

Economic Impact of the Minnesota Biodiesel Industry



Su Ye, Chief Economist
Minnesota Department of Agriculture
625 Robert Street North, St. Paul, MN 55155
www.mda.state.us
May 2017

Table of Contents

Executive Summary	2
Background	4
The IMPLAN Model	6
Economic Impact Analysis	7
Conclusion	14

Tables and Charts

<i>Table-1: Total Economic Impacts – Summary</i>	<i>3</i>
<i>Table-2: Minnesota Soybean Utilization Trend</i>	<i>9</i>
<i>Table-3: Minnesota Corn Utilization Trend</i>	<i>11</i>
<i>Table-4: Farm Level and Non-farm Level Sector – Economic Impact</i>	<i>13</i>
<i>Table-5: Selected Production Sectors – Economic Impact</i>	<i>14</i>
<i>Chart-1: Output Impact</i>	<i>3</i>
<i>Chart-2: Employment Impact</i>	<i>3</i>
<i>Chart-3: U.S. Biodiesel Plant Map</i>	<i>4</i>
<i>Chart-4: U.S. Biodiesel Production and Consumption Trends</i>	<i>5</i>
<i>Chart-5: Minnesota Biodiesel Production and Demand</i>	<i>5</i>
<i>Chart-6: MN Biodiesel Feedstock Sources</i>	<i>7</i>
<i>Chart-7: U.S. Soybean Production: Top States</i>	<i>8</i>
<i>Chart-8: Minnesota Soybean Utilization</i>	<i>9</i>
<i>Chart-9: Minnesota Soybean Oil Production</i>	<i>10</i>
<i>Chart-10: U.S. Corn Production: Top States</i>	<i>11</i>
<i>Chart-11: Minnesota Corn Utilization</i>	<i>12</i>
<i>Chart-12: Minnesota DDG Production</i>	<i>12</i>
<i>Chart-13: Output Impact by Sector</i>	<i>13</i>
<i>Chart-14: Employment Impact by Sector</i>	<i>14</i>
<i>Chart-15: Total Output Impact Breakdown</i>	<i>15</i>
<i>Chart-16: Total Output Impact by Sector</i>	<i>15</i>
<i>Chart-17: Output Impact by Type</i>	<i>15</i>
<i>Chart-18: Employment Impact by Type</i>	<i>15</i>

Executive Summary

Minnesota was the first state in the U.S. to mandate the use of biodiesel. In 2002, the Minnesota state legislature mandated that all diesel fuels sold in the state must contain at least 2 percent biodiesel (B2) by the year 2005 (MS§ 239.77 [BIODIESEL CONTENT MANDATE]). Since then, the mandate raised the blend level to 5 percent (B5) in 2009 and 10 percent (B10) in 2012. The mandate is scheduled to increase to 20 percent (B20) in 2018.

The Minnesota biodiesel mandate became a catalyst for Minnesota's biodiesel industry, which emerged to fulfill the initial B2 mandate, or 16-million-gallon-a-year biodiesel volume requirement, and later grew into a 74-million-gallon-a-year industry.

Minnesota's current annual biodiesel production includes 33 million gallons of soy biodiesel and 41 million gallons of non-soy biodiesel from three production facilities. Soy biodiesel, which uses soybean oil as feedstock, makes up 45 percent of the total biodiesel production in Minnesota; and non-soy biodiesel, which uses other oils/fats/grease as feedstock, comprises 55 percent of the total.

Minnesota consumes 1 billion gallons of diesel fuel a year, of which, 77 million gallons come from biodiesel. The state currently supplies 74 million gallons or 96 percent of its own biodiesel needs, and imports 3 million gallons or 4 percent from other states to fulfill the consumption demand. By 2018, when the B20 mandate comes into effect, Minnesota's annual biodiesel demand will reach 130 million gallons.

The Minnesota Department of Agriculture recently conducted an economic impact study to analyze the biodiesel industry's output and employment effects on the state economy. The study covered both soy biodiesel and non-soy biodiesel with a combined annual production capacity of 74 million gallons. The IMPLAN (Impact Analysis for Planning) economic input-output model is used in this impact analysis.

The economic impacts are measured to include the direct, indirect, and induced impacts. ***Direct impact*** represents the effect of biodiesel output. ***Indirect Impact*** represents the effect on all other economic sectors supporting the biodiesel industry. ***Induced impact*** represents the effect on all economic sectors due to the expenditures of new income generated by the direct and indirect impacts. ***Total impact*** is the sum of direct, indirect and induced impacts.

Current feedstock for Minnesota biodiesel production includes soybean oil, distillers corn oil, and other grease/fats/oils. Major production sectors analyzed in the biodiesel economic impact study include:

1. Soybean farming and processing;
2. Corn farming and processing;
3. Oil/fats/grease rendering; and
4. Biodiesel production/transesterification.

The economic impact is based on the 2016 biodiesel production of 74 million gallons, comprised of 33 million gallons of soy biodiesel and 41 million gallons of non-soy biodiesel.

Biodiesel production in Minnesota generates an economic “multiplier effect” that benefits many economic sectors, such as agriculture, manufacturing, transportation, wholesale and retail trade, services, finance, insurance, real estate, public utilities, and other. Each 1 million gallons of biodiesel production supports 73 jobs and contributes \$22.8 million in state-wide total economic output.

Total Output Impact

- Total output impact includes direct, indirect, and induced impacts on all economic sectors due to biodiesel production.
- Total output impact is estimated at **\$1.7 billion**.

Total Employment Impact

- Total employment impact represents the number of jobs in all economic sectors associated with biodiesel production, including direct, indirect, and induced impacts.
- Total employment impact is estimated at **5,397 jobs**.

Table-1: Total Economic Impacts – Summary Table

(Based on Minnesota 2016 Biodiesel production of 74 million gallons)

Economic Impacts	Output Impact (Million \$)	Employment Impact (Number of jobs)
Direct Impact	\$241.92	124
Indirect Impact	\$1,206.28	3,638
Induced Impact	\$239.90	1,635
Total Impacts	\$1,688.10	5,397

Chart-1: Output Impact (Million \$)

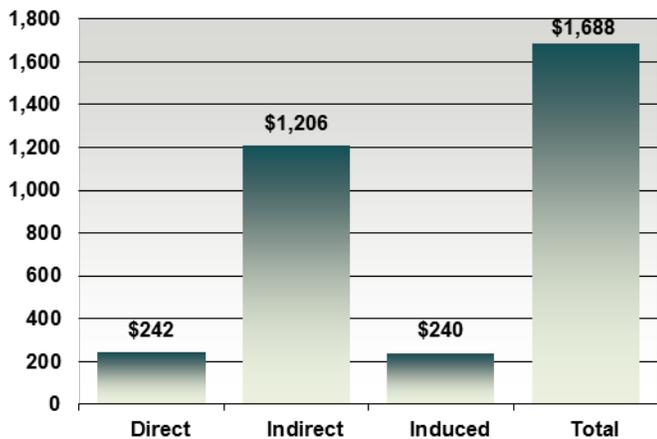
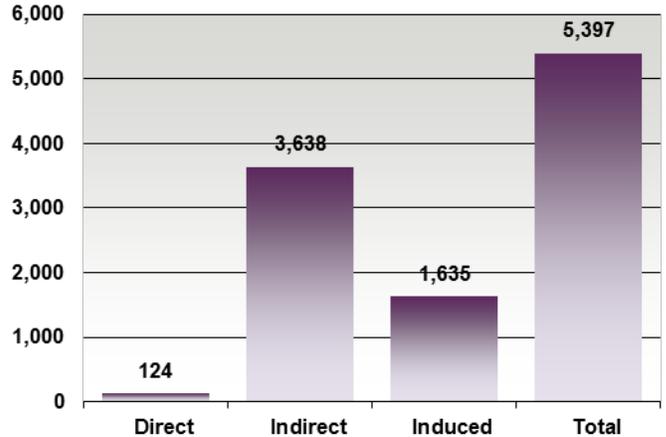
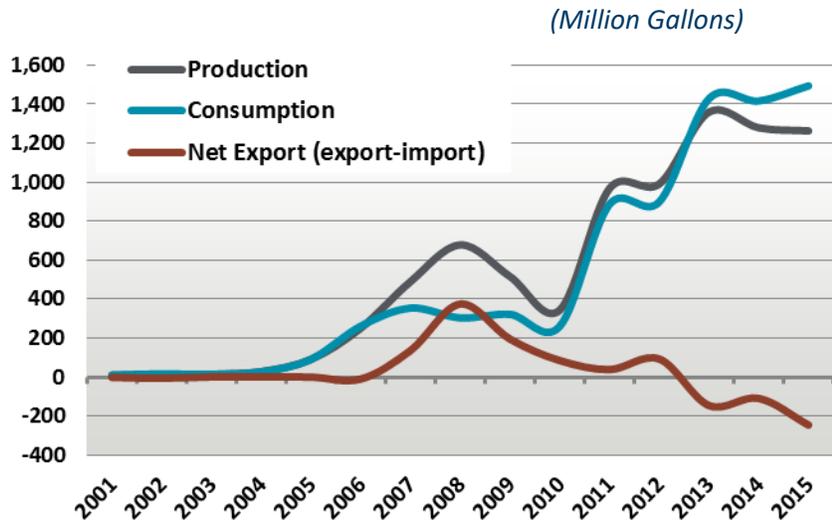


Chart-2: Employment Impact (Number of Jobs)



(The IMPLAN economic input-output model is used in this impact analysis, www.implan.com.)

Chart-4: U.S. Biodiesel Production and Consumption Trends

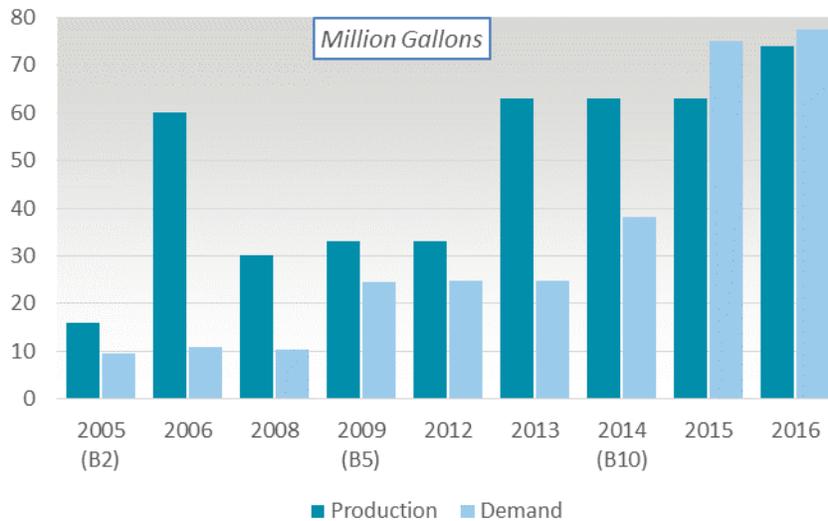


Source: U.S. Department of Energy (DOE), Energy Information Administration (EIA)

Minnesota consumes 1 billion gallons of diesel fuel a year, of which, 77 million gallons come from biodiesel. The state currently supplies 74 million gallons or 96 percent of its own biodiesel needs, and imports 3 million gallons or 4 percent from other states to fulfill the consumption demand. By 2018, when the B20 mandate comes into effect, Minnesota’s annual biodiesel demand will reach 130 million gallons.

Chart-5: Minnesota Biodiesel Production and Demand*

Note about the chart: Minnesota implemented B2 in 2005, B5 in 2009, and B10 in 2014. The dates may not coincide with the Mandate due to postponements resulting from supply shortages and other technical issues.



*Calculated estimates based on diesel consumption

Source: Minnesota Department of Agriculture (MDA)

The IMPLAN Economic Impact Model (www.implan.com)

The IMPLAN Input-Output model (I-O Model) is used for the Minnesota Biodiesel Economic Impact analysis. IMPLAN – Economic Impact Analysis for Planning – is an economic impact modeling system and database that allows users to estimate changes in the economy due to changes of one or more production activities.

The Input-Output (I-O) model and analyses track the interdependence among various producing and consuming sectors of the economy. More particularly, this methodology measures the relationships between the production activity in one industry or final demand for goods and services and the inputs required to satisfy such production and demand.

This economic impact analysis includes the following components:

- Output and output impact, and
- Employment and employment impact

Output – Output represents the value of industry production. In IMPLAN, these are annual production estimates measured in sales.

Output Impact – Output impact represents the changes of an industry’s (or set of industries’) production level due to changes in production of a specified industry.

Employment – Employment represents the number of jobs in an industry or economy in Full-Time Equivalents (or FTE) terms and annualized basis.

Employment Impact – Employment impact represents the changes in the number of jobs in an industry (or set of industries) due to changes in production of a specified industry.

Direct Impact – The effect on an industry’s production output due to an increase (or decrease) of a final demand.

Indirect Impact – The effect on all other economic sectors due to purchases by such industry to generate the above-mentioned production output.

Induced impact – The effect on all economic sectors due to the expenditures of new income generated by the direct and indirect impacts.

Total impact – The sum of direct, indirect and induced impacts.

Multipliers – In economic impact studies, “Multipliers” are a frequently used term, along with “Multiplier Effect” or “Ripple Effects”. They describe the “Indirect” and “Induced” impacts in output and employment due to changes in a production activity of an industry.

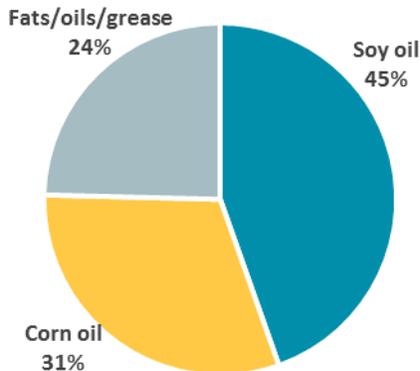
Minnesota Biodiesel Economic Impact Analysis

This economic impact analysis is based on Minnesota’s biodiesel production of 74 million gallons a year, which includes 45 percent of soy biodiesel and 55 percent non-soy biodiesel. The following feedstock sources are utilized in biodiesel production: soy oil, distillers corn oil, and other fats/oils/grease.

The benefits of biodiesel production spreads across many economic sectors, starting at the farm level. Soybeans, corn, and livestock are the three main sources of raw materials that supply the feedstock for biodiesel production: soy oil, corn oil, and other fats/oils/grease from animals and plants.

In Minnesota, soy oil was historically the leading feedstock source for the state’s biodiesel production due to its availability and ready-access from in-state soybean crushing plants. An acre of soybeans could yield 75 gallons of biodiesel based on a yield of 50 bushels per acre. In recent years, however, there has been a shift in Minnesota toward a mixed feedstock which includes other oils such as distillers corn oil.

Chart-6: MN Biodiesel Feedstock Sources



Source: Minnesota Department of Agriculture (MDA)

An incentive to support and grow Minnesota’s biodiesel industry is adding value to the state’s two largest crops – corn and soybeans. Minnesota corn and soybean prices are generally lower than the national average by \$0.13 per bushel for corn and \$0.11 per bushel for soybeans. Processing these two crops into soy oil and corn oil for biodiesel production help add value to the raw agricultural commodities.

Major sectors included in the biodiesel economic impact study:

1. Soybean production and processing (soy oil for biodiesel);
2. Corn production and processing (corn oil for biodiesel);
3. Oil/fats/grease rendering; and
4. Biodiesel production/transesterification.

These four economic sectors are the “value chain” of Minnesota’s biodiesel industry. Agriculture and manufacturing industries are the drivers in delivering the economic benefits from the entire biodiesel production process to the state economy.

I. Economic Impact: Minnesota Soybean Production and Processing

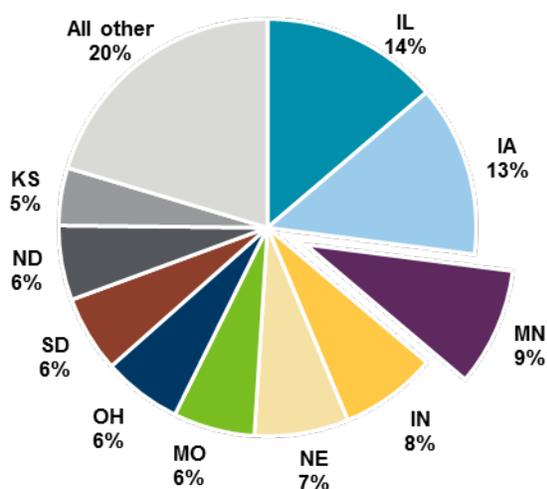
Minnesota's biodiesel production has grown from 16 million gallons made from 100 percent soy oil to 74 million gallons made from multiple feedstocks. Since soy oil is currently still the major source of feedstock for biodiesel, the following section reviews the state's soybean production and processing to assess this input source. Major supporting industries include ag input, wholesale trade, transportation, finance and insurance, and services.

Key facts:

- Minnesota is the nation's third largest soybean-producing state. Only Illinois and Iowa produce more soybeans than Minnesota.
- Minnesota soybean production reached 394 million bushels from 7.5 million acres in 2016.
- Soybeans are the second largest crop in Minnesota, contributing \$2.8 billion or 17 percent of the state's total agricultural cash receipts (2015 data – latest available).
- Soybean processing/crushing utilizes 191 million bushels of soybeans, or one-half of Minnesota's annual soybean crop.
- Soybean crushing yields a total of 2.23 billion pounds of soy oil, of which 12 percent is currently processed into soy biodiesel.
- About 22 million bushels of soybeans, or 5.6 percent of Minnesota's annual soybean crop, is currently processed into soy oil for biodiesel production.

Chart-7: U.S. Soybean Production: Top States

(%-share by production)



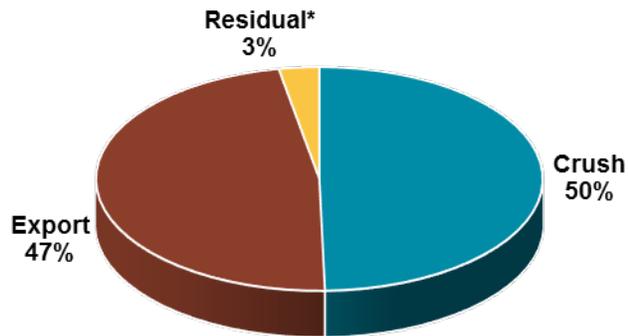
Source: U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

Table-2: Minnesota Soybean Utilization Trend (2000-2016)

Year	Production (Million bu.)	Crush (Million bu.)	Export (Million bu.)	Soy Oil Production (Million lb.)
2000	293	178	105	739
2001	266	149	109	761
2002	309	200	105	748
2003	238	78	156	1,119
2004	233	27	172	1,246
2005	306	75	177	1,297
2006	319	101	182	2,079
2007	267	127	179	2,065
2008	265	97	165	1,869
2009	285	105	169	1,877
2010	329	147	159	1,813
2011	275	107	164	1,873
2012	305	136	163	1,892
2013	259	82	162	1,941
2014	302	99	186	2,089
2015	378	179	187	2,151
2016	394	173	191	2,230

Source: ProExporter Network (PRX)

Chart-8: Minnesota Soybean Utilization



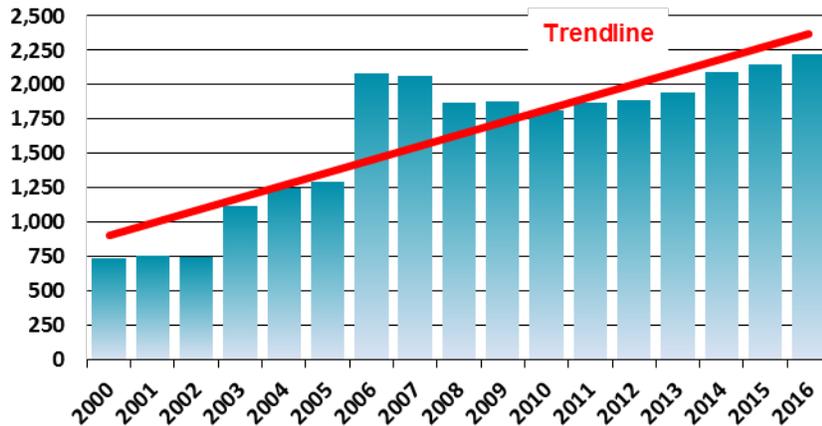
*Residual: all other uses

Source: PRX

Source: ProExporter Network (PRX)

Chart-9: Minnesota Soybean Oil Production

(Million Pounds)



Source: USDA, NASS

Soybean production and processing impacts:

- 22 million bushels soybean utilization (5.6 percent annual soybean crop);
- 242 million pounds soy oil utilization (12 percent annual production);
- \$506 million in economic activity (30 percent of the total economic impact of biodiesel);
- 1,528 jobs (28 percent of the total employment impact of biodiesel).

II. Economic Impact: Minnesota Corn Production and Processing

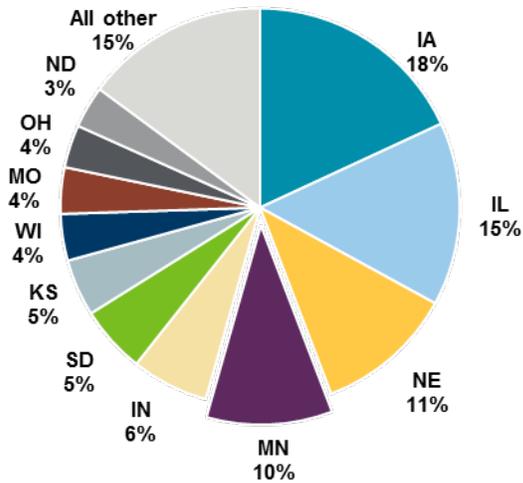
Minnesota corn production and processing benefit from biodiesel due to the utilization of corn oil as feedstock. Distillers corn oil has been increasingly used in the biodiesel production since the 2010's. Distillers corn oil is extracted from distillers dried grains (DDG) in the dry mill process of ethanol production where DDG is the co-product. Minnesota has 17 dry mill ethanol plants that annually process approximately 400 million bushels of corn. Today's ethanol dry mill plants are more profitable as a result of extracting distillers corn oil from the production process. Major supporting industries include ag input, wholesale trade, transportation, finance and insurance, and services.

Key facts:

- Corn is the No. 1 crop in Minnesota.
- Minnesota is the nation's fourth largest corn-producing state.
- Minnesota corn production reached 1,544 million bushels in 2016, a record-high.
- Corn accounts for \$4.1 billion or 25 percent of the state's total agricultural cash receipts.
- Corn processing utilizes 36 percent of Minnesota's annual corn crop, including ethanol and non-ethanol processing.
- About 420 million bushels of corn is utilized in dry mill production of ethanol and DDG, from which distillers corn oil is extracted for biodiesel.
- About 29 percent of Minnesota's distillers corn oil is processed into biodiesel.

Chart-10: U.S. Corn Production: Top States

(%-share by production)



Source: U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS)

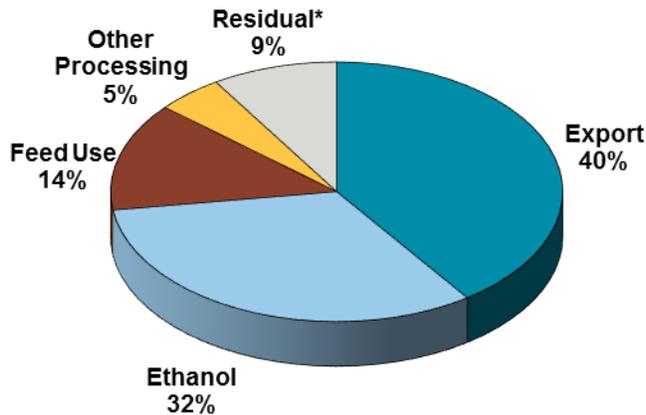
Table-3: Minnesota Corn Utilization Trend (2000-2016)

Year	MN Corn Utilization			
	Production	Export	Processing	Feed use
2000	964	498	115	239
2001	806	477	138	240
2002	1,052	614	190	233
2003	971	478	214	234
2004	1,121	441	195	231
2005	1,192	616	226	230
2006	1,103	739	229	218
2007	1,146	465	343	204
2008	1,181	496	388	209
2009	1,244	449	477	204
2010	1,292	591	493	204
2011	1,201	509	499	193
2012	1,374	694	463	196
2013	1,294	449	498	198
2014	1,178	329	532	204
2015	1,429	600	528	199
2016	1,544	591	548	199

Source: ProExporter Network (PRX)

Chart-11: Minnesota Corn Utilization

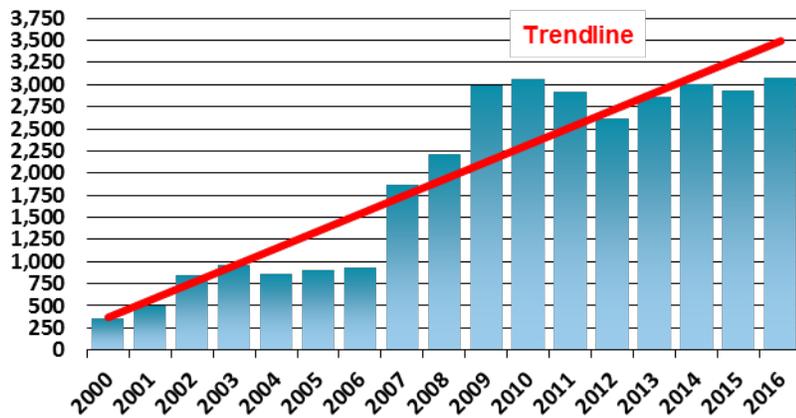
(%-share by bushels)



*Residual: all other uses

Source: ProExporter Network (PRX)

Chart-12: Minnesota DDG Production (Million Pounds)



Source: ProExporter Network (PRX)

Corn production and processing impacts:

- 120 million bushels corn utilization (8 percent annual corn crop);
- 180 million pounds distillers corn oil utilization;
- \$763 million in economic activity (45 percent of the total economic impact of biodiesel);
- 2,990 jobs (55 percent of the total employment impact of biodiesel).

III. Economic Impact: Fats, oils, and grease rendering and blending

About one-fourth of Minnesota’s biodiesel feedstock comes from fats, oils, and greases. Minnesota’s fats/oils/grease rendering output grew by more than 60 percent since 2010. Major supporting industries include farming, wholesale trade, transportation, and restaurants/food service.

Fats/oils/grease rendering and blending impacts:

- \$53 million in economic activity (3 percent of the total economic impact of biodiesel);
- 102 jobs (2 percent of the total employment impact of biodiesel).

IV. Economic Impact: Biodiesel Production and Transesterification

Processing the feedstock into biodiesel (transesterification) generates production activities in feedstock supplies and manufacturing processes. Soy oil, corn oil and other fats/oils/grease are utilized as raw materials and add value to a large range of products and services in the economy. Major supporting industries include manufacturing, wholesale trade, transportation, farming, public utility, and services.

Biodiesel production/transesterification impacts:

- The combined feedstock production of soybeans, soy oil, corn, corn oil, and fats/oils/grease;
- \$366 million in economic activity (22 percent of the total economic impact of biodiesel);
- 776 jobs (14 percent of the total employment impact of biodiesel).

Table-4: Farm Level and Non-farm Level Sector – Economic Impact

Impacted Industries	Output (Million \$)	Employment (# of jobs)
Farm level impacts	\$676	2,014
Non-farm level impacts	\$1,012	3,382
Total impacts	\$ 1,688	5,397

The following tables provide the detailed analysis of output and employment impacts by sector.

Economic Impact Breakdown by Sector

Chart-13: Output Impact by Sector (Million \$)

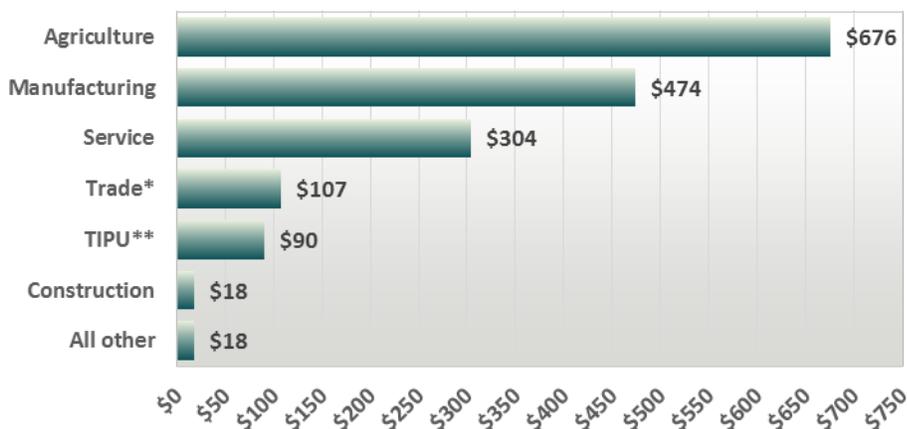
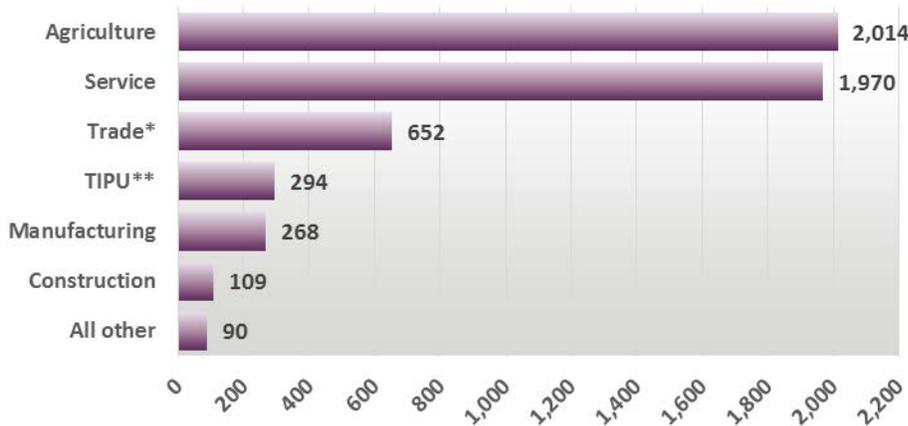


Chart-14: Employment Impact by Sector (# of Jobs)



*Trade: Wholesale/retail trade

**TIPU: Transportation, Information, Power and Utilities

Conclusion

At the current 74-million-gallon a year production level, biodiesel in Minnesota benefits many economic sectors and creates production, processing, supply and service activities. For rural Minnesota, this is an important economic development engine that promotes agricultural utilization and brings employment opportunities. Biodiesel production:

- Contributes over \$600 million in direct farm-level production output.
- Adds value to Minnesota’s top two crops – corn and soybeans – instead of marketing them as raw commodities at farm-gate prices.
- Increases agricultural processing output by \$157 million.

Statewide, each 1 million gallons of biodiesel production supports 73 jobs and contributes \$22.8 million in state-wide total economic output. In total, the biodiesel industry in Minnesota:

- Generates a total annual output impact of \$1.7 billion.
- Creates employment opportunities for 5,397 jobs.

Table-5: Selected Production Sectors – Economic Impact

Impacted Sectors	Output (Million \$)	Employment (# of Jobs)
Soybean production & processing	\$506	1,528
Corn production & processing	\$763	2,991
Fats/oils/grease rendering & blending	\$53	102
Biodiesel production/transesterification	\$366	776
Combined Total	\$1,688	5,397

Chart-15: Total Output Impact Breakdown

(%-share by value)

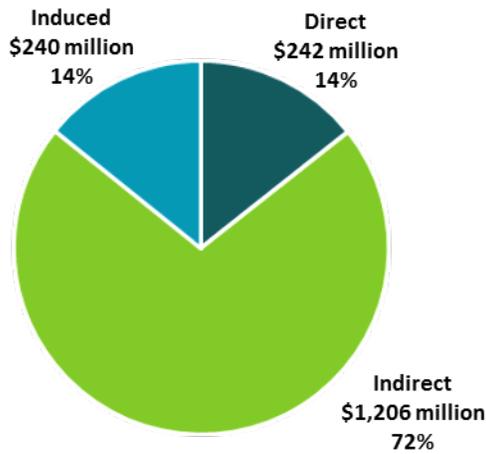
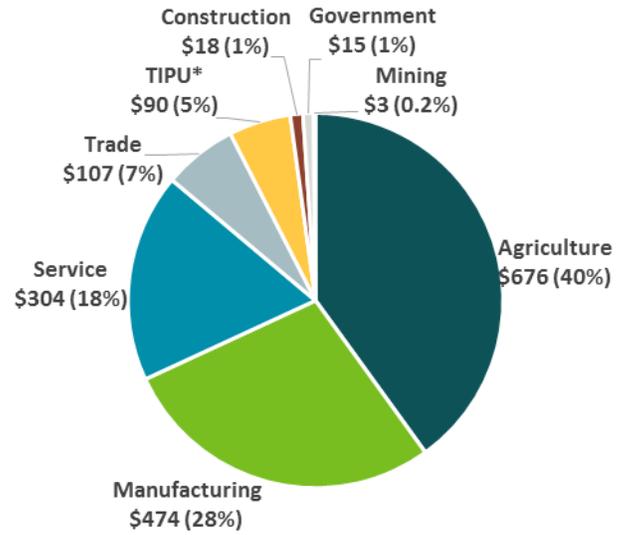


Chart-16: Total Output Impact by Sector

(%-share by value)



*FIRE: Finance, insurance, and real estate

**TCPU: Transportation, communication, and public utilities

Economic Impact Breakdown: Direct, Indirect, and Induced

Chart-17: Output Impact

(Million \$)

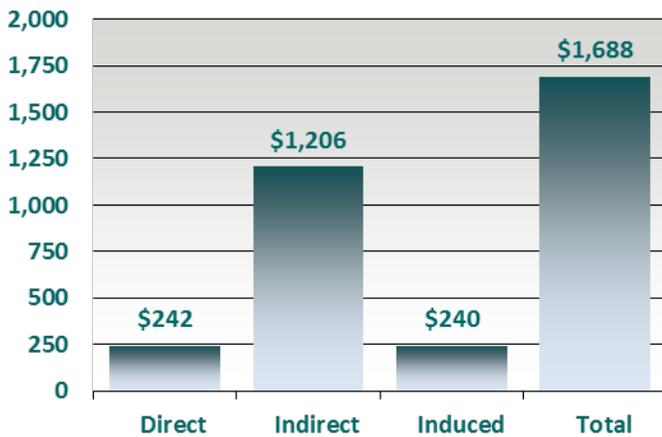
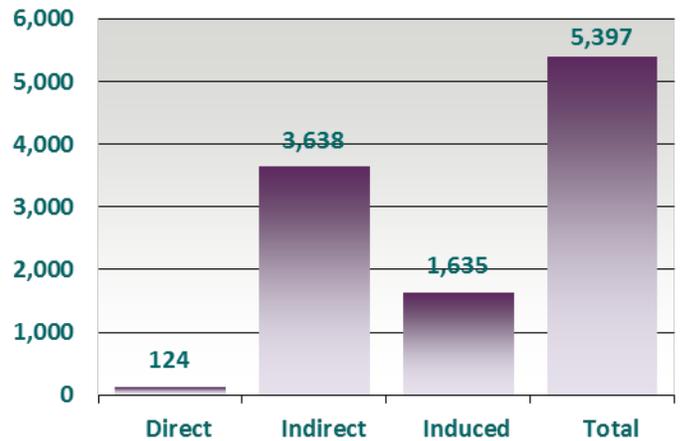


Chart-18: Employment Impact

(Number of Jobs)



The economic impacts, or “multiplier effects”, include the direct, indirect, and induced impacts:

- **Direct impact** represents the effect of biodiesel production.
- **Indirect Impact** represents the effect on all other economic sectors supporting the biodiesel industry.
- **Induced impact** represents the effect on all economic sectors due to the expenditures of new income generated by the direct and indirect impacts.
- **Total impact** is the sum of direct, indirect and induced impacts.

In accordance with the Americans with Disabilities Act, this information is available in alternative forms of communication upon request by calling 651/201-6000. TTY users can call the Minnesota Relay Service at 711. The MDA is an equal opportunity employer and provider.