ABF Economics
Agriculture and BioFuels Consulting, LLP

CONTRIBUTION OF THE ETHANOL INDUSTRY TO THE ECONOMY OF MINNESOTA IN 2018

February 13, 2019

Prepared for the Minnesota Bio-Fuels Association

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Executive Summary

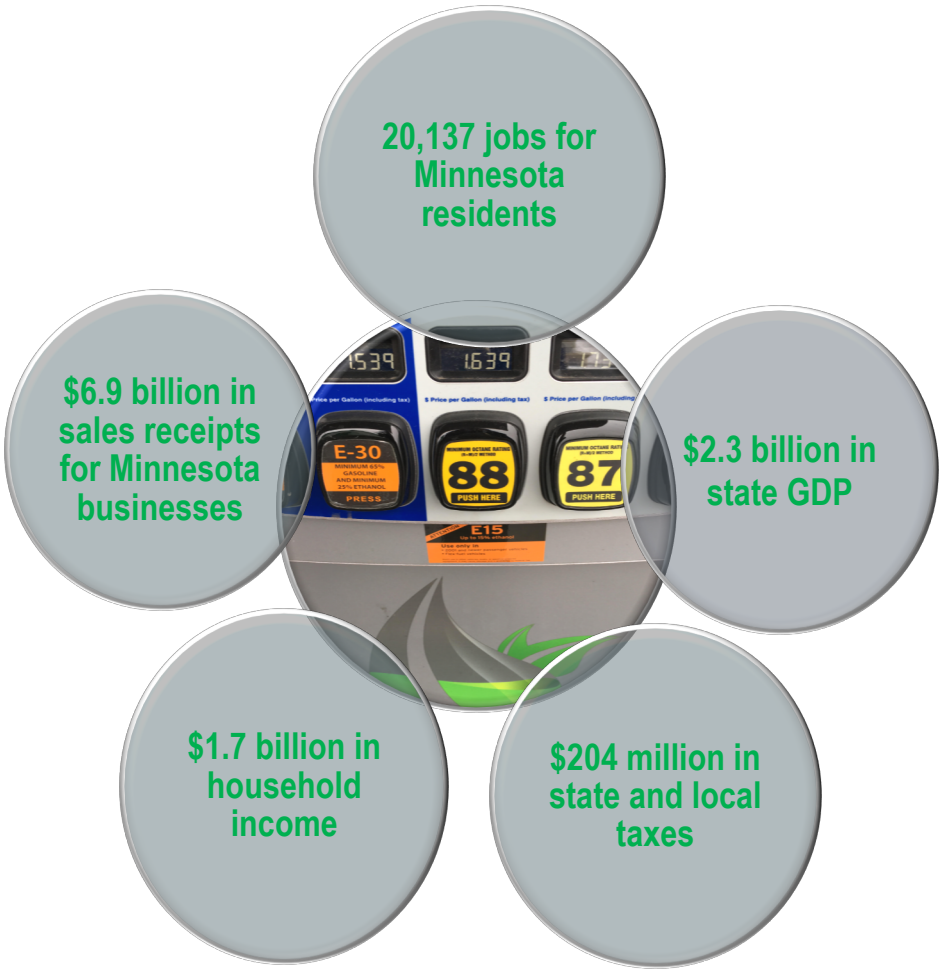
From the farm to the fuel pump, the ethanol industry is a vital component of Minnesota's economy. The ethanol industry provides jobs and income not only for the people who work at bio refineries, but also for businesses that sell inputs and supplies to the ethanol industry. This includes Minnesota farmers who produce most of the corn used by Minnesota's biofuel industry. Private and public-sector biofuels research and development also contribute to the state's economy and Minnesota participates in the rapidly growing export markets for ethanol and co-products.

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 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's ethanol industry produced 1.27 billion gallons in 2018, up 6.2 percent from 2017 levels. The ethanol industry in Minnesota spent $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 circulates fully through the Minnesota economy, the ethanol industry:

- Generated nearly $7 billion in gross sales for Minnesota businesses
- Accounted for nearly $2.3 billion in state Gross Domestic Product (GDP)[1]
- Generated more than $1.7 billion worth of income for Minnesota households
- Supported more than 20,000 full time jobs in the state, and
- Contributed $204 million to state and local government tax rolls.[2]

Annual Economic Impact of the Ethanol Industry in Minnesota



[1] GDP is the value of the goods and services produced in the economy
[2] This study estimated the annualized impact of producing 1.27 billion gallons of ethanol on Minnesota's economy. Figures reflect the capacity of ethanol plants operating at year's end.

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Introduction

Minnesota's ethanol industry continued to provide a significant contribution to the state economy in 2018. Minnesota's 19 operating ethanol plants produced 1.27 billion gallons of ethanol, 6.2 percent more than in 2017. However, the year was challenging in several respects. Ethanol profitability was pressured by the combination of higher feedstock (corn) prices and lower ethanol prices. The one bright spot was that lower ethanol prices were partially offset by a sharp increase in the price of DDGS, the principal ethanol co-product.[3]

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. The ethanol produced in Minnesota used 450 million bushels of corn, or 33 percent of Minnesota's 2018 1.37 billion-bushel corn crop.

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

[3] Sources: 1. USDA/NASS Agricultural Prices; 2. USDA/AMS Market News. Updated 1/9/19

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 analysis.

1. National Trends in Ethanol Production

Despite achieving new records for total output and export volumes, the U.S. ethanol industry experienced a challenging year in 2018 due to U.S. government actions and new trade barriers that restricted demand. Ethanol production reached an estimated 16.1 billion gallons in 2018, up 1.1 percent from 2017 and marking the sixth straight year of incremental growth.

- World oil prices strengthened throughout most of 2018 before dropping sharply in the last two months of the year. Nonetheless, oil prices posted a 32 percent gain during 2018, leading to higher consumer gasoline prices. The impact of higher average motor gasoline prices during 2018 offset a strong consumer economy so that gasoline consumption was essentially unchanged for the year. Domestic ethanol demand fell slightly as a result of both stagnant gasoline demand and the impact of Small Refinery Exemptions (SREs) which are discussed below.

- Responding to record production, larger stocks, and the impact of SREs, ethanol prices generally fell from year-earlier levels throughout 2018. Ethanol stocks at year end 2018 were 2.4 percent higher than at the end of 2017. Minnesota cash ethanol prices fell 7.6 percent for all of 2018 while Iowa ethanol prices (FOB plant) fell 6.3 percent and Omaha Rack ethanol prices were 16.4 percent lower.

- The two bright spots for the ethanol industry in 2018 were robust export markets and sharply higher DDGS prices. Ethanol exports through November 2018 were up more than 29 percent from year-earlier levels and were poised to reach a record level of more than 1.6 billion gallons for the year. Distillers dried grain prices at Minneapolis increased more than 32 percent from depressed 2017 levels. These higher co-product prices helped offset lower ethanol prices.

- The input markets were an impediment for the ethanol industry during 2018. Corn production for the 2018/19 marketing year was virtually unchanged from 2017. Higher demand, largely from the feed sector, reduced stock levels and supported corn prices.

As reported by USDA AMS Market News[4], average cash market No. 2 Yellow corn prices for 2018 were up 4.5 percent in Minneapolis, 2.5 percent in Iowa and 1.1 percent in Central Illinois.

- Ethanol margins followed a typical seasonal pattern in 2018 with returns over variable costs increasing through mid-year. However, margins deteriorated through the year as profitability suffered from stable (and high) feedstock costs and lower ethanol prices. Despite this pattern, ethanol profitability (returns over variable costs) remained positive for the full year. Our analysis estimates an average return over variable costs for the Minnesota ethanol industry for the full year of 25 cents per gallon, lower than 2017 but consistent with profitability for the entire U.S. industry.[5]

The regulatory environment continued to provide challenges for the industry. On November 30, the Environmental Protection Agency (EPA) released its final rule for 2019 renewable volume obligations (RVOs) under the Renewable Fuel Standard (RFS).[6] The final rule continues the requirement for 15 billion gallons of conventional renewable fuel (e.g., corn starch ethanol) in 2019 which is equal to the level established by Congress in the 2007 Energy Independence and Security Act. The EPA did, however, increase the advanced biofuel requirement by 630 million gallons to 4.92 billion gallons. Within this category the RVO for cellulosic biofuels was set at 418 million gallons, far short of the statutory level of 7 billion gallons, but 130 million gallons higher than the 2018 cellulosic biofuel requirement.

The other major regulatory issue that impacted both ethanol volumes and prices during 2018 was the continued use of SREs by the EPA. The original Renewable Fuel Standard (RFS) passed in 2005 gave the EPA authority to extend a temporary exemption from biofuel mandates for small refineries. EPA reports that 48 SREs were granted retroactively for the 2016 and 2017 compliance years and that 22 petitions are pending for 2018.[7] Under the exemption authority, the EPA reinstates RINs (Renewable Identification Numbers, which are essentially credits under the RFS) to small refiners.[8] Refiners granted exemptions can use these RINs to comply with

[4] https://marketnews.usda.gov/mnp/ls-report

[5] By comparison Iowa State University estimates an average return over variable costs of 18 cents per gallon for January through November for a typical Iowa ethanol plant. Iowa State University AgDecision Maker Ethanol Profitability available at http://www.extension.iastate.edu/agdm/energy/xls/d1-10ethanolprofitability.xlsx accessed Jan 3, 2019

[6] Federal Register/Vol. 83, No. 237/Tuesday December 11, 2018

[7] https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rfs-small-refinery-exemptions. Accessed January 24, 2019

[8] Renewable Fuels Association. "The Impact of Small Refinery Exemptions on Ethanol Demand" November 20, 2018.

the RFS requirements instead of blending physical gallons of biofuels. There is growing consensus that extension of these SREs is leading to reduced ethanol (and biodiesel) consumption and lower prices. The retroactivity of RINs for 2017 likely reduced ethanol demand in 2018.

In October 2018 President Trump directed the EPA to initiate rulemaking to expand the Reid Vapor Pressure (RVP) waiver for E15. This expansion would allow E15 to be sold year-round. EPA has not yet issued rules for expanded use.

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. We have assumed that R&D spending on biofuels continued to expand during 2018 as the need for new feedstocks grows. Reflecting this we assumed that industry R&D expenditures grew at the overall rate of inflation and totaled an estimated 902 million in 2018.[9] Minnesota participates in these R&D activities.

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

[9] 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.

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 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. 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 2018 expenditures for the Minnesota ethanol industry. Expenditures are a combination of input price and quantity used for ethanol production. The Minnesota prices for corn, ethanol and DDGS are shown in Appendix A. Operating costs increased nearly 10 percent during 2018 largely due to higher feedstock (corn) prices. Note that feedstocks account for 70 percent of operating costs. Ethanol co-product prices increased during the year but not enough to offset lower ethanol prices. Although total revenue grew reflecting higher production, costs increased faster so that average industry net revenue declined from year-earlier levels.

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
2018 Costs and Returns
Minnesota Dry Mill Ethanol Production

	2017 Mil $	2018 Mil $	Percent Change
Production (Mil gal)	1,204	1,279	6.2%
Feedstock (corn)	$1,329	$1,458	9.7%
Enzymes, yeast and chemicals	$82	$89	8.5%
Denaturant	$62	$83	33.9%
Natural Gas, electricity, water	$247	$263	6.5%
Direct labor	$76	$82	7.9%
Maintenance & Repairs	$33	$36	9.1%
Transportation	$10	$10	0.0%
GS&A	$39	$43	10.3%
Total Operating Costs	$1,878	$2,064	9.9%
$/Gallon	$1.56	$1.61	3.5%
REVENUE			
Ethanol	$1,746	$1,713	-1.9%
DDGS	$391	$583	49.1%
Corn Oil	$66	$82	24.2%
Total Revenue	$2,203	$2,378	7.9%
EBIDTA	$325	$314	-3.4%
$/Gallon	$0.27	$0.25	-7.4%

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.

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).[10]

- **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

[10] 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.

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.[11]

As pointed out earlier, U.S. exports of ethanol grew significantly in 2018. Since Minnesota is the nation's fourth largest ethanol producer the state's industry participates in the export market. The methodology for estimating the impact of trade differs from that used for industry output.[12] We have estimated the impact of ethanol exports by applying USDA Agricultural Trade multipliers for output and employment to the estimated value of exports for 2017. Since ethanol is an output of the chemical industry we used the USDA trade multipliers for the other organic chemicals industry. The USDA multipliers have three major components (or margins): production, transportation and warehousing, and wholesale/retail trade. Since IMPLAN already incorporates the impact of ethanol production, to avoid double counting impacts we only applied the margins for transportation and trade to the value of exports. This represents the post-production (or ex-plant) impacts from exports. These results were added to the IMPLAN results. Reflecting this we applied Minnesota's share of total production to the total national export impact when applying the USDA Trade Multipliers.

This study also recognizes the economic impact provided by capital expenditures associated with adding infrastructure for higher blend levels of ethanol to 69 additional retail stations in 2018. Assuming that capital costs increased at the rate of inflation these expenditures exceeded $10 million.

3. Contribution of the Ethanol Industry to Minnesota

Ethanol manufacturing contributes significantly to the Minnesota economy, spending nearly $2.1 billion on raw materials, other inputs, goods and services to produce 1.27 billion gallons of ethanol. Corn, which the industry uses as a renewable raw material to make ethanol, dried distiller's grains with solubles (DDGS), and industrial corn (refiner's) oil (ICO), accounts for 71 percent industry purchases (natural gas was the second largest input at 8.1 percent of total production costs). In 2018 the Minnesota ethanol industry used nearly 450 million bushels of corn to produce ethanol, DDGS, and ICO.[13]

[11] Employment numbers in this report are expressed in terms of full-time equivalent jobs.
[12] https://www.ers.usda.gov/data-products/agricultural-trade-multipliers.aspx
[13] 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,

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. In addition, the Minnesota ethanol industry purchased goods and services for expansion of production capacity and blender pumps to support distribution of higher blends of ethanol. 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) contributed $1.1 billion to Minnesota GDP based on economic conditions in 2018. Direct employment, including jobs at ethanol plants, amounts to 1,516 jobs in the state with household incomes totaling $326 million.[14] Note that the total income generated includes income (i.e., profits) to owners of locally owned plants, which is substantial. The Indirect contribution of ethanol manufacturing to GDP totaled $327 million and consisted of GDP created by non-agricultural input suppliers such as natural gas companies, 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. Induced GDP totaled $267 million, and induced household earnings total $349 million.

Since ethanol production relies primarily on corn grown by Minnesota farmers, ethanol plants have a very large impact on agriculture, supporting an estimated 3,400 direct farm and farm-related jobs.[15] 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

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.

[14] 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.

[15] 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.

support activities related to crop production ranging from farm managers and bookkeepers to farm equipment operators are supported by ethanol production. Indirect and induced jobs supported by the agriculture output used by Minnesota ethanol producers amount to an additional 3,677 indirect jobs in the corn production supply chain, and 1,849 jobs in business supported by the ethanol industry.

As the impact of the direct spending by ethanol plants expands throughout the economy, the employment impact grows significantly over a large number of sectors. These include jobs in engineering, marketing, sales, logistics, power automation providers, emission testers, accounting, rail transportation, industrial cleaning, underground tank installers, blender pump installers, water management, dust collector manufacturers, risk management service providers and enzyme providers.

Minnesota participated in the expansion the U.S. ethanol industry experienced in 2018. This included both new construction and expansion of existing facilities. Information provided by the Minnesota Bio-Fuels Association and U.S. Renewable Fuels Association indicates that 105 million gallons of new capacity were under construction or expansion at the end of 2018. We estimate that the Minnesota industry spent more than $260 million on capital expansion in 2018. Construction expenditures contributed nearly $400 million to Minnesota GDP, supported 3,226 jobs in all sectors of the economy and generated $281 million in household income.

The ethanol industry supported the establishment of new blender pumps needed to support the demand for higher ethanol blends. Minnesota petroleum marketers added 69 retail stations that offered higher blend levels of ethanol during 2018 for a total of 322 stations, up from 253 stations at the end of 2017. As indicated earlier the capital expenditures associated with the expansion of E15 and higher blends of ethanol totaled $10.3 million in 2018. This expansion of ethanol retail fueling infrastructure is estimated to add $11 million to Minnesota GDP, support 135 jobs in a wide range of industries such as underground tank installers and blender pump installers and add $8 million to household income.

The contribution of ethanol exports by the Minnesota industry is estimated to generate an additional $133 million of GDP and supported 596 jobs in all sectors of the state economy.

In total, ethanol plants, the corn and other feedstocks used by them, biofuels research, construction activity and trade contributed more than $2.3 billion to GDP for Minnesota, supported more than 20,100 full time jobs in the state and put more than $1.7 billion worth of

earnings in the pockets of Minnesota households. The total jobs and earnings estimates 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).

Table 2
Economic Impact of the Minnesota Ethanol Industry: 2018

	Sales Revenue (Mil $)	Gross Domestic Product (Mil $)	Employment (Full Time) Jobs	Household Earnings (Mil $)
Ethanol Mfg and R&D	**$3,871**	**$1,113**	**7,245**	**$927**
Direct	$2,513	$519	1,516	$326
Indirect	$784	$327	2,418	$252
Induced	$574	$267	3,311	$349
Agriculture	**$2,204**	**$661**	**8,926**	**$431**
Direct	$1,203	$125	3,400	$109
Indirect	$698	$363	3,677	$219
Induced	$303	$173	1,849	$103
Construction	**$508**	**$395**	**3,235**	**$281**
Direct	$263	$112	1,524	$106
Indirect	$118	$134	746	$86
Induced	$127	$149	965	$89
E15 Infrastructure	**$18**	**$10**	**135**	**$8**
Direct	$10	$6	83	$5
Indirect	$2	$1	11	$1
Induced	$6	$3	41	$2
Exports	**$267**	**$133**	**596**	**$97**
Grand Total	**$6,868**	**$2,312**	**20,137**	**$1,744**
Direct	$3,989	$762	6,523	$546
Indirect	$1,869	$958	7,448	$655
Induced	$1,010	$592	6,166	$543

Although, not shown in Table 2, we estimate that state and local taxes generated by the ethanol industry totaled nearly $204 million in 2018.[16]

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 1.27 billion gallons of ethanol the Minnesota ethanol industry used approximately 450 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 refiners' oil (ICO) recovered by corn dry mills has become an important feedstock for biodiesel production. 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 nearly 1.2 tons of feed consisting of corn and soybean meal.[17]

In the process of converting approximately 450 million bushels of corn into ethanol, the Minnesota ethanol industry produced an estimated 3.8 million tons of Dried Distiller's Grains with Solubles (DDGS) and 283 million pounds of corn refiner's oil in 2018. This amount of distillers' grains is sufficient to meet the annual feed requirements of more than 2.5 million beef and dairy cattle, or the entire inventory of cattle and calves in Minnesota.[18] Moreover since DDGS is used as a feed supplement it displaces both corn and soybean meal.[19] 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.

[16] Minnesota taxes were estimated by applying the share of state and local taxes for the U.S. to U.S. GDP (8.8 percent) to the estimate of Minnesota GDP contributed by the ethanol and supporting industries.

[17] 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

[18] Personal conversations with Dr. Caitlin Foley, Assistant Professor of Dairy Science at the University of Georgia 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 2.5 million cattle and calves in inventory on January 1, 2018.

[19] Corn refiners' oil also is used as a feed supplement and ingredient in compound feeds.

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's ethanol plants was used as a biodiesel feedstock, it could produce nearly 38 million gallons of biodiesel, or more than 45 percent of the biodiesel capacity of Minnesota's biodiesel plants.[20]

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's 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.

[20] http://www.eia.gov/biofuels/biodiesel/production/

APPENDIX A
MINNESOTA PRICES

	Corn, Farm Price, MN 2017 ($/bu) /1	Corn, Farm Price, MN 2018 ($/bu) /1	Percent Change	Corn, No 2 Yel Minneapolis 2017 ($/bu) /2	Corn, No 2 Yel Minneapolis 2018 ($/bu) /2	Percent Change
Jan	$3.21	$3.06	-4.7%	$3.20	$3.09	-3.4%
Feb	$3.25	$3.12	-4.0%	$3.23	$3.22	-0.5%
Mar	$3.31	$3.37	1.8%	$3.19	$3.32	4.1%
Apr	$3.24	$3.38	4.3%	$3.20	$3.37	5.3%
May	$3.31	$3.50	5.7%	$3.20	$3.51	9.7%
Jun	$3.29	$3.43	4.3%	$3.18	$3.21	1.1%
Jul	$3.30	$3.32	0.6%	$3.23	$3.13	-2.9%
Aug	$3.07	$3.21	4.6%	$3.02	$3.18	5.3%
Sep	$2.99	$3.10	3.7%	$2.95	$3.03	2.5%
Oct	$3.02	$3.22	6.6%	$2.93	$3.21	9.6%
Nov	$2.92			$2.96	$3.31	12.0%
Dec	2.98			$3.03	$3.43	13.2%
Average	$3.16	$3.27	3.6%	$3.11	$3.25	4.5%

	Ethanol Minnesota 2017 ($/gal) /2	Ethanol Minnesota 2018 ($/gal) /2	Percent Change	Distillers Grains 10%, MN 2017 ($/ton) /2	Distillers Grains 10%, MN 2017 ($/ton) /2	Percent Change
Jan	$1.35	$1.25	-7.4%	$95.50	$135.12	41.5%
Feb	$1.41	$1.33	-5.7%	$97.11	$138.48	42.6%
Mar	$1.44	$1.40	-2.4%	$96.22	$145.09	50.8%
Apr	$1.59	$1.45	-8.8%	$94.70	$157.50	66.3%
May	$1.44	$1.42	-1.0%	$95.25	$171.59	80.1%
Jun	$1.53	$1.43	-6.2%	$98.43	$144.74	47.0%
Jul	$1.53	$1.43	-6.9%	$104.68	$108.57	3.7%
Aug	$1.53	$1.31	-14.1%	$106.05	$113.66	7.2%
Sep	$1.57	$1.32	-15.7%	$108.25	$125.81	16.2%
Oct	$1.38	$1.25	-9.4%	$110.60	$128.38	16.1%
Nov	$1.35	$1.27	-5.9%	$120.24	$132.86	10.5%
Dec	$1.26	$1.18	-6.4%	$128.15	$159.09	24.1%
Average	$1.45	$1.34	-7.6%	$104.60	$138.41	32.3%

Sources: 1. USDA/NASS Agricultural Prices; 2. USDA/AMS Market News. Updated 1/9/19