be produced if all soybeans grown in Kansas were used. Based on diesel use estimates from 12 sectors in the state, 13 MGY of biodiesel would be needed assuming a 2 percent inclusion. Impacts from both a 5 and 24 MGY facility were estimated. The total annual economic impact for the state was determined to be $63 million and 248 jobs from a 5 MGY facility or $214 million with 815 jobs from a 24 MGY. State taxes generated could be between $1.1 to $6.3 million annually. School enrollment could increase by 36 to 154 students. Constructing biodiesel plants in Kansas is feasible due to the anticipated increased demand for biodiesel as well as biodiesel incentives.

Coltrain recently assessed biodiesel potential in Kansas. He concludes that biodiesel is normally priced at about $1.00-$1.40 per gallon higher than petro diesel. Overall, economy will be very sensitive to federal and state subsidies in the future.

THE FRAMEWORK OF THE PRESENT STUDY

This analysis assumes a plant size of 5 MGY. The plant size was chosen based partially on the potential biodiesel demand in North Dakota, described previously, of approximately 3 MGY. Also, this size plant is commonly used in other biodiesel feasibility reports. Table 3 has annual operating costs for a 5 MGY biodiesel plant for North Dakota.

The expenses and revenues estimated in this study were derived from a variety of sources. They were based on a compilation of industry data. Numerous biodiesel producers were contacted, and information was obtained about biodiesel costs. Two main sources of cost information were West Central Soy and Pacific Biodiesel. Pacific Biodiesel had the most detailed cost estimates and, therefore, are the basis for some of the numbers in this report. These numbers were compared to other more aggregate cost data to assure comparability. Other biodiesel feasibility reports were examined to obtain a range of operating and investment costs.

Investment costs and operating costs for biodiesel facilities are site-specific. Therefore, all costs have been localized. As stated above, various producers and feasibility studies were studied and compared to obtain a basis for biodiesel plant cost estimates. All numbers were scaled to meet requirements for a 5 MGY biodiesel facility. Local firms were contacted to get regional cost estimates for each category in order to ensure the costs used are consistent and specific to North Dakota.

Annual operating costs are summarized in Table 3 based on surveys with local firms and North Dakota prices. The crude soybean oil price of $0.25 per pound was provided by Harvest States in Mankato, MN. Methanol and catalyst prices are recent averages. The amounts of methanol and catalyst are assumed to be 22 percent and 10 percent of soybean oil quantities, respectively.

Transportation costs are estimates from Burlington Northern Santa Fe (BNSF) and are based on the assumption that soybean oil needs to be transported from Mankato, MN, to eastern North Dakota (304 miles) via railroad. Tank cars with a 25,000 gallon capacity would transport soybean oil 4 times per week. The cost for each car is approximately $1,400, which is $5,600 a week, or $291,200 annually. To obtain water prices, Cass Rural Water Users and The City of

Fargo Water Department were contacted, and an average price quote was used. The estimates, assuming 10 million gallons of water demand annually, were $30,232 and $38,000.

Table 3. Annual Operating Costs

Category		$/unit	units/year	$/year
Raw Material Costs				
	Crude Soybean Oil/gal	1.91	5,000,000	9,550,000
	Transportation			291,200
	Methanol / gal.	0.91	1,100,000	1,001,000
	Catalyst / lbs.	0.55	500,000	275,000
Utilities				
	Biodiesel for power unit	1.5	35,000	52,500
	Water / gal.		10,000,000	34,116
Fixed Costs				
	Staff - Operators	40,000	4	160,000
	Administrator	40,300	1	40,300
	Lab	48,000	1	48,000
	Support Staff	20,700	1	20,700
	General Laborer	16,600	1	16,600
	Sales	35,300	1	35,300
	Maintenance - % of cost	0.025		125,000
	Insurance - % of cost	0.025		125,000
	Service Contract	0.1	4,250,000	425,000
	Marketing Expenses			100,000
Depreciation Costs				
	Equipment			714,500
	Storage Tanks			52,301
	Building			17,187
Interest				
	Fixed Rate 8%			136,858
TOTAL				13,220,562

Salary information for plant personnel is from the North Dakota Career Resource Network. The positions assumed necessary for a plant in the state were 4 plant operators (to cover 24-hour plant operation), 1 administrator, 1 lab technician, 1 support staff, 1 sales person (for promotion and marketing activities), and 1 general laborer (for maintenance and miscellaneous duties). The assumed salaries are listed in Table 3 and range from $16,600 to $48,000.

Depreciation estimates came from the 2001 Farmer's Tax Guide. Using the straight line depreciation method, the building had a 20-year recovery period and the storage tanks and equipment had a 7-year recovery period. The building cost was multiplied by 5 percent, while tanks and equipment were multiplied by 14.29 percent to get the total depreciation number in Table 3. Interest costs were calculated using Farm Credit Services rates. A 10-year fixed interest rate of 8 percent with 40% equity was used to calculate the cost in Table 3.

The profitability of a biodiesel plant in North Dakota is dependent on the availability and price of soybean oil. Using annual production costs from Table 3, the cost per gallon of biodiesel is calculated for a 5 MGY biodiesel production facility. The price for crude, degummed soybean oil is assumed to be $0.25 per pound. This price was selected based on an estimate from Harvest States, and also based on historical and projected soybean oil prices from Figures 5 and 6. Using this price, the cost per gallon for producing biodiesel is $2.64. When the price for oil was varied from 17 cents to 25 cents, the biodiesel costs range from $2.02 to $2.64 per gallon (Table 4). Unfortunately, this is not competitive with regular petroleum diesel, which was about $0.91 per gallon in the Fargo area on September 12, 2002.

Table 4. Biodiesel Production Costs with Varying Soybean Oil Prices (Inputs)

Cost of Oil (per lb)	Annual Cost of Oil	Total Annual Expenses	Percent of Annual Costs	Cost of Biodiesel (per gallon)
$0.25	$ 9,550,000	$13,220,562	72.24%	$2.64
$0.22	$ 8,400,000	$12,070,562	69.59%	$2.41
$0.19	$ 7,250,000	$10,920,562	66.39%	$2.18
$0.17	$ 6,450,000	$10,120,562	63.73%	$2.02

Investment Costs

The investment costs for a 5 MGY biodiesel plant are shown in Table 5. The process used to determine investment costs is similar to that used for operating costs. The cost for transesterification machinery, permits and miscellaneous and working capital are pro-rated from Pacific Biodiesel budget estimates. Storage tank costs are based on estimates from Fargo Tank and Steel. It is assumed that a 5 MGY plant would require 625,000 gallons of storage for soy oil, as well as 83,333 gallons of storage for finished biodiesel. Building costs are from Gateway Building Systems, and land costs are based on estimates from Botsford & Qualey Land Company. The study assumes the biodiesel plant would require 5 acres of industrial land at a price of $75,000. The building size is 6,250 square feet and costs $55 per square foot. The square footage includes space for the biodiesel processing equipment, office and lab space, as well as an area for shipping and receiving.

Table 5. Investment Costs

Category	Cost
Transesterification machinery	$5,000,000
Storage tanks	366,000
Building/land	418,750
Permits & misc.	156,250
Working capital	901,901
Total	6,842,901

Site Location

In determining the best location for a potential North Dakota biodiesel plant, several factors were selected as criteria. Four factors were selected as the most important, based on total operating costs. The factors are availability and cost of feedstock (soybean oil), transportation, electricity, and water. Overwhelmingly, the most important factor is soybean oil. The plant should be located either near a soybean crushing plant and obtain soybean oil directly from there or near a railroad to obtain oil from another crushing facility. Transportation is a key factor because feedstock for biodiesel production will need to be transported to the facility. More than likely, rail would be the mode of transportation. Therefore, access to railroad transportation is essential. Finally, a biodiesel plant would require substantial power and water resources to operate. Although the electricity and water themselves are not a huge portion of operating costs, constructing new electric lines or water pipes would be costly. The greater the distance of new lines or pipe, the greater the expense becomes. Therefore, it is important the site be located near main, already existing electrical and water lines.

Soybean Production

North Dakota producers planted a total of 2,150,000 acres of soybeans in 2001 and harvested 2,110,000 of those acres. The east central region of the state produced the most soybeans, while the southeast and northeast came in second and third, respectively. The top three soybean producing counties in North Dakota in 2001 were Cass, Richland, and Barnes (National Agriculture Statistics Service). Tables 6 and 7 show specific soybean harvests for North Dakota regions and counties for 2001.

Table 6. North Dakota Soybean Production by Region, Crop Year 2001

Region	Soybeans Planted (acres)	Soybeans Harvested (acres)	Soybean Yield (bushels)	Rank
Northwest	9,500	9,000	18.1	7
North Central	23,000	23,000	28.0	6
Northeast	225,000	214,500	32.0	3
West Central	5,500	5,400	20.7	8
Central	145,000	144,000	31.7	4
East Central	935,000	919,000	34.7	1
Southwest	1,000	600	26.7	9
South Central	26,000	25,500	33.5	5
Southeast	780,000	769,000	34.7	2
Total	2,150,000	2,110,000	34.0	

Table 7. North Dakota Soybean Production by County, Crop Year 2001

County	Soybeans Planted (acres)	Soybeans Harvested (acres)	Soybean Yield (bushels)	Rank
Barnes	180,000	176,600	34.4	3
Cass	460,000	456,000	35.4	1
Dickey	92,000	91,700	35.9	10
Grand Forks	94,000	86,600	32.5	9
La Moure	140,000	139,800	35.6	5
Richland	300,000	291,500	33.2	2
Sargent	135,000	133,400	37.2	6
Steele	100,000	96,400	33.8	8
Stutsman	108,000	107,500	31.4	7
Traill	165,000	161,100	33.5	4

The following map illustrates soybean production concentration in North Dakota (Figure 9). The circles shown in Figure 9 represent the amount of production necessary to support a plant in that region. The southeast portion of the state has the highest concentration of soybean production. More specifically, Cass and Richland counties are the top producers. Figure 10 shows roads, railroads, and soybean production concentration for these two counties. Miscellaneous infrastructure, including major electrical lines, are included in Figure 11. All are available and easily accessible in the region. Distance to retail markets is another factor. Most wholesalers and retailers are located in the major North Dakota cities (e.g., Fargo, Wahpeton, Grand Forks, Valley City, Bismarck). The bulk of these cities are in eastern or central North Dakota, making eastern North Dakota the best place for a plant.

Regions in eastern North Dakota that met the specified criteria were identified. In general, the areas that met the criteria are around Fargo and Wahpeton. It is recommended that interested investors establish specific location criteria and invite plant location proposals from local communities. Location proposals will generate more detailed information concerning the best site for a biodiesel plant.

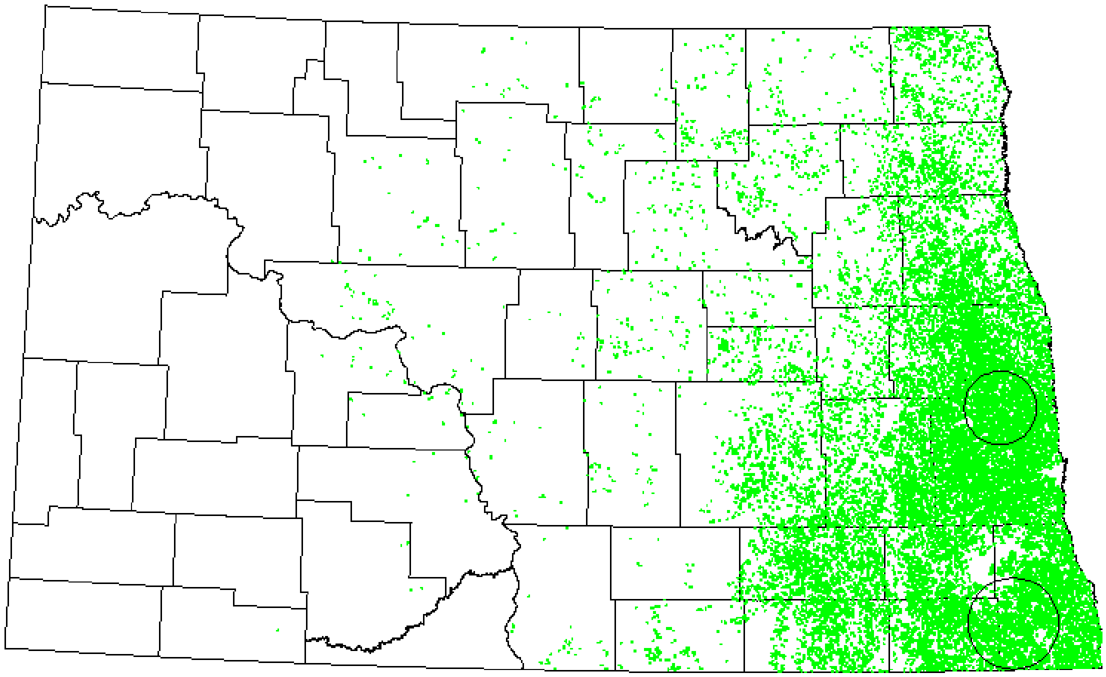

Figure 9. Soybean Production in 2001 Sufficient to Supply a 5 Million Gallon per Year Biodiesel Plant
Note: Each circle contains roughly 112,000 soybean acres.

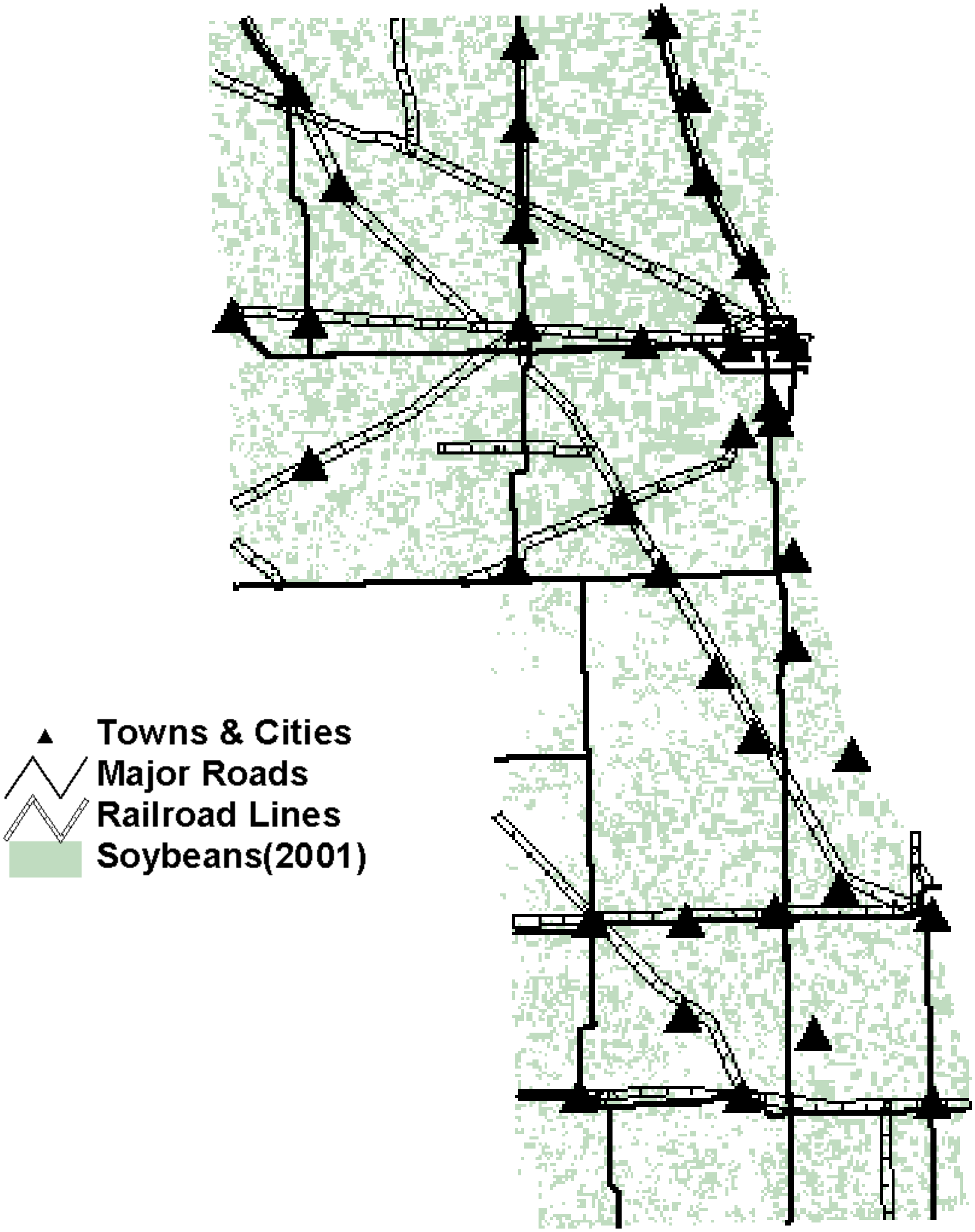

Figure 10. Soybeans, Highways, and Railroads in Cass and Richland Counties

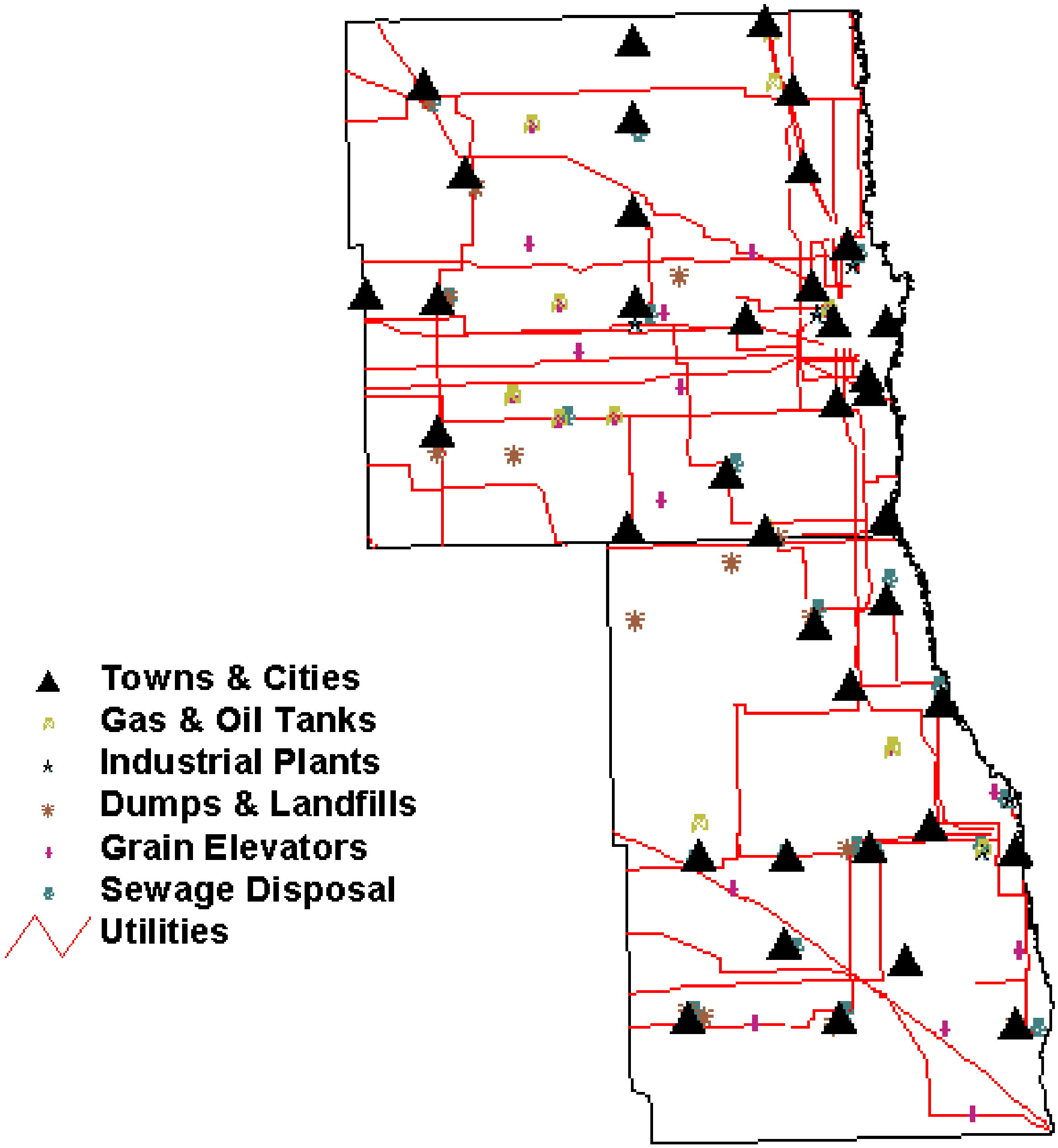

Figure 11. Miscellaneous Infrastructure in Cass and Richland Counties

WASTE GREASE AS A FEEDSTOCK

While soybeans are a plentiful crop in North Dakota and are a good source for biodiesel production, there are other feedstock options. One feedstock option that has received much attention is waste grease. Waste grease is recovered cooking oil from restaurants. This biodiesel feedstock is abundant and cheap, sometimes free if picked up directly from restaurants. A fast food restaurant, on average, produces about 250 pounds of waste grease per week (Hensrud). With approximately 90 fast food restaurants in the Fargo-Moorhead area, 22,500 pounds of grease are produced a week. A family bar and grill type restaurant like Bennigan's Grill & Tavern produces about 150 to 200 pounds a week (Larson). There are roughly 95 family, bar and grill restaurants in Fargo-Moorhead, which means 14,250 to 19,000 pounds of waste grease are produced each week. Combined, fast food restaurants and family restaurants in the Fargo-Moorhead area produce 36,750 to 41,500 pounds of waste grease a week. Using the smaller amount, 1,911,000 pounds of waste grease are produced a year. The waste grease from Fargo-Moorhead alone could produce roughly 261,780 gallons of biodiesel, which is 5.24 percent of the feedstock needed for a 5 MGY facility. All waste grease needs to be disposed of properly by companies who supply containers and are either paid to take it away or do it for free. This is another relatively inexpensive feedstock option for biodiesel production.

Price Impact

The Center for Agricultural Policy and Trade Studies evaluated the impact of a biodiesel plant on local soybean prices. Assuming a soybean price of $5.00 per bushel and a demand elasticity of .698, soybean prices in the tri-state area could increase $0.025 per bushel (Taylor)

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ECONOMIC IMPACT

The methods used to evaluate the potential economic impact of the biodiesel project have been utilized extensively in estimating impacts of a variety of industrial and resource development projects in North Dakota and throughout the Upper Midwest region (see, for example, Coon and Leistritz 2001, Bangsund and Leistritz 1999, 1998, and Leistritz). Estimated expenditures within the state economy during plant construction and during subsequent operations were obtained from the feasibility analysis. An input-output model was used to analyze these data. The model embodies interdependence coefficients or multipliers that measure the level of total gross business volume generated in each sector of the state economy from an additional dollar of sales to final demand in a given sector. The input-output model applies the plant's expenditures to these interdependence coefficients. Resulting levels of business activity were used to estimate secondary (indirect and induced) employment and state tax revenues, based on historic relationships.

Empirical testing has indicated that the model is accurate in estimating changes in levels of economic activity in North Dakota. Over the period 1958-2000, estimates of statewide personal income derived from the model averaged within 4 percent of actual empirical observations reported by the U.S. Department of Commerce (Leistritz et al., Coon and Leistritz 2002).

Results

Construction of the plant will involve an investment of about $6.8 million, but only a portion of this cost represents expenditures to entities within North Dakota. The direct in-state expenditures during plant construction are estimated to total $1.8 million (Table 8). Major components of the construction outlays include interest on working capital ($902,000), construction contracts for buildings ($419,000), and purchase and installation of storage tanks ($366,000). Once the plant is fully operational, its annual direct impacts are expected to total about $1.1 million The projected direct impact of the plant includes payroll ($321,000 annually), transportation ($291,000), insurance and interest ($262,000), and facility maintenance ($125,000).

Table 8. Estimated Direct Impacts within North Dakota by Economic Sector Associated with Biodiesel Plant Construction and Operation

Sector	Construction	Operation
	--------- $000 ---------	
Construction	$419	$125
Transportation		291
Communications and public utilities		34
Wholesaling, ag. processing, & misc. mfg.	366	
Finance, insurance, and real estate	902	262
Business and professional services	156	100
Households (salaries, wages, and dividends)		321
Total	$1,843	$1,133

One major expenditure associated with plant operation that was not included in the analysis was purchases of crude soybean oil (estimated to be $9.55 million annually). These purchases were not included in the impact of the biodiesel facility because, in the absence of the biodiesel plant, the soybean oil would be exported from the state. Because the intent of this study was to estimate the value added from processing soybean oil into biodiesel and the economic impact resulting from this activity, the soybean oil purchases were not included as part of the direct impacts.

Expenditures associated with plant construction are estimated to generate additional gross business volume for area firms totaling about $6.4 million (i.e., $1.8 million of direct expenditures, plus $4.6 million of secondary impacts). Sectors with substantial total impacts include *households, finance, insurance, and real estate* (FIRE) and *retail trade*. Area households are estimated to receive additional personal income totaling $1.7 million (Table 9). Plant construction is also anticipated to generate secondary employment of about 72 full-time equivalent (FTE) jobs (i.e., 72 person-years of employment).

Table 9. Total (Direct Plus Secondary) Impacts within North Dakota by Economic Sector Associated with Biodiesel Plant Construction and Operation

Sector	Construction	Operation
	--- $000 ---	--- $000 ---
Gross Business Volume (gross receipts):		
Construction	538	202
Transportation	22	302
Communications and public utilities	190	149
Wholesaling, ag. processing, & misc. mfg.	713	46
Retail trade	1,076	687
Finance, insurance, and real estate	1,131	413
Services	382	243
Households	1,738	1,217
Other[1]	603	253
Total	$6,393	$3,512
Revenues from selected State Taxes:		
Sales and use	$50	$32
Personal income	26	18
Corporate income	13	6
Total	$89	$56
Secondary Employment (FTE jobs)	72	57

[1]Includes agriculture, mining, and government.

Plant operation is expected to generate about $3.5 million annually in additional gross business volume when the facility is fully operational (Table 9). That is, the $1.1 million of direct impacts lead to secondary effects of about $2.4 million, for a total economic impact of $3.5 million. Sectors that receive substantial effects include *households* and *retail trade*. Area households would receive about $1.2 million of additional personal income. Plant operation is estimated to create about 57 secondary jobs in various sectors of the state economy, in addition to the 9 persons employed directly by the facility.

The additional economic activity in various sectors of the North Dakota economy resulting from the construction and operation of the plant would also result in additional revenues from selected state taxes. The economic effects of plant construction are expected to result in about $89,000 in revenues from *state sales and use, personal income*, and *corporate income* taxes (Table 9). During the plant's operating phase, annual revenues from these taxes are expected to total about $56,000, with sales and use tax receipts accounting for about 57 percent of the total. (These tax revenues are in addition to the taxes that will be paid directly by the biodiesel facility and/or its ownership entity.)

CONCLUSIONS

Biodiesel may be one answer to energy production and environmental concerns in the Unites States. This alternative fuel is attractive because it is renewable in addition to providing other environmental benefits. Biodiesel can be used 100 percent pure or blended with petroleum diesel at any ratio. The physical and chemical operating characteristics of biodiesel are similar to those of regular petroleum diesel and, therefore, it can be used in existing diesel engines with little or no modification. The biodiesel production process is relatively straightforward and requires low investment. Alcohol is added to a feedstock, such as soybean oil, in the presence of a catalyst. This mixture is heated and agitated, which results in biodiesel and the byproduct, glycerine.

The structure of the diesel market in North Dakota is difficult to assess because it is concentrated and competitive and, therefore, is a major obstacle for biodiesel. North Dakota does have 20 retailers who sell biodiesel to consumers almost exclusively for agricultural purposes. The City of Fargo's Division of Solid Waste, along with North Dakota's state fleet, also use biodiesel. The potential biodiesel market for North Dakota is comprised of three sectors: agriculture, construction, and state fleet. The calculated biodiesel demand for North Dakota is 2,910,667 gallons of biodiesel, assuming a 2 percent blend of biodiesel. The demand could be higher with larger blends of biodiesel.

There are two options for obtaining soybean oil for producing biodiesel; buy it or crush it. Crushing the oil would mean building an extraction facility, which would cost nearly 40 million dollars. Purchasing the oil would be the economical option, but locating an ample supply of crude, degummed oil may be difficult. The most promising suppliers of oil for a possible North Dakota biodiesel production facility would be the ADM crushing plant in Enderlin, ND, or a facility that is under construction in Brewster, MN.

The production costs for biodiesel plants are uncertain, but the estimates of these costs for this study were carefully conducted. Using annual operating costs for a 5 MGY production plant located in southeastern North Dakota and assuming a soy oil price of 25 cents per gallon, the cost per gallon of biodiesel is $2.64. This is expensive when compared to the wholesale price of regular diesel in the Fargo area, which was $0.91 in late 2002. When using a range of prices for soy oil, the cost per gallon could be decreased to $2.02 with an oil price of $0.17.

Although the technology associated with producing biodiesel is available, constructing and operating a soybean oil based biodiesel plant is premature in this area. Operating costs are high, making it a high-risk proposition. Building and operating a soybean oil biodiesel plant in North Dakota will become more attractive as the industry's technology advances and operation costs decrease.

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