ABF Economics
Agriculture and BioFuels Consulting, LLP

CONTRIBUTION OF THE ETHANOL INDUSTRY TO THE ECONOMY OF MINNESOTA IN 2019

February 7, 2020

Prepared for the Minnesota Bio-Fuels Association

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Executive Summary

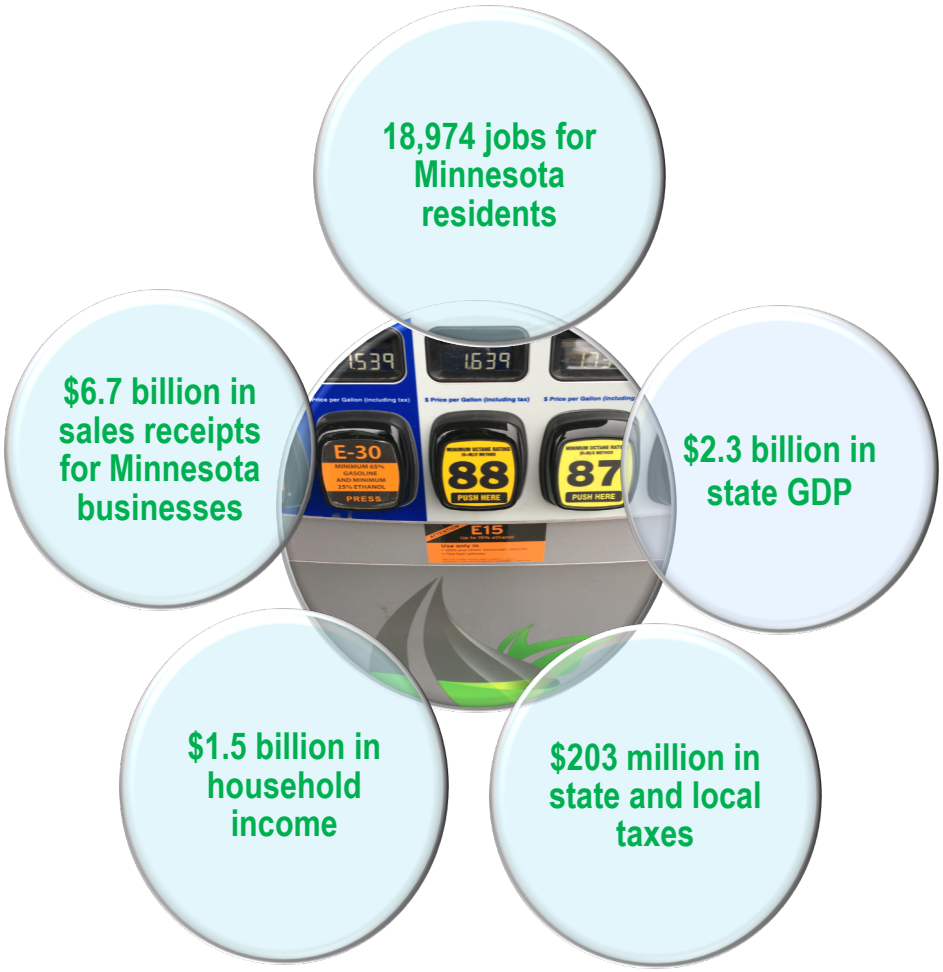
From the farm to the fuel pump, the ethanol industry is a vital component of Minnesota's economy. The ethanol industry provides jobs and income not only for the people who work at bio refineries, but also for businesses that sell inputs and supplies to the ethanol industry. This includes Minnesota farmers 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 1.31 billion gallons in 2019, up 3.1 percent from 2018 levels. The ethanol industry in Minnesota spent $2.2 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 $6.7 billion in gross sales for Minnesota businesses
- Accounted for more than $2.3 billion in state Gross Domestic Product (GDP)[1]
- Generated $1.5 billion worth of income for Minnesota households
- Supported nearly 19,000 full time jobs in the state, and
- Contributed $203 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 1.31 billion gallons of ethanol on Minnesota's economy. Figures reflect the production of ethanol plants operating at year's end.

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Introduction

Minnesota's ethanol industry continued to provide a substantial contribution to the state economy in 2019. Minnesota's 19 operating ethanol plants produced 1.31 billion gallons of ethanol, 3.1 percent more than in 2018. However, the year was challenging in several respects. Ethanol profitability was pressured by the combination of higher feedstock (corn) prices and lower ethanol and co-product prices. Demand growth also was an issue for the ethanol industry both domestically and internationally. The presence of the small refiner exemption granted by EPA reduced blending requirements. The combination of weak foreign economic demand and the trade dispute with China resulted in lower exports of ethanol and Distiller's Grains.

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 36 percent of Minnesota's 2019 1.26 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

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

The U.S. ethanol industry was buffeted by several factors that forced producers to cut operating rates and, in some cases, shut plants resulting in only the second decline in annual industry output in two decades (the last being 2012, when a severe drought was experienced). Chief among these was a sharp decline in industry profitability. This was primarily the result of regulatory concerns associated with the Environmental Protection Agency's (EPA's) continued support for small refinery exemptions (SREs), effects of the U.S.-China trade war, and declining gasoline demand. Ethanol production for 2019 is estimated at 15.8 billion gallons, nearly two percent below 2018 levels. Nevertheless, the ethanol industry continues to make a substantial positive contribution to the American economy.

- Industry average ethanol margins fell an estimated 7.3 percent for 2019. Returns over operating costs averaged $0.17 per gallon in 2019, $0.07 per gallon below 2018 levels. Operating costs, led by feedstock prices, increased 4.3 percent per gallon while industry revenues fell by two percent per gallon. The deterioration was significant enough that many facilities cut operating rates and approximately ten operating plants were idled or closed during the year.

- On the revenue side, ethanol revenues increased modestly in 2019 with prices (FOB plant) in Iowa increasing 1.4 percent, Eastern Corn Belt plants up 2.9 percent and Omaha rack prices increasing 2 percent. The largest negative impact on industry revenues came from the co-products markets with distillers dried grain (DDGS) prices falling 4.5 percent at Eastern Corn Belt plants.

- The input markets were an impediment for the ethanol industry during 2019 with most input prices increasing during the year. Feedstocks (mainly corn) account for more than 70 percent of ethanol production costs. 2019 was a bizarre year for crop production. Heavy flooding in major corn producing states resulted in record levels of prevented plant acres and while total planted area for corn increased modestly in the spring, average yields fell resulting in a five percent decline in corn output. Stock levels for the

2018 crop year declined modestly and despite expected reduction in demand, stocks for the 2019 season are projected to fall again.[3] This situation led to a 10.1 percent increase in cash market corn (No. 2 Yellow, Central Illinois) prices for all of 2019.[4]

- World oil prices started the year substantially below year earlier levels and despite a modest strengthening by midyear fell 12.6 percent for all of 2019. This decline was matched by gasoline prices. It is interesting to note that despite a strong consumer economy, lower gasoline prices were not sufficient to stimulate demand for finished gasoline, the principal market for ethanol. EIA reported that Americans consumed 143 billion gallons of finished gasoline in 2018 and year-to-date data suggests that gasoline consumption posted a small decline in 2019. Domestic ethanol demand was flat during 2019 because of both stagnant gasoline demand and the impact of SREs on reducing blending requirements. The share of ethanol in gasoline remains virtually unchanged at 10.1 percent.

- The trade arena in 2019 was disappointing for both ethanol and DDGS. Exports of ethanol declined 12 percent in volume terms while the value of ethanol exports fell 11 percent. Exports of DDGS experienced similar patterns with volumes declining more than 10 percent and export values failing nine percent. Larger ethanol supplies in Brazil, general weakness in other major importing economies, and the continuing trade dispute between the U.S and China were major factors underlying weakness in trade.

- The regulatory environment continued to provide challenges for the industry. The EPA's final rule for 2019 renewable volume obligations (RVOs) under the Renewable Fuel Standard (RFS) continued the requirement for 15 billion gallons of conventional renewable fuel (e.g., corn-starch ethanol) in 2019, nominally equal to the level established by Congress in the 2007 Energy Independence and Security Act.[5] The final rule for 2020 continued the conventional requirement at 15 billion gallons but increased the advanced biofuel requirement from to 4.92 billion gallons in 2019 to 5.09 billion in 2020. The major regulatory issue that continued to affect the ethanol industry in 2019 was the continued use of SREs by the EPA, which effectively reduced the required volumes. The RFS passed in 2005 gave the EPA authority to extend a temporary

[3] https://www.usda.gov/oce/commodity/wasde/wasde1219.pdf
[4] https://www.ers.usda.gov/data-products/feed-grains-database.aspx#.UYr22794GZY
[5] Federal Register/Vol. 83, No. 237/Tuesday December 11, 2018

exemption from biofuel mandates to small refineries. Under the exemption authority, the EPA has reinstated RINs (Renewable Identification Numbers, which are essentially credits under the RFS) to small refiners.[6] Refiners that receive exemptions can use these RINs to comply with the RFS requirements instead of blending physical gallons of biofuels. These waivers effectively reduce the amount of biofuel required to enter the motor fuel supply. An EPA analysis published in October 2019 reported that the 31 SRE waiver requests granted for the 2018 compliance year exempted 7.4 percent of the total RFS renewable fuel volume mandate, or about 1.43 billion gallons.[7] EPA reports that 21 petitions were received for 2019.[8]

- In response to President Trump's 2018 direction for the EPA to initiate rulemaking to expand the Reid Vapor Pressure (RVP) waiver to gasoline blended with up to 15 percent ethanol (E15), the EPA announced regulatory changes to allow E15 to take advantage of the 1-psi RVP waiver for the summer months that has historically been applied only to E10. E15 may now be sold year-round.

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

[6] Renewable Fuels Association. "The Impact of Small Refinery Exemptions on Ethanol Demand" November 20, 2018.
[7] "EPA refinery exemptions reduced renewable fuel blending requirements in 2018". EIA Today in Energy, October 25, 2018.
[8] https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rfs-small-refinery-exemptions. Accessed January 6, 2020

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 2019 expenditures for the Minnesota ethanol industry. Expenditures are a combination of input price and quantity used for ethanol production.[9] Operating costs

[9] Several changes in assumptions were incorporated in this year's analysis. The decline in denaturant expenditures reflects, in part, a change in the assumption regarding the pricing benchmark. The decline in expenditures for water is due to an update of the assumption of water use per gallon of ethanol produced. Reflecting recent data published

increased 6.9 percent during 2019 largely due to higher feedstock (corn) prices. Note that feedstocks accounted for 74 percent of operating costs in 2019. While corn prices increased during 2019 ethanol co-product prices fell putting additional downward pressure on profitability during the year. The average price of No. 2 Yellow Corn at Minneapolis increased 11.1 percent during 2019 while the price of DDGS (Central Illinois) fell 3.2 percent The combination of higher operating costs and lower revenues resulted in a 15 cents per gallon decline in average industry profitability for 2019.

Table 1
2019 Costs and Returns
Minnesota Dry Mill Ethanol Production

	2018 Mil $	2019 Mil $	Percent Change
Production (Mil gal)	1,279	1,315	2.8%
Feedstock (corn)	$1,458	$1,637	12.3%
Enzymes, yeast and chemicals	$89	$94	5.6%
Denaturant	$83	$53	-36.1%
Natural Gas, electricity, water	$263	$243	- 7.6%
Direct labor	$82	$86	4.8%
Maintenance & Repairs	$36	$38	5.6%
Transportation	$10	$11	10%
GS&A	$43	$45	4.7%
Total Operating Costs	$2,064	$2,207	6.9%
$/Gallon	$1.61	$1.68	4.3%
REVENUE			
Ethanol	$1,713	$1,723	0.6%
DDGS	$583	$537	-7.9%
Corn Oil	$82	$85	3.7%
Total Revenue	$2,378	$2,345	-1.4%
EBIDTA	$314	$138	- 56%
$/Gallon	$0.25	$0.10	- 60%

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

by Grain Crushings and Co-Products Production report we increased ethanol and Distiller's corn oil yields and reduced DDGS yields. The result of this is more ethanol per bushel of corn, lower DDGS production and more DCO per bushel of corn.

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.

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 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]

Minnesota is the nation's fourth largest ethanol producer and the state's industry participates in the export market. As pointed out above exports of ethanol and DDGS fell during 2019 and this was felt in Minnesota. 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 2019. Since ethanol is an output of the chemicals industry, we used the USDA trade multipliers for the other basic organic chemicals industry. The USDA multipliers have three major components (or margins): production, transportation and warehousing, and wholesale/retail

[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.

[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

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 70 additional retail stations in 2019. The Minnesota Commerce Department reports that an additional 24 E85 were operating by year end and an additional 46 stations offered Midblends.[13] Assuming of $242,550 for a station with 6 pumps and associated infrastructure, we estimate the capital expenditures for expansion of higher ethanol blends at nearly $17 million.[14]

3. Contribution of the Ethanol Industry to Minnesota

Ethanol manufacturing contributes significantly to the Minnesota economy, spending more than $2.2 billion on raw materials, other inputs, goods and services to produce 1.31 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 74 percent industry purchases (natural gas was the second largest input at 7.5 percent of total production costs). In 2019 the Minnesota ethanol industry used more than 450 million bushels of corn to produce ethanol, DDGS, and ICO.[15]

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

[13] 2019 Minnesota E85 + Midblends Station Report. Minnesota Department of Commerce
[14] http://ethanolproducer.com/blog/article/2015/05/blog-what-does-it-take-to-get-e15-at-a-retail-station
[15] 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.

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 $1.2 billion to Minnesota GDP based on economic conditions in 2019. Direct employment, including jobs at ethanol plants, amounts to 1,588 jobs in the state with household incomes totaling $360 million.[16] Note that the total income generated includes income (i.e., profits) to owners of locally owned plants, which is substantial. The Indirect and induced contribution of ethanol manufacturing to GDP totaled $784 million. Induced effects are provided non-agricultural input suppliers such as natural gas companies while induced impacts come from businesses that benefit from income spent by ethanol plant workers and owners, and income spent by employees who work in supporting industries.

Since ethanol production relies primarily on corn grown by Minnesota farmers, ethanol plants have a very large impact on agriculture, supporting an estimated 3,818 direct farm and farm-related jobs.[17] Most agriculture jobs supported by the ethanol industry are jobs in support activities related to crop production, ranging from farm advisors, producers and distributors of crop protection products, fertilizer, and farm equipment, and other service providers. In addition, jobs supported by income generated and spent by employees supports a significant number of jobs in seemingly unrelated sectors such as retailers and service sectors. Indirect and induced jobs supported by the agriculture output used by Minnesota ethanol producers amount to an additional 4,129 indirect jobs in the corn production supply chain, and 2,076 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

[16] 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.
[17] 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.

installers, water management, dust collector manufacturers, risk management service providers and enzyme providers.

The ethanol industry in Minnesota continued to add capacity during 2019 but at a considerably slower rate than previous years. The Minnesota Bio-Fuels Association reports that 63 million gallons of new capacity were under construction or expansion at the end of 2019. We estimate that the Minnesota industry spent more than $103 million on capital expansion in 2019, more than half the spending that took place in 2018. As a consequence, the contribution of plant construction was smaller than in 2018. Construction expenditures contributed nearly $160 million to Minnesota GDP, supported 1,268 jobs in all sectors of the economy and generated $110 million in household income.

The ethanol industry supported the establishment of new blender pumps needed to support the demand for higher ethanol blends. As discussed earlier, Minnesota petroleum marketers added 70 retail stations that offered higher blend levels of ethanol during 2019. The capital expenditures associated with the expansion E85 and midlevel blends (E15 and higher) reached nearly $17 million in 2019. This expansion of ethanol retail fueling infrastructure is estimated to add $18 million to Minnesota GDP, support 224 jobs in a wide range of industries such as underground tank installers and blender pump installers and add $13 million to household income.

The contribution of ethanol exports by the Minnesota industry is estimated to generate an additional $186 million of GDP and supported 672 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 nearly 19,000 full time jobs in the state and put more than $1.5 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: 2019

	Sales Revenue (Mil $)	Gross Domestic Product (Mil $)	Employment (Full Time) Jobs	Household Earnings (Mil $)
Ethanol Mfg and R&D	**$3,696**	**$1,206**	**6,787**	**$799**
Direct	$2,484	$422	1,588	$360
Indirect	$739	$458	2,460	$185
Induced	$473	$326	2,739	$254
Agriculture	**$2,475**	**$744**	**10,023**	**$485**
Direct	$1,351	$141	3,818	$123
Indirect	$784	$408	4,129	$246
Induced	$340	$195	2,076	$116
Construction	**$199**	**$156**	**1,268**	**$111**
Direct	$103	$44	599	$42
Indirect	$46	$53	293	$34
Induced	$50	$59	376	$35
E15 Infrastructure	**$30**	**$18**	**224**	**$13**
Direct	$17	$11	137	$9
Indirect	$4	$2	19	$1
Induced	$9	$5	68	$3
Exports	**$301**	**$186**	**672**	**$99**
Grand Total	**$6,701**	**$2,310**	**18,974**	**$1,507**
Direct	$3,955	$618	6,142	$534
Indirect	$1,874	$1,107	7,573	$565
Induced	$872	$585	5,259	$408

Although, not shown in Table 2, we estimate that state and local taxes generated by the ethanol industry totaled nearly $203 million in 2019.[18]

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 1.31 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

[18] 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.

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 Distiller's corn oil (DCO) 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.[19]

In the process of converting approximately 450 million bushels of corn into ethanol, the Minnesota ethanol industry produced an estimated 3.6 million tons of DDGS and 327 million pounds of DCO in 2019. This amount of distillers' grains is sufficient to meet the annual feed requirements of about 2 million beef and dairy cattle, or more than 80 percent of the entire inventory of cattle and calves in Minnesota.[20] Moreover since DDGS is used as a feed supplement it displaces both corn and soybean meal.[21] 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's ethanol plants was used as a biodiesel feedstock, it could produce nearly 45 million gallons of biodiesel, or more than half of the biodiesel capacity of Minnesota's biodiesel plants.[22]

CONCLUSION

[19] 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
[20] 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 2.4 million cattle and calves in inventory on January 1, 2020. https://www.nass.usda.gov/Publications/Todays_Reports/reports/catl0120.pdf
[21] Distiller's corn oil also is used as a feed supplement and ingredient in compound feeds.
[22] http://www.eia.gov/biofuels/biodiesel/production/

The ethanol industry continues to make 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 that displaces 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.