

**CONTRIBUTION OF THE ETHANOL INDUSTRY TO
THE ECONOMY OF THE UNITED STATES IN 2019**

Prepared for the Renewable Fuels Association by

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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.¹ This situation led to a 10.1 percent increase in cash market corn (No. 2 Yellow, Central Illinois) prices for all of 2019.²

- 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 falling 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

¹ <https://www.usda.gov/oce/commodity/wasde/wasde1219.pdf>

² <https://www.ers.usda.gov/data-products/feed-grains-database.aspx#.UYr22794GZY>

Independence and Security Act.³ The final rule for 2020 continued the conventional requirement at 15 billion gallons but increased the advanced biofuel requirement from 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 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.⁴ 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.⁵ EPA reports that 21 petitions were received for 2019.⁶

- 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.

According to the Renewable Fuels Association (RFA), at year's end the ethanol industry's more than 200 plants had a total capacity of 16.8 billion gallons. However, due to the factors discussed above, approximately 190 plants were operating in 26 states producing at a rate of 15.8 billion gallons. Conventional feedstocks (e.g., corn and sorghum) accounted for the vast majority of ethanol production. At year's end, about 183 million gallons of capacity was under expansion or construction.

³ Federal Register/Vol. 83, No. 237/Tuesday December 11, 2018

⁴ Renewable Fuels Association. "The Impact of Small Refinery Exemptions on Ethanol Demand" November 20, 2018.

⁵ "EPA refinery exemptions reduced renewable fuel blending requirements in 2018". EIA Today in Energy, October 25, 2018.

⁶ <https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rfs-small-refinery-exemptions>. Accessed January 6, 2020

This study estimates the contribution of the ethanol industry to the American economy in 2019 in terms of employment, income, and Gross Domestic Product (GDP) directly and indirectly supported by the industry.

Expenditures by the Ethanol Industry in 2019

Ethanol producers are part of a manufacturing sector that adds substantial value to agricultural commodities produced in the United States and makes a significant contribution to the American economy.

Expenditures by the ethanol industry for raw materials, other goods, and services represent the purchase of output of other industries. The spending for these purchases circulates through the local and national economy, generating additional value-added output, household income, and employment in all sectors of the economy.⁷ Ethanol industry expenditures can be broken into three major categories: construction of new production facilities, ongoing production operations, and research and development.

1. Construction

Industry capacity increased an estimated 292 million gallons during 2019, with new plants coming online and expansion and “debottlenecking” of conventional ethanol and second-generation production facilities. At year’s end, RFA reported 183 million gallons of new capacity under construction or expansion.

2. Ongoing production operations

The industry spent more than \$27 billion on raw materials, other inputs, and goods and services to produce ethanol during 2019, 2.3 percent more than a year ago. Production costs were based on a model of dry mill ethanol production maintained by the author of this report. These estimates

⁷ Expenditures for feedstock and energy were estimated using 2019 calendar year average prices. Revenues were estimated using 2019 calendar year average prices for ethanol; Distiller’s grains, and Distillers’ corn oil. Prices were provided by USDA/ERS and AMS, and EIA.

are consistent with generic dry mill ethanol costs, such as those published by Iowa State University.⁸ Table 1 details the expenditures by the ethanol industry in 2019.

Table 1
Estimated Ethanol Production Expenditures, 2019

OPERATING COSTS	2018 Mil \$	2019 Mil \$	Percent Change
Feedstock (corn)	\$19,094	\$20,268	6.1%
Enzymes, yeast and chemicals	\$1,151	\$1,152	0.1%
Denaturant	\$852	\$635	-25.5% ⁹
Natural Gas, electricity, water	\$3,007	\$2,743	-8.8%
Direct labor	\$1,148	\$1,071	-6.8%
Maintenance & Repairs	\$502	\$502	0.1%
Transportation	\$145	\$145	0.1%
GS&A	\$598	\$599	0.1%
Total Operating Costs	\$26,497	\$27,114	2.3%
\$/Gallon	\$1.65	\$1.72	4.3%

The largest share of spending was for corn and other feedstocks used as raw material to make ethanol. The ethanol industry used 5.5 billion bushels of corn (and corn equivalent) on a gross basis in 2019, valued at \$20.3 billion. Reflecting this, the ethanol industry is a major source of support for agricultural output and farm income. Together, feedstock and energy accounts for about 83 percent of ethanol production costs.

This analysis estimates both the total production effect and the crop price (farm income) effects of ethanol production on agriculture based on a structural model of U.S. agriculture maintained by the author. The impact of demand for corn to produce ethanol on farm income was adjusted so as to not overstate the impact of ethanol demand on revenue for the corn sector.

⁸ See the Ethanol profitability spreadsheet maintained by Don Hofstrand "AgDecision Maker D1-10 Ethanol Profitability" available at <http://www.extension.iastate.edu/agdm/energy/xls/d1-10ethanolprofitability.xlsx>

⁹ The sharp 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.

The remainder of spending by the ethanol industry for ongoing operations is for a range of inputs such as enzymes, yeast and chemicals; electricity, natural gas, and water; labor; transportation; and services such as maintenance, insurance, and general overhead.

3. Research and Development

The renewable fuels industry is a significant engine for research and development (R&D) both in the public and private sectors. Much of the R&D activity in the biofuels industry is aimed at discovering and developing advanced biofuels feedstock and the technology needed to meet 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 development 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 2019. Reflecting this we estimated that industry R&D expenditures grew at the overall rate of inflation and totaled an estimated \$906 million in 2019.¹⁰

4. Co-product value

Most ethanol is produced by dry mills that also produce valuable co-products in the form of DDGS and distiller's corn oil (DCO).¹¹ There is significant ongoing research directed at improving these co-products, notably DDGS, to increase inclusion rates in swine and poultry and enhancing suitability as a feed ingredient in markets such as aquaculture. The ethanol industry produced an estimated 43.6 million short tons of DDGS and nearly 3.9 billion pounds of DCO in 2019 with an

¹⁰ A recent example of R&D spending is the ARPA-E SMARTFARM funding announced on December 19. 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.

¹¹ DDGS and corn distillers oil production is reported monthly in the USDA Grain Crushings and Co-Products Production report. <http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1899>

aggregate market value of \$7.5 billion. In large part the decline in industry revenue is attributable to sharply lower DDGS prices.

Spending associated with ethanol production, expansion and new construction activity, and R&D circulates and re-circulates throughout the entire economy several-fold, stimulating aggregate demand, and supporting jobs and household income. The economic activity associated with export activity adds to this impact. In addition, expanded economic activity generates tax revenue for government at all levels.

Methodology

We estimate the impact of the ethanol industry on the American economy by applying expenditures by the relevant supplying industry to the appropriate final demand multipliers for value added output, earnings, and employment.

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. For example, grain production is linked through both forward and backward linkages to other economic sectors in each state's economy.

The household sector is linked to all sectors as it provides the labor and management resources. In turn, changes that affect incomes of the household sector 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 and this is a critical component of the national economy.

This study uses the IMPLAN (Impact Analysis for Planning) multiplier database to develop a model of the national economy, including sectors that support the ethanol industry, the links between them, and the level of national 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 in an economy are linked together; and the output (i.e., sales) 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, a model for the U.S. economy was constructed using current IMPLAN software and data.

As in the past, we continue to treat industry earnings as an addition to the household sector since the income is paid to owners of operating ethanol plants. As a result, the impact of corporate earnings is estimated using multipliers for the household sector and incorporated into direct GDP.

IMPLAN models provide three economic measures that describe the economy: value added, income, and employment.

- Value added is the total value of the goods and services produced by businesses in the country and is generally referred to as GDP
- Labor income 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 farm income through higher crop receipts than would be the case without ethanol production.
- Employment represents the annual average number of employees, whether full or part-time, of businesses producing output. It is expressed in full-time equivalent jobs. Value added including labor income and employment represent the net economic benefits that accrue to the nation because of increased economic output.

There are three types of effects measured with a multiplier: direct, indirect, and induced effects. Direct effects are the known or predicted changes in the economy associated with the industry directly involved (in this case, ethanol). Indirect effects are the business-to-business transactions required to produce direct effects (i.e., increased output from businesses providing intermediate inputs). Finally, 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).

We also continue to reflect the additional value of output of co-products (DDGS and DCO) in the analysis. Since these are co-products, and the backward linkages for their production is accounted for in the expenditures for ethanol production, the value for DDGS and DCO was treated as income and value

added only, and we applied income multipliers to the employee compensation portion to avoid double counting.

As was the case in our previous studies, we incorporated the explicit impact of ethanol and DDGS exports in the economic impact analysis. The methodology for estimating the impact of trade differs from that used for industry output.¹² We estimated the impact of ethanol and DDGS exports by applying USDA Agricultural Trade multipliers for output and employment to the estimated value of exports for 2019 reported in the USITC trade databases. Since ethanol and DDGS are outputs of the organic 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 and DDGS 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.

Results

Table 2 summarizes the impact of ethanol industry production and exports on the U.S. economy in 2019. The full impact of the spending for annual operations of ethanol production, co-product output, exports, and R&D is estimated to have contributed nearly \$43 billion to the nation's GDP in 2019, 7.7 percent less than in 2018. A major reason for the lower GDP impact can be traced to reduced industry earnings. Agriculture remains a significant source of industry economic impact. This reflects the importance of ethanol demand to total corn utilization, the aggregate value of crop production, and crop receipts and farm income. The manufacturing activity of ethanol production alone contributed \$12.2 billion to the U.S. economy.

¹² <https://www.ers.usda.gov/data-products/agricultural-trade-multipliers.aspx>

Table 2
Economic Impact of the Ethanol Industry: 2019

	2019 GDP (Mil 2019\$)	2019 Employment FTEs	2019 Income (Mil 2019\$)
Ethanol Production	\$12,196	77,112	\$6,712
Direct	\$3,709	9,500	\$1,862
Indirect	\$4,698	28,121	\$2,681
Induced	\$3,790	39,491	\$2,169
Construction	\$393	3,880	\$259
Direct	\$130	1,351	\$102
Indirect	\$116	984	\$73
Induced	\$147	1,544	\$84
Agriculture	\$23,130	241,000	\$12,360
Direct	\$4,278	54,766	\$1,916
Indirect	\$11,917	113,262	\$6,476
Induced	\$6,935	72,972	\$3,968
R&D Expenditures	\$1,406	12,249	\$906
Exports (Total)	\$5,850	14,771	\$3,101
Total Ethanol	\$42,975	349,010	\$23,338
Direct	\$8,600	68,684	\$4,233
Indirect	\$22,991	160,935	\$12,590
Induced	\$11,384	119,392	\$6,515

Employment

Jobs are created from the economic activity supported by ethanol production. While ethanol production is not a labor-intensive industry (accounting for about 9,500 full time equivalent direct jobs nation-wide)¹³, the economic activity of supporting industries generates a substantial number of jobs in the nation.

¹³ The Census Bureau does not report employment in ethanol production. This analysis conservatively assumes the average ethanol plant employs approximately 50 full-time equivalent employees.

When the direct, indirect and induced jobs supported by ethanol production, construction activity, agriculture, exports, and R&D are included, the ethanol industry supported nearly 350,000 jobs in 2019.

Since ethanol production is more capital intensive than labor intensive, the number of direct jobs supported by the ethanol industry is relatively small and is concentrated primarily in manufacturing and agriculture. 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. In general, as the impact of the direct spending by the ethanol industry expands throughout the economy, the employment impact expands significantly and is spread over a large number of sectors. The number of jobs supported by ethanol and DDGS exports is estimated at more than 14,800. Most of these jobs are concentrated in transportation and export trade related administrative and financial industries.

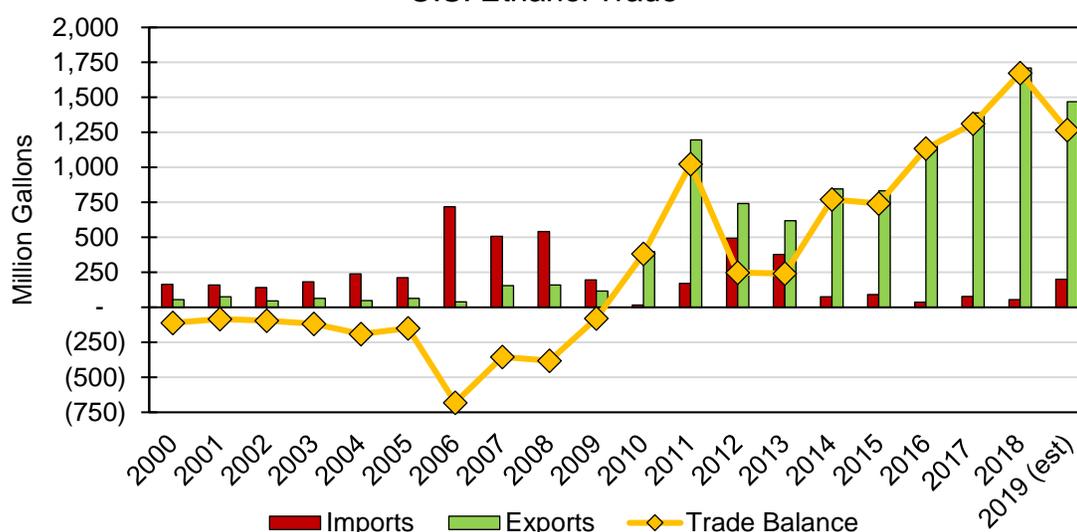
Income

Economic activity and associated jobs produce income for American households. The economic activities of the ethanol industry put more than \$23 billion into the pockets of Americans in 2019. As is the case with employment, the direct impact on income by the ethanol industry is largely concentrated in manufacturing and services. In many respects, this mirrors the employment structure of the American economy. The most significant impact of the ethanol industry continues to be increased income to farmers who benefit from the demand for feedstock, which leads to both increased production and increased prices, as well as earnings from locally-owned ethanol plants.

Exports

U.S. ethanol exports have expanded significantly over the last decade and continue to post a substantial trade surplus. Ethanol exports in 2019 are projected to total more than 1.5 billion gallons with an export value of \$2.4 billion. The projected 11 million tons of DDGS that are exported were valued at nearly \$2.3 billion. Moreover, the ethanol industry is generating a trade surplus and helping to reduce the nation's trade deficit. Figure 1 illustrates the growth in ethanol exports, imports and trade balance.

Figure 1
U.S. Ethanol Trade



Source: Foreign Agricultural Service. Global Agricultural Trade System (GATS)

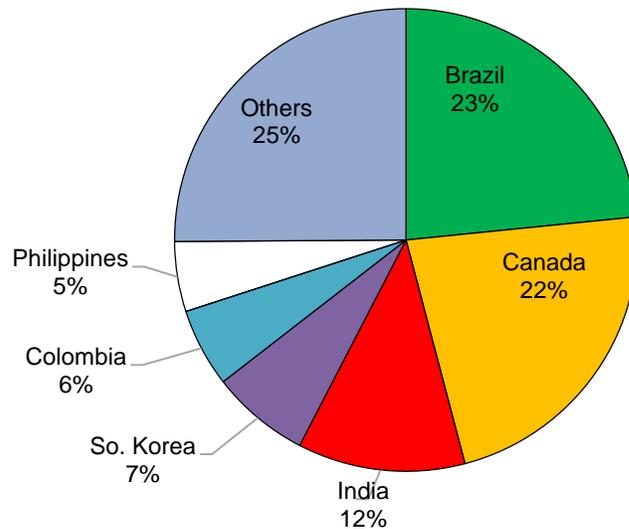
Exports of ethanol and distillers' grains generate economic activity largely through the requirements to transport output from plants to ports and final destinations. This largely involves truck, rail, barge, and ocean shipping. Additional impacts are generated by labor, administrative and financial requirements necessary to support export activity. These impacts are categorized as indirect since they are subordinate to production. Using the USDA Trade Multipliers suggests that the \$4.2 billion of export value added \$5.9 billion to GDP and supported nearly 15,000 jobs in all sectors of the economy.

The growth in U.S. ethanol exports reflects not only larger exportable supplies but also global expansion of renewable fuel use. A recent FAPRI forecast indicates that world ethanol production is projected to grow 0.8 percent in 2019.¹⁴ As indicated earlier production in the U.S., the world's largest producer, decreased 1.9 percent in 2019 while output in Brazil, the world's second largest producer, continued to grow increasing an estimated 6.1 percent in 2019. Nevertheless, Brazil is the leading importer of ethanol from the U.S. accounting for more than 23 percent of U.S. exports through November 2019. Canada has continued to be a leading export market for ethanol. Exports to Canada totaled 298 million gallons through November 2019, or 22.5 percent of U.S. exports. India was the third largest market for U.S.

¹⁴ FAPRI Baseline Review 2019. December 2019. Food & Agricultural Policy Research Institute, University of Missouri

ethanol followed by South Korea, Colombia and the Philippines. Exports to China have dropped sharply over the past several years because of tariffs placed on U.S. ethanol and, as a result of the U.S. – China trade dispute, China imported no ethanol from the U.S. in 2019. As shown in Figure 2, five markets account for three-quarters of total U.S. ethanol exports.

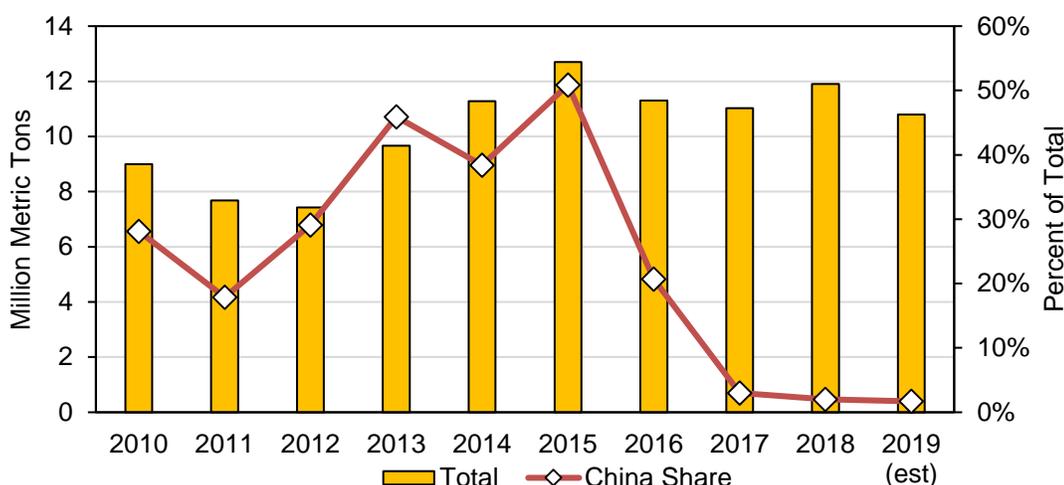
Figure 2
U.S. Ethanol Exports, Jan-Nov 2019



Source: FAS GATS

DDGS exports through November 2019 are down 8.3 percent from year earlier levels and are projected to total about 11 million metric tonnes for all of 2019 while the value of exports fell nine percent. The biggest story for DDGS export markets continues to be the collapse of the China market. As shown in Figure 3, China's share of U.S. exports decreased from 6.5 million metric tons as recently as 2015 (51 percent of total) to about 166,000 metric tons in 2019, or 1.7 percent of total U.S. exports.

Figure 3
 U.S. DDGS Exports



Source: USDA Foreign Agricultural Service Global Agricultural Trade System (GATS).

Tax revenue

The combination of GDP and household income supported by the ethanol industry contributed an estimated \$4.1 billion in tax revenue to the Federal Treasury in 2019. State and local governments also benefit from the economic activity supported by the ethanol industry, earning \$3.8 billion in 2019.

Crude oil displacement

Ethanol also plays a positive role in reducing our dependence on imported oil, expands the supply of motor gasoline, reduces the U.S. trade deficit, and reduces greenhouse gas emissions relative to conventional gasoline.

Ethanol displaces crude oil needed to manufacture gasoline and expands the volume of motor gasoline available to consumers. According to the Energy Information Administration (EIA), U.S. dependence on imported oil and refined products has dramatically declined since peaking in 2005. The movement to energy self-sufficiency in the U.S. is demonstrated by the substantial decline in the share of petroleum imports. EIA reports that the share of petroleum products provided by imports through November 2019

fell to 3.7 percent on a net basis, compared to 11.4 percent in 2018 and a peak of 60.3 percent in 2005.¹⁵ The use of domestic biofuels (ethanol and biodiesel) continues to be a contributor to the steady decline in oil import dependence. The production of 15.8 billion gallons of ethanol displaced 540 million barrels of crude oil needed to produce gasoline in 2019. If applied to imports, the value of the crude oil displaced by ethanol is estimated at nearly \$32 billion in 2019.¹⁶ This money stays in the American economy and, when combined with the GDP generated by ethanol production, is helping keep America strong.

State Level Impacts of Ethanol Production

The ethanol industry has diversified geographically in recent years. At the end of 2019, RFA reports an aggregate industry capacity of 16.8 billion gallons with 190 operating plants producing 15.8 billion gallons. Each of these plants is essentially a bio refinery that is an integral part of the other basic organic chemicals industry in the U.S. manufacturing sector. As such, the expenditures on feed grains and other feedstocks and inputs generates economic activity, income and supports job creation.

The methodology used to estimate state-level impacts differs from previous years. The calculation of state-level economic activity generated by ethanol production was a multi- step process. The first step involved estimating state-level expenditures by multiplying ethanol production reported by RFA to the national operating cost per gallon. Base estimates of GDP, income and employment were calculated by multiplying the appropriate IMPLAN multiplier for the Other Basic Organic Chemical Manufacturing industry (of which ethanol is a part) to the estimated operating expenditures by state. The results represent only the impact of ethanol production and exclude new construction activity, exports and R&D. The final step involved calculating the “gap” between the estimates and total national level impacts and scaling up the state estimates to match the national level GDP, jobs, and income. As discussed in more detail below, scaling up the state-level base estimates to account for the gap is necessary for several reasons. Chief among these is that the state-level analyses used multipliers for only one industry, other

¹⁵ EIA. Monthly Energy Review December 2019. Table 3.3a Petroleum Trade: Overview. DOE/EIA-0035(2019/12)

¹⁶ Ethanol directly competes with and displaces gasoline as a motor fuel. According to the EIA, one 42-gallon barrel of crude oil produced 19.7 gallons of gasoline in 2019. Ethanol has a lower energy content (76,700 btu per gallon LHV) than gasoline (114,000 btu per gallon LHV), and thus it takes 1.48 gallons of ethanol to provide the same energy as one gallon of gasoline. Therefore, 15.8 billion gallons of ethanol are the equivalent of 10.4 billion gallons of gasoline. Since one barrel of crude produces 19.7 gallons of gasoline, it takes 540 million barrels of crude to produce 10.4 billion gallons of gasoline, the amount displaced by ethanol. This oil was valued at the 2019 year-to-date average composite acquisition cost of crude oil by refiners of \$59/bbl.

basic organic chemicals, and does not reflect other supplying industries. As might be expected, the impact on a state's economy is generally proportional to ethanol production. Table 3 details these results for states with at least 100 million gallons of production capacity.

Table 3
Contribution of Ethanol Production to Individual State Economies, 2019*

	Production (Mil Gal)	Production Share	GDP ((Mil \$))	Employment Jobs	Income (Mil \$)
IA	4,126	26.0%	\$9,096	82,294	\$4,910
NE	2,176	13.7%	\$4,797	43,401	\$2,589
IL	1,833	11.5%	\$4,041	36,560	\$2,181
MN	1,315	8.3%	\$2,900	26,232	\$1,565
IN	1,083	6.8%	\$2,388	21,601	\$1,289
SD	1,002	6.3%	\$2,209	19,985	\$1,192
WI	648	4.1%	\$1,429	12,924	\$771
ND	487	3.1%	\$1,074	9,713	\$579
KS	518	3.3%	\$1,142	10,332	\$616
OH	408	2.6%	\$900	8,138	\$485
TX	335	2.1%	\$739	6,682	\$399
MI	283	1.8%	\$624	5,644	\$337
TN	230	1.4%	\$507	4,587	\$274
MO	165	1.0%	\$364	3,291	\$196
NY	165	1.0%	\$364	3,291	\$196
CA	158	1.0%	\$348	3,151	\$188
CO	125	0.8%	\$276	2,493	\$149
GA	120	0.8%	\$265	2,393	\$143
PA	110	0.7%	\$243	2,194	\$131

*Excludes construction, exports and R&D

The results in Table 3 are generalized impacts. The impacts of comprehensive analysis of any individual state will differ from these results. The reason for this is complex. First, the structure of each state economy is unique, economic impact multipliers reflect this and will differ from national-level multipliers for any given industry. This analysis uses multipliers for only one industry, other basic chemicals manufacturing, and does not reflect other supplying industries. Additionally, there are regional differences in feedstock costs, ethanol and DDGS prices, and other input costs that have not been explicitly considered. Relatively few states procure all of their feedstock and other inputs locally. Consequently, the analysis does not factor in leakages (spending that takes place out-of-state for inputs imported from a neighboring state). This means, for example, that the impacts may be overstated for a

corn-deficient state like California or Texas to the extent that the dollars spent for corn imported from other states represent income for farmers in supplying states and are not netted out of the analysis. Similarly, corporate and co-op income is generated by plants domiciled in a particular state and ownership varies from state-to-state. Finally, the analysis does not allocate R&D expenditures or exports on a state-by state basis since these are not likely equally distributed over all states.

Conclusion

Despite economic and regulatory challenges in 2019, the ethanol industry continued to make a significant contribution to the economy in terms of job creation, generation of tax revenue, and displacement of crude oil and petroleum products. The importance of the ethanol industry to agriculture and rural economies is particularly notable. Continued growth and expansion of the ethanol industry through new technologies and feedstocks will enhance the industry's position as the original creator of green jobs and will enable America to make further strides toward energy independence.