CONTRIBUTION OF THE ETHANOL INDUSTRY TO THE ECONOMY OF MINNESOTA

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Prepared for the Minnesota Bio-Fuels Association

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Executive Summary

From the farm to the fuel pump, the ethanol industry is a vital component of Minnesota's economy. Ethanol plants provide jobs and income not only for the people who work at the plants, but also for businesses that sell ethanol plants supplies including Minnesota farmers who produce most of the corn used by Minnesota's biofuels industry. Private and public sector biofuels research and development also contribute to the state's economy.

The impact of the ethanol industry on the Minnesota economy was estimated by applying economic impact multipliers to expenditures for goods and services purchased from supplying industries. This analysis was based on economic impact multipliers developed from the most recent IMPLAN (Impact Analysis for Planning) economic model and database. IMPLAN was used to construct a model of the Minnesota economy including the sectors that support the ethanol industry, the links between them, and the level of economic activity. IMPLAN models generate a range of economic indicators that describe an economy, but the most commonly used are value added (GDP), labor income (also known as household earnings), and employment.

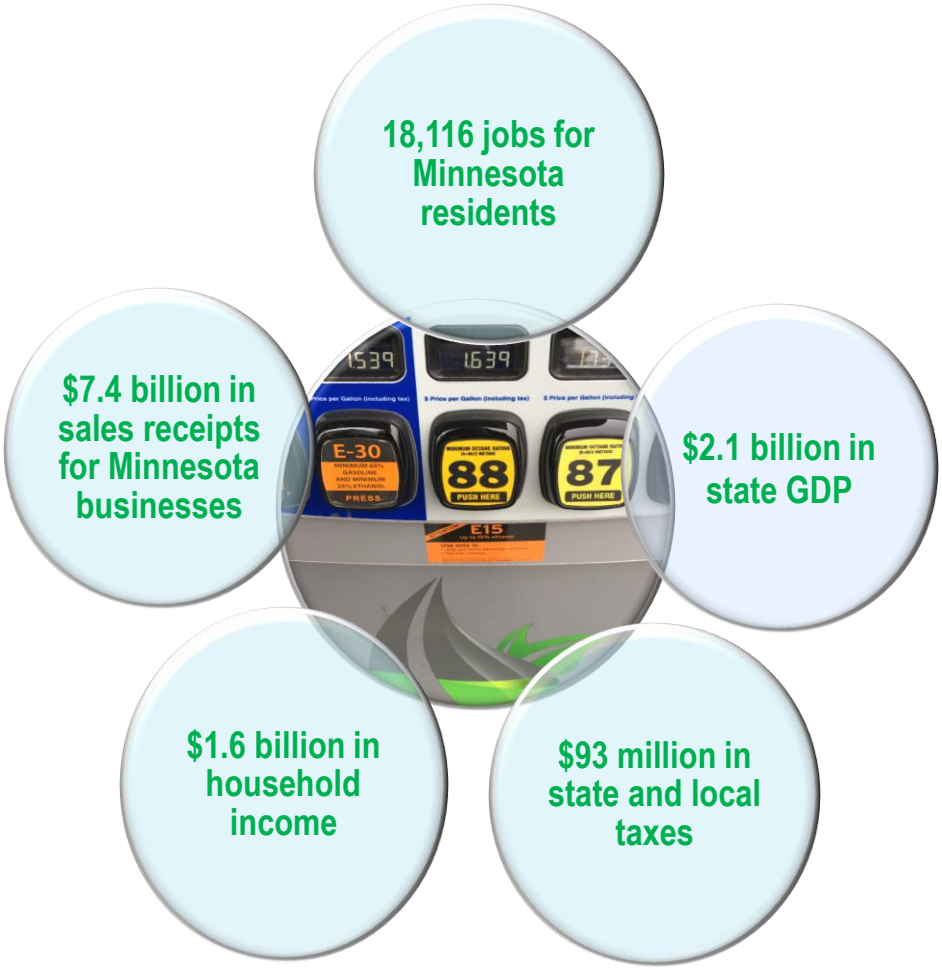
Minnesota ethanol output increased 11 percent to more than 1.2 billion gallons in 2015. However due to lower prices for corn and other inputs, total spending to produce ethanol during 2015 declined over 2014 levels. The ethanol industry in Minnesota spent approximately $2.1 billion on raw materials (mostly corn), other inputs, goods and services to produce ethanol and primary co-products DDGS and corn refiner's oil. When the impact of these expenditures circulate fully through the Minnesota economy, the ethanol industry:

- Generated $7.4 billion in gross sales for Minnesota businesses
- Accounted for more than $2.1 billion in state Gross Domestic Product (GDP)[1]
- Generated $1.6 billion worth of income for Minnesota households
- Supported more than 18,100 full time jobs in the state, and
- Contributed $93 million to state and local government tax rolls.[2]

[1] GDP is the value of the goods and services produced in the economy

[2] This study estimated the annualized impact of producing 1.22 billion gallons of ethanol on Minnesota's economy. Figures reflect the capacity of ethanol plants operating at year's end.

Annual Economic Impact of the Biofuels Industry in Minnesota



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Introduction

Minnesota's 21 operating ethanol plants have an annual capacity of more than 1.2 billion gallons. This requires approximately 423 million bushels of corn (nearly 30 percent of Minnesota's 2015 corn crop) with a farm gate value of approximately $1.5 billion at 2015 average prices. Ethanol plants purchase agricultural raw materials (mostly corn), other inputs, and a wide range of goods and services such as industrial chemicals; electricity, natural gas, and water; labor; and services such as maintenance, insurance, and general overhead. In addition, funding for biofuels research and development from various sources including the federal government and the private sector benefit the state's economy.

Expenditures on these goods and services represent the purchase of output of other industries and a substantial share of these dollars is spent in Minnesota and the economic impact stays in the state. Spending associated with ethanol production circulates throughout the entire economy several fold. Consequently, this spending stimulates aggregate demand, supports jobs not only in ethanol production but also jobs throughout the entire economy, generates additional household income, and provides tax revenue for state and local government.

At the request of the Minnesota Bio-Fuels Association (MBA), ABF Economics developed models to estimate the economic impacts of ethanol production in Minnesota. The following report summarizes our methods and results. This report: 1) summarizes current trends in the national biofuel industry, 2) outlines the methods used to estimate impacts, and 3) presents results of the models.

1. National Trends in Ethanol Production

The U.S. ethanol industry experienced another record-breaking year in 2015 despite a challenging competitive environment. Industry output increased 3.4 percent for all of 2015 to a new record of 14.8 billion gallons. The year started off with strong year-over-year gains in ethanol production as

producers responded to lower feedstock prices. The third largest ever 2015 corn crop pushed feedstock prices lower until the third quarter of the year. The collapse in global oil prices accompanied by record levels of ethanol production helped drive ethanol prices lower and strained profitability. Average Minnesota cash market corn prices during 2015 were nearly 11 percent lower than a year earlier while ethanol prices were a third lower than it was in 2014.[3]

On the demand side, consumers responded to sharply lower retail gasoline prices by increasing consumption of finished motor gasoline. Reflecting this, domestic ethanol use increased 4 percent during 2015 to record levels. While still small relative to domestic use, ethanol exports posted a 3.4 percent increase for the first 10 months of 2015. Slow improvements in infrastructure continued to restrain overall growth in the availability and consumption of higher blends of ethanol. Despite this, the number of refueling stations offering E-85 and E-15 in Minnesota continued to grow in 2015.

The ethanol industry faced both economic and regulatory challenges in 2015. The economic challenges included the sharpest decline in world oil and refined product prices since the bursting of the 2008 "Commodity Price Bubble". West Texas Intermediate Crude oil prices that peaked at $105.79 per barrel in June 2014 fell steadily through 2015 averaging $37 per barrel in December 2015, 65 percent below peak levels. During this same period ethanol prices, F.O.B. (Free On Board) [4]Iowa Plant and Omaha Rack were down nearly 40 percent. As pointed out feedstock (corn) prices also declined during 2015 but so did co-product prices with DDGS prices (10 percent moisture, Iowa) down 9.5 percent and distiller's corn oil prices down 19.5 percent during 2015. As a result of these factors ethanol profitability suffered. According to Iowa State University, net returns over variable costs for a typical Iowa dry mill ethanol plant averaged $0.21 per gallon during 2015, down sharply from the $0.71 per gallon return experienced in 2014.[5]

The regulatory environment also provided challenges for the industry. In November the EPA released the final volume requirements for 2014, 2015 and 2016 under the Renewable Fuel

[3] No. 2 Yellow Corn, Central Illinois; ethanol FOB Iowa Plant and Ethanol Omaha Rack. Source USDA

[4] Pertains to a transaction whereby the seller makes the product available within an agreed on period at a given port at a given price; it is the responsibility of the buyer to arrange for the transportation and insurance. http://www.eia.gov/dnav/pet/TblDefs/pet_pri_wco_tbldef2.asp

[5] Iowa State University AgDecision Maker Ethanol Profitability and Biodiesel Profitability available at http://www.extension.iastate.edu/agdm/energy/xls/d1-10ethanolprofitability.xlsx and http://www.agmrc.org/renewable_energy/biodiesel/biodiesel-profitability accessed January 24, 2016

Standard (RFS2) program. EPA's final rule provides levels for most biofuels at levels well above the Agency's proposal released earlier in the year. However, the required volumes remained well below the statutory requirements set forth by the 2007 law establishing the RFS. Overall, the EPA Final Rule calls for total biofuels — corn ethanol, advanced biofuels, cellulosic ethanol, and biomass biodiesel to be blended at 18.1 billion gallons, well under the 22.3 billion gallon statutory level set by the 2007 law which authorizes the RFS2. In particular, the 2016 RFS2 level of 14.5 billion gallons for corn ethanol is 500 million gallons under the 15-billion gallon statutory level. Similarly, the RFS2 gallon targets for Cellulosic and Other Advanced biofuels, while higher than EPA's initial 2015 proposal, are substantially below statutory levels.

In addition to ethanol refining and agriculture, there is a significant amount of public and private sector funding for research and development aimed at discovering and developing advanced biofuels feedstock and the technology needed to meet the RFS2 targets for cellulosic and advanced biofuels. The primary public sector agencies underwriting R&D in biofuels are the U.S. Departments of Energy (USDOE), Agriculture (USDA), and Defense (DOD). In addition to the federal government, many states are funding R&D in feedstock as well as infrastructure. These public funds are being leveraged significantly by private sector firms undertaking research in a wide range of biofuels activities. Based on a review of publically available data and recent published research on Federal government spending on R&D, we have reduced our estimate of R&D expenditures for biomass biofuels in the U.S. to $850 million in 2015, about half that assumed for 2014.[6]

While it is difficult to estimate how much of this is accounted for by Minnesota institutions and firms, we assume that the state's share amounts to about 20 percent of total national biofuels research and development expenditures.

[6] Estimates of the amount of R&D spending on biomass and biofuels vary substantially. For a discussion of R&D spending on biofuels see "Agricultural Preparedness and the Agriculture Research Enterprise". President's Council of Advisors on Science and Technology. Washington DC, December 2012. A 2013 study prepared by Mary Solecki, Anna Scodel and Bob Epstein at E2 Environmental Entrepreneurs. "Advanced Biofuel Market Report 2013" suggests that R&D spending on biofuels approaches $1.7 billion. A (relatively) new report on federal spending on R&D in energy published by EIA ("Direct Federal Financial Interventions and Subsidies in Energy in Fiscal year 2013", March 2015) estimates Federal R&D expenditures for biomass of $300 million in FY 2013. This study does not include estimates for corporate (private sector) R&D.

2. Methodology

Economic impact analysis measures the effects of an economic activity or event on a specific geographic area. For example, policy makers or business leaders may want to know how a proposed manufacturing plant would affect a regional economy, or conversely, they may want to know how closing a plant or military base would affect a community. In some cases, federal and state laws require economic impact studies before implementing a policy or project or changing tax policies. Regardless of the reason, impact studies provide useful information for guiding economic development and or to mitigate potential negative impacts. Economic impact analysis is an important decision making tool that can enhance the quality of decisions made, as well as the decision making process in both public and private sectors.

Basically, economic impact models are accounting frameworks for a predefined geographic area that measures how goods and services flow through different economic sectors including industries, households and governments. Spending, or the lack of spending by these sectors, is the primary driver in an impact model. Spending associated with renewable fuels production circulates throughout the entire Minnesota economy several fold. Consequently, this spending stimulates aggregate demand, supports the creation of new jobs, generates additional household income, and provides tax revenue for state and local governments. ABF estimated the impact of the ethanol industry on the Minnesota economy by applying expenditures by the relevant supplying industry to the appropriate final demand multipliers for value added output, earnings, and employment.

In this study, ABF used the IMPLAN (Impact Analysis for Planning) economic model to construct a model of the Minnesota economy including the sectors that support the ethanol industry, the links between them, and the level of economic activity. IMPLAN is a commonly used economic input-output (I-O) model. I-O models are constructed based on the concept that all industries within an economy are linked together; the output of one industry becomes the input of another industry until all final goods and services are produced. I-O models can be used both to analyze the structure of the economy and to estimate the total economic impact of projects or policies. For this analysis, ABF used a model of the Minnesota economy based on the most recent IMPLAN software and data to estimate economic impacts of the ethanol industry.

To understand how the economy is affected by an industry such as ethanol production, it is necessary to understand how different sectors or industries in the economy are linked. For example, in the renewable fuels production sector, the ethanol industry buys corn from the

agriculture sector; which in turn, buys inputs from other suppliers such as fertilizer and pesticide producers that also purchase products from a range of other industries. These are referred to as backward linkages. Use by other sectors of natural gas as an input, such as other manufacturing operations, is a forward linkage. Natural gas production and transmission industries are linked through both forward and backward linkages to other economic sectors of the state's economy.

The household sector is linked to all other sectors as it provides the labor and management resources. In turn, changes that affect household incomes typically have significant impacts compared to a change in the sales of other sectors. This is because households typically spend most of their income on both retail and service goods, both of which are critical components of the economy.

Table 1 shows estimated 2015 expenditures for the Minnesota ethanol industry. Each type of expenditure is linked to an appropriate IMPLAN sector, and analyzed using IMPLAN software. In addition to the impacts of these expenditures, our analysis includes corporate income of the ethanol plants, and income generated by locally owned and cooperative ethanol firms. All corporate income generated by the ethanol industry that stays in the state is included in GDP impacts. Corporate earnings transferred to firms outside of Minnesota are leakages for the economy and are not included. A review of ownership of ethanol firms based on information provided by MBA suggests that approximately two-thirds of the state's ethanol plants are locally owned or have significant local ownership. The earnings of locally owned firms are treated as an addition to the household sector since the income is paid to Minnesotans so their impact is more accurately estimated using multipliers for the household sector.

Table 1
Annual Ethanol Industry Costs and Returns in Minnesota: 2015

Ethanol Industry Purchases	Ethanol Industry Expenditures ($millions)
Corn	$1,501
Enzymes, Yeast and Chemicals	$87
Denaturant	$69
Electricity	$64
Natural Gas	$184
Water	$15
Direct labor	$42
Maintenance & Repairs	$33
Transportation	$10
Professional Services	$47
Total Operating Costs	**$2,052**
Change from 2014	-23.8%
Revenues	
Ethanol	$1,975
Distiller's Dried Grain	$515
Corn Oil	$51
Total Revenues	**$2,541**
Change from 2014	-12.8%
EBITA	**$489**
Change from 2014	-39.4%

Source: ABF Economics

Multipliers measure three types of impacts: direct, indirect, and induced impacts:

- Direct effects are the known or predicted changes in the economy.
- Indirect effects are the business-to-business transactions required to produce direct effects (i.e., increased output from businesses providing intermediate inputs).
- Induced effects are derived from spending on goods and services by people working to satisfy direct and indirect effects (i.e., increased household spending resulting from higher personal income).

Multipliers are calculated from I-O models that are constructed from data for a specified geographic area. The economy in question is divided into a number of producing industries or sectors that sell and purchase goods and services to and from each other, and these inter-industry purchases and sales are key data in I-O models. Sector goods and services are purchased by domestic households, international customers in the form of exports, government (federal, state, and local), and for

private sector investment. Purchases that are not part of an economy's supply chain are final demand. For example, wheat farmers sell wheat to mills that produce flour and sell it to food manufacturers and bakers that make bread. Those food manufacturers then sell the bread to wholesale and retail outlets, and ultimately consumers purchase the bread to eat. Consumer purchases are final demand. For an economy with n sectors, if X_i represents total output for sector i, Y_i represents final demand for sector i products, and z_{ij} represent inter-industry flows, then:

$$X_i = \sum_{j=1}^{n} z_{ij} + Y_i \qquad (1)$$

If a_{ij} represents the I-O technical coefficients where $a_{ij} = z_{ij} / X_j$ so that sectors use inputs in fixed proportions (i.e., constant returns to scale Leontief production function) then the above equation becomes:

$$X_i = \sum_{i=1}^{n} a_{ij} X_i + Y_i \qquad (2)$$

The standard formulation of the basic I-O model and its application, in matrix notation is:

Transactions balance:	$X = AX + Y$	(3)
Solving for X:	$X = (I - A)^{-1}Y$	(4)
For a change in Y:	$\Delta X = (I - A)^{-1}\Delta Y$	(5)

Where X is the gross output column vector, A is the matrix of fixed I-O coefficients, Y is the final demand column vector, and I is the identity matrix. This model measures changes in output given changes in final demand (i.e., consumption, investment, government, or exports). The Leontief inverse, $(I - A)^{-1}$, provides the I-O multipliers used to determine impacts. Elements of the matrix are very useful and important as each number in the matrix represents a series of direct and indirect effects. Gross output requirements are translatable into employment coefficients in a diagonal matrix that one can use with the Leontief inverse to estimate employment impacts. Similar calculations produce value-added (GDP) and income multipliers.

When using IMPLAN an important consideration is the definition of the geographic area used in a study. Economies extend far beyond political boundaries, and workers and their incomes and transactions among industries flow across political boundaries. Thus, some indirect effects are likely to occur beyond the geographic region under study. These are called leakages, as opposed to linkages (supplier-purchaser relationships) within a region, and smaller geographic regions such

counties will have more leakages. In contrast, a larger area such as a state or nation will have relatively fewer leakages.

IMPLAN models generate a range of economic indicators that describe an economy, but the most commonly used are output (gross business revenues), value added (GDP), employment, and labor income (also known as household earnings):

- **Gross Output** is the value of production for all industries in an economy measured by gross sales revenues (i.e., sales).[7]

- **Value added** is the total value of goods and services produced by businesses in an economy. Generally referred to as **gross domestic product** (GDP), it is the sum of labor income, taxes paid by industries and households, and other property type income such as corporate profits. Value added including labor income and employment represent the net economic benefit that accrues to an economy as a result of increased economic output.

- **Labor income or Household Earnings** is the sum of employee compensation (including all payroll and benefits) and proprietor income (income for self-employed work). In the case of this analysis, demand for corn and other feedstock to produce ethanol supports household earnings through higher receipts than would be the case without ethanol production.

- **Employment** represents the annual average number of employees (full time equivalents), of businesses producing output.[8]

3. Contribution of the Ethanol Industry to Minnesota

Ethanol manufacturing contributes significantly to the Minnesota economy, spending roughly $2.1 billion on raw materials, other inputs, goods and services to produce 1.2 billion gallons of ethanol. Corn, which the industry uses as a renewable raw material to make ethanol, distillers dried grains with solubles (DDGS), and industrial corn oil, accounts for approximately half of the industry's

[7] Although output is a valid metric and important from the perspective of individual businesses, it does not measure the net value of production in an economy. For example, if a farmer sells corn to a mill for $1.00, and the mill processes the corn into feed and sells it for $3.00, the total output value would be $4.00. The net economic value (or value added) only counts the incremental increase in value, and includes the original $1.00 sales and the additional $2.00 in value added after the mill processed the corn into feed for a total value added of $3.00.

[8] Employment numbers in this report are expressed in terms of full-time equivalent jobs.

purchases. In 2015 the Minnesota ethanol industry used about 423 million bushels of corn (about 30 percent of the state's harvest) to produce ethanol, DDGS and corn oil. [9]

In addition to providing a growing and reliable domestic market for Minnesota, the ethanol industry also provides the opportunity for farmers to enjoy some of the value added to their commodity by further processing. Locally owned ethanol plants, including cooperative farmer owned plants account for about 60 percent of Minnesota fuel ethanol plants and production capacity.

The remainder of the spending by the ethanol industry is for a wide range of inputs such as industrial chemicals; electricity, natural gas, and water; labor; transportation; and services such as maintenance, insurance, and general overhead. Spending for these goods and services represents the purchase of output of other industries, many of which operate in Minnesota.

Table 2 summarizes results of our analysis. Ethanol manufacturing and supporting research and development (excluding expenditures on grain feedstock which is allocated to the agriculture sector) generates nearly $1,423 million worth of GDP for Minnesota based on economic conditions in 2015. Direct employment at ethanol plants amounts to 1,050 jobs in the state with household incomes totaling $464 million.[10] Note that the total income generated includes income (i.e., profits) to owners of locally owned plants, which is substantial. Indirect GDP totaled $470 million, and consisted of GDP created by non-agricultural input suppliers such as natural gas companies, and induced GDP amounts to $451 million. Induced GDP comes from businesses that benefit from income spent by ethanol plant workers and owners, and income spent by employees who work in supporting industries. Indirect household earnings are $380 million, and induced household earnings total $318 million.

[9] The authors of this report recognize that the corn used in ethanol manufacturing might be grown regardless of the ethanol industry, albeit farmers would likely realize lower prices for their corn without the ethanol industry. Regardless, corn production is currently a major part of the industry's supply chain, and thus should be included in an economic impact analysis, which by definition is distinct from a cost benefit analysis.

[10] The Census Bureau does not report employment in ethanol production. The number of direct jobs associated with ethanol production is based on an estimated industry average of 50 jobs per plant.

Since ethanol production relies primarily on corn grown by Minnesota farmers, ethanol plants have a very large impact on agriculture, supporting 2,802 direct farm and farm-related jobs.[11] Most of the agriculture jobs supported by the ethanol industry are farm workers and laborers associated with corn production and harvest. However, a wide range of jobs in support activities related to crop production ranging from farm managers and bookkeepers to farm equipment operators are supported by ethanol production. As the impact of the direct spending by the ethanol plants expands throughout the economy, the employment impact grows significantly over a large number of sectors. Indirect and induced jobs supported by the agriculture output used by Minnesota ethanol producers amount to an additional 4,298 indirect jobs in the corn production supply chain, and 1,916 indirect jobs in business supported by the household income generated by the ethanol industry.

In total, ethanol plants, the corn used by them, and biofuels research generates more than $2.1 billion in GDP for Minnesota, supports 18,116 full time jobs in the state and puts approximately $1.6 billion worth of earnings in the pockets of workers in the state. The total figures for jobs and earnings include all industries in Minnesota that support ethanol manufacturing; not only businesses that make up the supply chain such as corn farmers (i.e., indirect impacts), but also firms that benefit from the employee spending by workers that staff ethanol plants and supporting industries (i.e., induced impacts). For example, in terms of induced jobs the largest sectors in Minnesota impacted by ethanol production are retail trade and health care. When measured by household earnings, the sectors most affected include natural gas distributors (indirect), and the health care and banking and finance industries (induced). Appendix 1 shows the major industries affected for both agriculture and ethanol refining and research by output, GDP, household earnings and employment. Although, not shown in Table 2, we estimate (using IMPLAN) that state and local taxes generated by the ethanol industry totaled nearly $95 million in 2015.

[11] Based on a review of the location of Minnesota's ethanol plants and the guideline that most ethanol pants procure their feedstock from within a 50-75 mile radius of the plant, we estimated that about three-quarters of the corn used to produce ethanol in Minnesota was grown by Minnesota farmers.

Table 2

Ethanol's Contribution to the Minnesota State Economy: 2015

Ethanol Manufacturing and R&D	Sales Revenues (Mil $)	Gross Domestic Product (Mil $)	Jobs Supported (Employment) (full time equivalents, Thou))	Household Earnings (Mil $)
Direct	$2,868.6	$511.1	1,749	$463.8
Indirect	$1,061.4	$470.3	2,151	$379.6
Induced	$1,071.2	$451.0	5,199	$317.6
Total	**$5,001.3**	**$1,432.3**	**9,100**	**$1,161.1**
Agriculture (corn feedstock)				
Direct	$1,238.4	$93.1	2,802	$78.9
Indirect	$833.6	$433.8	4,298	$260.5
Induced	$302.6	$171.3	1,916	$102.4
Total	**$2,374.7**	**$698.1**	**9,016**	**$441.8**
Total				
Direct	$4,107.0	$604.1	4,552	$542.8
Indirect	$1,895.0	$904.0	6,449	$640.1
Induced	$1,373.8	$622.3	7,115	$420.0
Grand Total	**$7,376.0**	**$2,130.4**	**18,116**	**$1,602.9**

Source: ABF Economics using IMPLAN Pro™ data and software

4. Co-Product Production and Fuel Co-Existing with Food

The ethanol industry produces valuable co-products in addition to biofuel. In order to produce 1.2 billion gallons of ethanol the Minnesota ethanol industry used approximately 423 million bushels of corn. The ethanol production process converts the starch in the grain to sugar which is then fermented and distilled into alcohol, most of which is used for fuel. It is important to recognize that this process converts only the starch in the grain and leaves the remaining fiber, nutrients, and oil to be recovered as co-products used primarily as a feed ingredient for livestock and poultry. The oil can also be used to make biodiesel. Consequently the full food value of the corn used to produce ethanol is retained. This set of factors is of particular relevance as it demonstrates the production of biofuel can, and does, co-exist with food. By producing valuable feed ingredient co-products, the ethanol industry effectively reduces the amount of grain required by the livestock and poultry industry. A USDA study on the substitution of corn and soybean meal by ethanol co-products

reported that one ton of DDGS could effectively replace 1.22 tons of feed consisting of corn and soybean meal.[12]

In the process of converting approximately 423 million bushels of corn into ethanol, the Minnesota ethanol industry produced an estimated 3.6 million tons of Dried Distiller's Grains (DDGS) and 198 million pounds of corn distiller's oil in 2015. The 3.6 million tons of DDGS are sufficient to meet the annual feed requirements of more than 2.7 million beef and dairy cattle, or the entire inventory of cattle and calves in Minnesota.[13] Moreover since DDGS is used as a feed supplement it displaces both corn and soybean meal.[14] Thus, given the availability of DDGS from ethanol production, the livestock and poultry industry requires less grain corn and soybean meal to feed the same number of animals and produce the same amount of meat and dairy products.

The corn refiner's oil produced as an ethanol co-product is used as a feedstock for biodiesel production, as an animal feed ingredient and as an intermediary for industrial products. If all of the corn refiner's oil produced by Minnesota ethanol plants was used as a biodiesel feedstock, it could produce more than 26 million gallons of biodiesel, or more than 40 percent of the biodiesel produced by Minnesota's biodiesel plants.

CONCLUSION

The ethanol industry makes a significant contribution to the economy of Minnesota in terms of job and income creation and generation of tax revenue while producing a renewable fuel to displace refined petroleum products. The importance of the ethanol industry to Minnesota agriculture and rural economies is particularly notable. Continued growth and expansion of the ethanol industry through innovation and the use of new technologies and renewable feedstock will enhance the industry's position as the original creator of green jobs, and will enable Minnesota, and America, to make further strides toward energy independence.

[12] Linwood A. Hoffman and Allen Baker. "Estimating the Substitution of Distillers' Grains for Corn and Soybean Meal in the U.S. Feed Complex". USDA/ERS FDS-11-1-01. Updated January 7, 2012

[13] Personal conversations with Dr. Caitlin Foley, Assistant Professor of Dairy Science at Delaware Valley University suggest an average daily DDGS consumption of 5 to 10 lbs. per cow per day is a reasonable assumption. This is consistent with inclusion rates cited in the literature. USDA/NASS reported that Minnesota had 2.42 million cattle and calves in inventory on January 1, 2016.

[14] Corn refiner's oil also is used as a feed supplement and ingredient in compound feeds.

Appendix

Table A-1
Top 10 Industries Impacted by Ethanol Manufacturing and Biofuels Research and Development by Employment (2015)

Sector	Employment
Retail trade (including food service)	1,516
Health care	902
Natural gas distribution	393
Banking and finance	350
Real estate	335
Accounting, tax preparation, bookkeeping, and payroll services	246
Employment services	236
Legal services	217
Maintenance and repair construction of nonresidential structures	204
Wholesale trade	195
Total Top 10 Sectors	4,594

Source: ABF Economics using IMPLAN Pro™ data and software

Table A-2
Top 10 Industries Impacted by Ethanol Manufacturing and Biofuels Research and Development by Household Earnings (2015, $millions)

Sector	Household Earnings
Heath care	$50.56
Natural gas distribution	$40.95
Banking and finance	$23.59
Legal services	$18.50
Wholesale trade	$18.24
Maintenance and repair construction of nonresidential structures	$14.13
Accounting, tax preparation, bookkeeping, and payroll services	$13.62
Retail trade (including food service)	$29.46
Insurance carriers	$11.30
Real estate	$8.35
Total Top 10 Sectors	$228.69

Source: ABF Economics using IMPLAN Pro™ data and software

Table A-3
Top 10 Industries Impacted by Ethanol Manufacturing and Biofuels Research and Development by Gross Domestic Product (2015, $millions)

Sector	Gross Domestic Product
Health care	$121.33
Natural gas distribution	$112.21
Retail trade (including food service)	$103.47
Real estate	$91.11
Wholesale trade	$55.07
Banking and finance	$44.27
Legal services	$33.02
Insurance carriers	$31.64
Petroleum refineries	$18.93
Employment services	$14.54
Top 10 Sectors	$625.59

Source: ABF Economics using IMPLAN Pro™ data and software

Table A-4
Top 10 Industries Impacted by Ethanol Manufacturing and Biofuels Research and Development by Business Sales Receipts (2015, $millions)

Sector	Sales Receipts
Health care	$439.65
Retail trade (including food service)	$323.90
Real estate	$263.44
Petroleum refineries	$231.73
Banking and finance	$202.58
Wholesale trade	$201.44
Natural gas distribution	$112.95
Legal services	$97.50
Electric power transmission and distribution	$99.76
Other basic organic chemical manufacturing	$116.39
Top 10 Sectors	$2,089.39

Source: ABF Economics using IMPLAN Pro™ data and software

Table A-5
Top 10 Industries Impacted by Corn Production Used in Ethanol Manufacturing by Employment
(2015)

Sector	Employment
Support activities for agriculture	1,268
Real estate	672
Retail trade (including food service)	623
Wholesale trade	427
Banking and finance	377
Health care	299
Insurance carriers	232
Non-residential maintenance and repair	161
Employment services	139
Ground Transportation	133
Total Top 10	4,332

Source: ABF Economics using IMPLAN Pro™ data and software

Table A-6
Top 10 Industries Impacted by Corn Production Used in Ethanol Manufacturing by Household Earnings
(2015, $millions)

Sector	Household Earnings
Support activities for agriculture	$49.89
Wholesale trade	$41.49
Banking and finance	$28.63
Insurance carriers	$24.45
Health care	$19.70
Real estate	$16.30
Retail trade (including food service)	$15.39
Ground Transportation	$12.20
Non-residential maintenance and repair	$11.96
All other crop farming	$10.50
Total Top 10	$230.50

Source: ABF Economics using IMPLAN Pro™ data and software

Table A-7
Top 10 Industries Impacted by Corn Production Used in Ethanol Manufacturing by Gross Domestic Product
(2015, $millions)

Sector	Gross Domestic Product
Real estate	$113.14
Wholesale trade	$69.57
Support activities for agriculture	$50.64
Insurance carriers	$35.94
Banking and finance	$31.42
Health care	$20.72
Retail trade (including food service)	$20.18
Petroleum refineries	$15.40
Ground transportation	$12.92
Non-residential maintenance and repair	$12.34
Total Top 10	$382.26

Source: ABF Economics using IMPLAN Pro™ data and software

Table A-8
Top 10 Industries Impacted by Corn Production Used in Ethanol Manufacturing by Business Sales Receipts
(2015, $millions)

Sector	Sales Receipts
Real estate	$141.54
Wholesale trade	$104.28
Petroleum refineries	$84.82
Insurance carriers	$74.61
Support activities for agriculture and forestry	$65.22
Banking and finance	$64.85
Maintenance and repair construction of nonresidential structures	$31.39
Ground transportation	$32.12
Retail trade (including food service	$37.47
Health care	$36.36
Total Top 10	$672.68

Source: ABF Economics using IMPLAN Pro™ data and software