UNIVERSITY OF MINNESOTA EXTENSION

CENTER FOR COMMUNITY VITALITY

Economic Contribution of Minnesota's Ethanol Industry, 2022

A report of the Economic Impact Analysis Program

Authored by Brigid Tuck

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March 2023

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Authored by Brigid Tuck, senior economic impact analyst

Executive summary: Economic contribution of Minnesota's ethanol industry in 2022

Minnesota is a national leader in ethanol production. The ethanol industry in Minnesota began as a grassroots effort. Farmers, with an abundance of corn and a history of cooperation, recognized the potential to add value to corn and capture the profits in their local communities.

Growth in the industry has driven increased economic activity. To measure the contribution of the industry, the Minnesota Bio-Fuels Association partnered with University of Minnesota Extension on a study. Major findings from the analysis follow.

Economic contribution in 2022: In 2022, Minnesota's ethanol industry generated $8.0 billion of economic activity through sales. This includes $1.9 billion of income for Minnesota residents. The industry supported 25,820 jobs. It also contributed $2.7 billion to the state's gross domestic product (GDP).

Benefiting industries: Industries that benefited most from ethanol production in Minnesota included real estate, wholesale trade (including local farmer's cooperatives), crop production, and utilities.

Tax contribution: Minnesota's ethanol industry generated an estimated $183.8 million in state and local tax collections. Collections were relatively evenly distributed between property ($50.9 million), sales ($55.7 million), and income taxes ($65.1 million).

Ethanol production: Minnesota's ethanol production increased to 1,341.9 million gallons in 2022—a 6 percent increase from 2021.

Revenues and expenditures: Overall, ethanol plants experienced a decline in net return per gallon of ethanol, from $0.53 per gallon in 2021 to $0.35 in 2022. Production expenses increased, primarily driven by rising corn and natural gas prices.

Revenues, meanwhile, increased compared to 2021. Through 2022, ethanol prices remained higher than historical averages. Corn oil and DDGS prices were both up approximately 30 percent at the end of December compared to the same time the previous year.

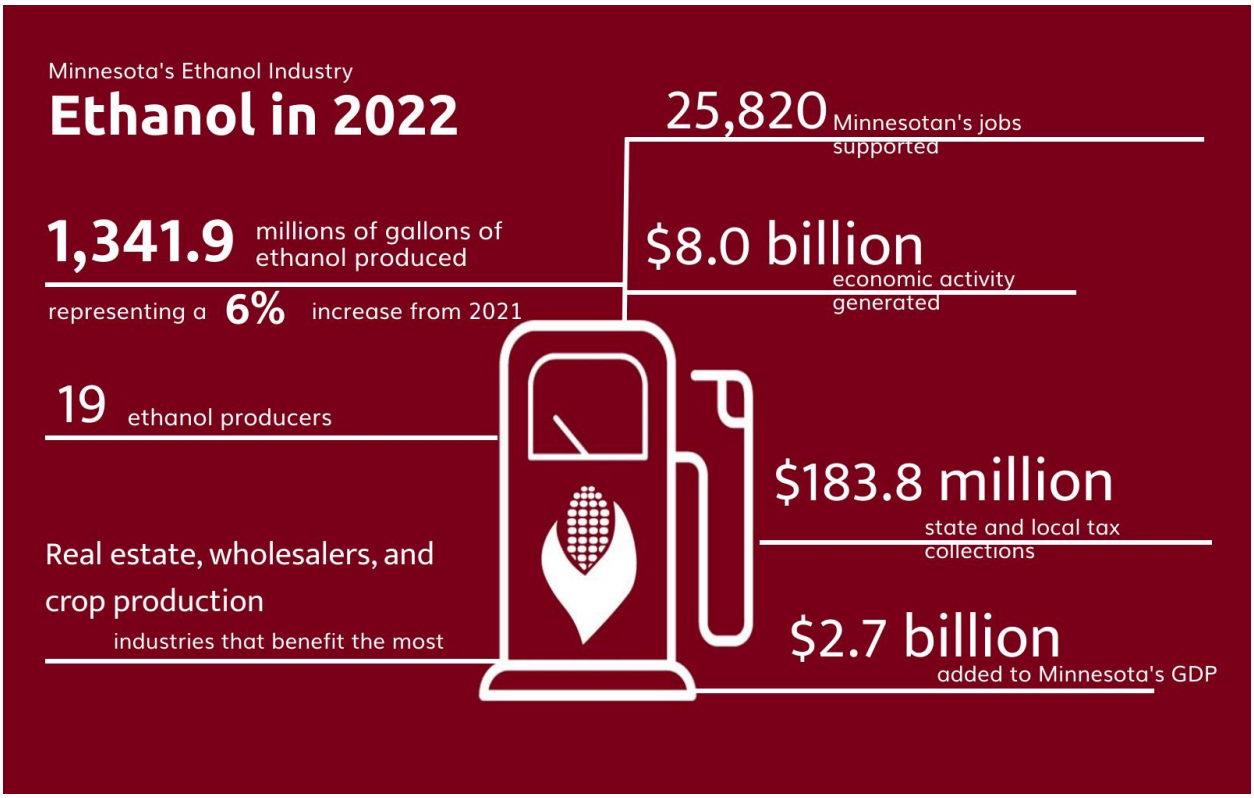
Ethanol's co-products: Ethanol plants produce fuel (ethanol), animal protein (DDGS), and distillers' corn oil. Each of these products has value in the economy. Minnesota's 2022 DDGS supply could support 1.9 million cows, 2.4 million pigs, and 59.3 million turkeys. For context, Minnesota farms have 2.2 million cattle, 8.6 million pigs, and 37.5 million head of turkeys.

In 2022, Minnesota's ethanol plants produced an estimated 409 million pounds of corn oil. The corn oil is mostly used for biodiesel production but is also blended into poultry and swine feed. If all of Minnesota's 2022 distillers' corn oil had been used in biodiesel production, it would have generated 53.1 million gallons of biodiesel. This represents nearly two-thirds of Minnesota 85.5 million gallons of biodiesel production capacity.

A year in review: During 2022, Minnesota's ethanol industry faced considerable uncertainty and volatility. Compared to trends prior to the 2020 pandemic, production variability increased. Overall, the average daily production increased between 2021 and 2022, but there were also several periods in 2022 where production fell to uncommonly low levels. In addition to production challenges, ethanol plants faced economic and financial concerns, including rising energy costs (especially for natural gas), wage pressures, and a tight labor market.

Industry challenges: Economic and global uncertainty continue to be major concerns for ethanol producers headed into 2023. In a rapidly changing price environment, ethanol producers may be able to secure inputs (e.g., corn, natural gas) at one price point for a few weeks, but then face steep increases when looking to make additional purchases during the next buying cycle. Consumer spending also continues to experience unprecedented shifts. During the pandemic, consumers shifted to the purchase of goods. Now, they are shifting back to the purchase of services, which leads to questions about future demand for goods. Additionally, while economic indicators, such as GDP and employment, remain strong, speculation of an impending recession continues.

Finally, ethanol producers continue to watch changes in national policy. Minnesota producers continue to watch the Small Refinery Exemption (SRE), which provides biofuel blending exemptions for small refineries. The exemption leads to decreased demand for ethanol. There are also concerns about national policies to move away from liquid fuels—for example, shifts toward electric vehicles. At the national level, ethanol producers also continue to advocate for increased exports.

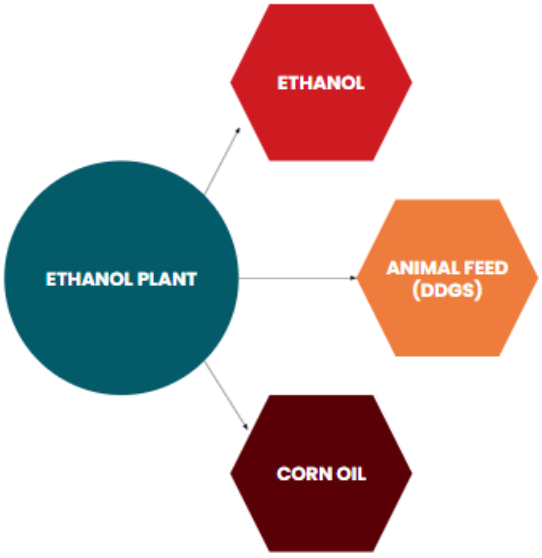


Introduction

Minnesota is a national leader in ethanol production. The ethanol industry in Minnesota began as a grassroots effort. Farmers, with an abundance of corn and a history of cooperation, recognized the potential to add value to corn and capture the profits in their local communities. Thus, they created the "Minnesota Model" of ethanol production, which started farmer-owned ethanol production plants.[1] Production has increased from less than 1 million gallons in 1989 to 1.3 billion gallons in 2022. Minnesota is currently home to 19 ethanol plants, spread across Minnesota's landscape.

Ethanol plants produce ethanol as an alternative to petroleum-based fuels. The ethanol plants ferment and distill simple sugars from biological sources. In Minnesota, the primary source (often referred to as a feedstock) in ethanol production is corn. In addition to ethanol, many plants also produce Dried Distillers' Grains (DDGS), which farmers feed as a protein to their livestock. Ethanol plants in Minnesota also produce corn oil.[2] These byproducts—DDGS and corn oil—diversify revenue streams and provide revenue stability for ethanol producers (Chart 1).

Chart 1: Ethanol Plant Products



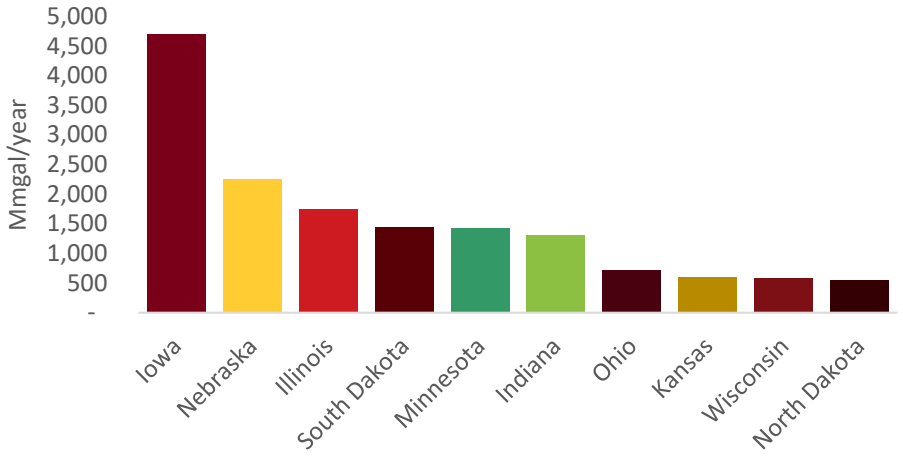
Minnesota is the fifth-largest ethanol producer in the United States, as measured by production capacity. In 2022, the United States' total production capacity was nearly 17.4 billion gallons. Iowa leads the nation with a production capacity of 4.5 billion gallons per year (Chart 2).

Minnesota has the capacity to produce 1.4 billion gallons annually, meaning Minnesota has the potential to provide slightly more than 8 percent of all national ethanol production. Minnesota's

[1] Bevill, K. (10 March 2008). Building the "Minnesota Model". *Ethanol Producer Magazine.* https://ethanolproducer.com/articles/3855/building-the-minnesota-model
[2] Learn more about ethanol production at https://www.mda.state.mn.us/environment-sustainability/ethanol-basics-and-faqs

ethanol plant capacity ranges from the smallest plant at 24 million gallons per year to the largest plant with capacity for 150 million gallons per year.

Chart 2: Top 10 States: Fuel Ethanol Production Capacity, January 2022, Source: US Energy Information Administration



The ethanol industry in 2022

In 2022, Minnesota's ethanol industry faced considerable uncertainty and volatility. Compared to trends prior to the 2020 pandemic, production variability increased (Chart 3). Overall, the average of daily production increased from 2021 to 2022, but there were several periods in 2022 when production fell to uncommonly low levels.

Chart 3: Weekly Midwest Plant Production of Fuel Ethanol, 2017-2022, Source: U.S. Energy Information Administration

For example, production in mid-September 2022 was down 7 percent from the same week pre-pandemic and at the week's lowest output in eight years.[3] Production also fell in December 2022,

[3] Braun, K. (22 Sept 2022). Column: Historic plunge for U.S. ethanol output amid struggling gas demand. *Reuters.* https://www.reuters.com/markets/commodities/historic-plunge-us-ethanol-output-amid-struggling-gas-demand-2022-09-22/

with average daily production 20 percent lower for the week ending December 30 compared to the same week in 2021. Changes in gasoline demand drove some of the variability. Between global conflicts and inflation, gasoline prices fluctuated significantly, leading to shifts in consumer demand.

In addition to production challenges, ethanol plants faced economic and financial concerns, including rising energy costs (especially natural gas), wage pressures, and a tight labor market.

Despite all the uncertainty, Minnesota's ethanol producers fared relatively well in 2022. Production rose to an estimated 1,341.9 million gallons (Table 1), a 6 percent increase compared to 2021. Corn, the main feedstock and cost for ethanol production, saw prices rise in 2022, leading to a significant increase in overall ethanol production costs. Thus, the operating cost per gallon of ethanol increased to an estimated $2.95 per gallon in 2022.

Table 1: Minnesota's Ethanol Industry Statistics

Category	2020	2021	2022	Percent change 2021-2022
Production (mill gallons)	955.5	1,271.5	1,341.9	6%
Feedstock/corn (millions)	$1,090.6	$2,454.2	$3,126.6	27%
Operating costs per gallon	$1.55	$2.40	$2.95	23%
Revenue per gallon	$1.65	$2.93	$3.30	13%
Net returns per gallon	$0.11	$0.53	$0.35	-34%

Sources: Minnesota Bio-Fuels Association, Iowa State Ethanol report, USDA Economic Research Service, Extension estimates

On the revenue side, ethanol and co-product prices remained fairly strong, so ethanol producers still realized positive net returns per gallon for the year. The net return was lower compared to 2021 but higher than 2020. On average, ethanol plants brought in $3.30 per gallon of revenues, leaving a net return of $0.35 per gallon.

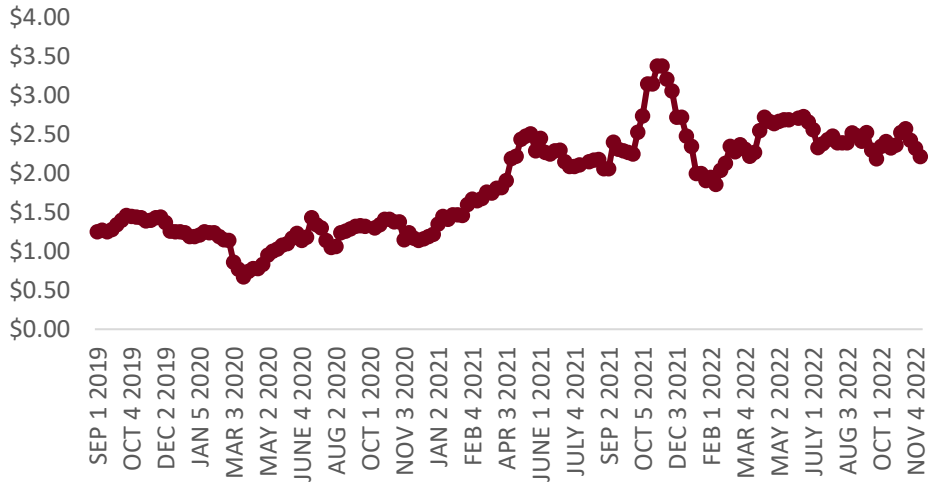
The price of ethanol, while down after highs in 2021, remained above the historical average ($2.19) during most of 2022.[4] Prices fell through the months of January and February, with a low of $1.86 per gallon before beginning to rise again (Chart 4). Prices then leveled off and remained in the $2.40 to $2.70 range for much of spring, summer, and early fall. Prices dropped slightly in early winter.

Prices for DDGS and corn oil also remained higher in 2022. The price of DDGS was $213.06 per ton in the first week of December 2022, up 31 percent from the same period in December 2021. Corn oil in the same week sold for $0.75 per pound, up 33 percent.

For information on how Extension estimated revenues, expenditures, and returns, please see Appendix 1.

[4] Historic ethanol prices found here: https://tradingeconomics.com/commodity/ethanol

Chart 4: Minnesota Ethanol Prices, Fall 2019-Winter 2022
(date format is month, week, year)



In 2022, an estimated 479.3 million bushels of corn went into ethanol production in Minnesota, representing 33 percent of the 1.5 billion bushels harvested in the state in 2022.

Economic and global uncertainty continue to be major concerns for ethanol producers headed into 2023. In a rapidly changing price environment, ethanol producers may be able to secure inputs (e.g., corn, natural gas) at one price point for a few weeks but then face steep increases when making additional purchases during the next buying cycle. Consumer spending also continues to experience unprecedented shifts. During the pandemic, consumers shifted to the purchase of goods. Now, they are shifting back to the purchase of services, which leads to questions about future demand for goods. Additionally, while economic indicators, such as GDP and employment, remain strong, speculation of an impending recession continues.

Finally, ethanol producers continue to watch changes in national policy. Minnesota producers continue to watch the Small Refinery Exemption (SRE), which provides biofuel blending exemptions for small refineries. The exemption leads to decreased demand for ethanol. There are also concerns about national policies to move away from liquid fuels—for example, shifts toward electric vehicles. At the national level, ethanol producers also continue to advocate for increased exports.

Economic contribution

Ethanol production creates economic activity in Minnesota. An economic contribution analysis can quantify that activity. Economic contribution includes direct, indirect, and induced effects. The direct effect of an industry is the spending by the industry to operate. In this analysis, it is spending by ethanol producers on items such as corn, enzymes and yeasts, utilities, and employee wages. As the ethanol producers purchase these items, they cause their suppliers to increase production, creating additional economic activity. Ethanol producers also pay their workers, who in turn, spend their incomes, generating even more economic activity. These are indirect and induced effects.

Economists use input-output models to measure economic contribution. The models measure the flow of goods and services within an economy. Once that flow is established, the model can determine how a change in one sector of the economy (say, manufacturing) affects other sectors of

the economy (for instance, construction). Extension used the input-output model IMPLAN with the Type SAM multipliers for this analysis.

Direct effect

As mentioned, the direct effect is the spending by the industry to operate. In 2022, Minnesota's ethanol producers spent an estimated $3.96 billion to operate (Table 2). The most significant expense (accounting for 79 percent of costs) was corn purchases. Ethanol producers also bought inputs, such as enzymes and yeast, purchased utilities, and paid their workers. Overall, producers spent an estimated $2.95 to produce a gallon of ethanol.

Table 2: Direct Effects of Minnesota's Ethanol Industry: 2022

Operating Costs	2022 (Millions)
Production (mill gallons)	1,341.9
Feedstock (corn)	$3,126.6
Enzymes, yeasts and chemicals	$93.0
Denaturant	$62.5
Utilities	$439.2
Direct labor	$89.1
Maintenance and repairs	$33.5
Transportation	$10.1
General & administrative expenses	$102.9
Total operating costs	$3,957.0
$/Gallon	$2.95

Revenues	2022 (Millions)
Ethanol	$3,193.7
Dried Distillers' Grain (DDGS)	$933.5
Corn oil	$302.7
Total revenue	$4,429.9
$/Gallon	$3.30
Net return over operating costs	$472.9
$/Gallon	$0.35

Sources: Minnesota Bio-Fuels Association, Iowa State Ethanol Production Profitability report, USDA Economic Research Service, Extension estimates

On the revenue side, prices for ethanol, DDGS, and corn oil were strong. Ethanol producers, in turn, realized an estimated $4.4 billion in revenues or $3.30 per gallon. Ethanol sales accounted for 73 percent of revenues in 2022.

All in all, revenues exceeded costs and ethanol producers made an estimated $0.35 per gallon in net returns over operating costs. As mentioned, many of Minnesota's ethanol plants are farmer-owned cooperatives, so these profits largely remain in farm country.

Indirect and induced effects

As mentioned, a business or industry creates indirect and induced effects when they make direct expenditures. Indirect effects are associated with the spending for goods and services used as inputs into the industry. For example, when an ethanol plant purchases enzymes and chemicals, those manufacturers must increase their production, thus triggering increases across the supply chain. These are often called business-to-business effects.

Induced effects are associated with spending by the ethanol plant's workers. Workers earn income and then spend that money for housing, health care, and at local places, such as restaurants and grocery stores. These are often called consumer-to-business effects.

The next section will present the data for the indirect and induced effects of Minnesota's ethanol industry.

Total economic contribution

In 2022, Minnesota's ethanol industry generated an estimated $8 billion of economic activity in Minnesota (Table 3). This includes $1.9 billion in labor income, or wages for Minnesota workers. The industry supported 25,820 jobs.

Table 3: Total Economic Contribution of Minnesota's Ethanol Industry: 2022, Dollar Values Are All in Millions

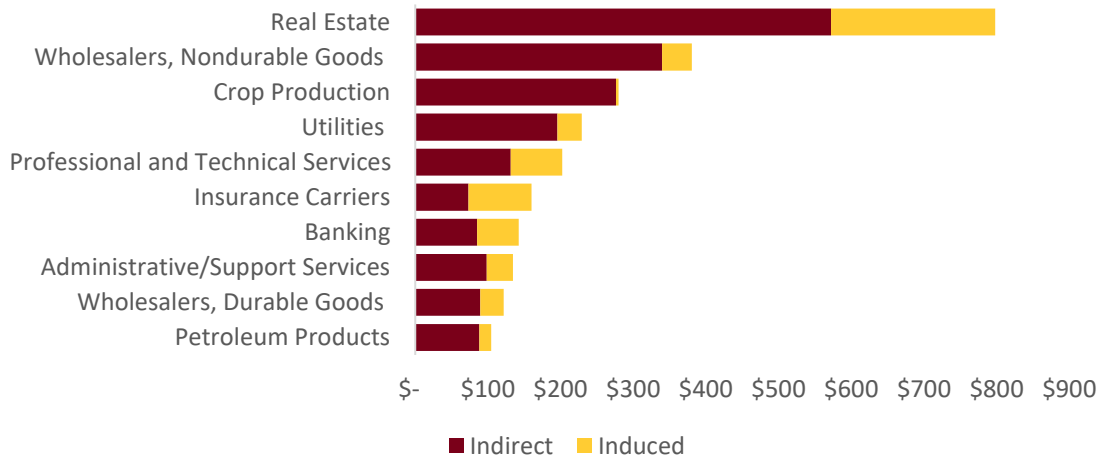
Category	Employment (FTE)	Output	Gross Domestic Product	Labor Income
Direct	7,950	$3,949.2	$592.1	$646.2
Indirect	10,910	$2,642.5	$1,249.0	$753.9
Induced	6,960	$1,416.2	$829.6	$481.0
Total	25,820	$8,007.9	$2,670.7	$1,881.1

Sources: Extension estimates

Ethanol production creates relatively significant indirect or business-to-business impacts in the state. This is a result of the value-added nature of the industry. Ethanol producers take a product already grown here and use it to create another revenue generating product. Thus, ethanol captures both the value of corn production and the value of ethanol, DDGS, and corn oil.

Of the $8 billion of economic activity, $4 billion is at businesses beyond the ethanol plants themselves. Chart 5 illustrates the industries that benefit the most from production. Indirect effects are high in industries such as real estate, wholesale trade, and crop production. The impacts in real estate relate to the role land and infrastructure plays in both ethanol and corn production. They reflect the transactions to own, rent, and sell land. Wholesale trade is the industry in which goods are typically sold from one business to another—for example, ethanol producers do not purchase yeast from the local grocery store; rather, they buy in bulk through a wholesaler.

Chart 5: Top Industries Impacted, Minnesota's Ethanol Industry, Millions, 2022 (Indirect and Induced Effects)



Indirect, or consumer-to-business impacts, which reflect the spending of workers and corn growers, are highest in areas such as real estate, insurance, and professional and technical services. Here, the real estate impacts reflect the workers owning homes or renting apartments. The professional and technical services impacts illustrate the role agriculture and ethanol play in keeping small businesses, such as tax preparers and lawyers, employed in communities.

State and local tax collections

Finally, ethanol production also spurred tax collections. In 2022, ethanol production generated an estimated $183.8 million in taxes. The taxes were relatively evenly distributed across property, sales, and income taxes (Table 4).

Table 4: State and Local Tax Contribution of Minnesota's Ethanol Industry: 2022, Dollar Values Are All in Millions

Category	Taxes
Property	$50.9
Sales	$55.7
Income	$65.1
Other	$12.1
Total	$183.8

Sources: Extension estimates

There are two main components to the economic contribution of ethanol production—the purchases of feedstock and the purchase of other inputs. Since corn is already grown in Minnesota, it is valuable to examine the impacts separately to see how they play out.

Impact of ethanol production (excluding corn)

Ethanol producers spent $822.6 million on inputs beyond feedstock in 2022 (Table 5). This created $1.5 billion of economic activity in the state, including $282.3 million of labor income. The purchases supported 3,484 jobs.

Table 5: Economic Contribution of Minnesota's Ethanol Production (Excluding Corn): 2022 Dollar Values Are All in Millions

Category	Employment	Output	Gross Domestic Product	Labor Income
Direct	1,034	$822.6	$222.9	$89.1
Indirect	900	$313.2	$153.5	$85.9
Induced	1,550	$314.4	$184.3	$107.3
Total	3,484	$1,450.2	$560.7	$282.3

Sources: Extension estimates

Impact of corn production

Growing corn is a major contributor to the contribution of ethanol. In 2022, ethanol producers paid an estimated $3.1 billion to farmers for their corn (Table 6). This supported $6.6 billion of economic activity in the state. Corn growing for ethanol production supported 22,350 workers who earned $1.6 billion for their labor.

Table 6: Economic Contribution of Minnesota's Corn Produced for Ethanol: 2022, Dollar Values Are All in Millions

Category	Employment	Output	Gross Domestic Product	Labor Income
Direct	6,920	$3,126.6	$369.2	$557.0
Indirect	10,020	$2,329.3	$1,095.5	$668.0
Induced	5,410	$1,101.8	$645.3	$373.7
Total	22,350	$6,557.7	$2,110.0	$1,598.7

Sources: Extension estimates

The role of ethanol's co-products

Ethanol plants produce fuel (ethanol), protein for animal feed (DDGS), and distillers' corn oil. Each of these products have value within the economy.

DDGS as animal protein

In 2022, Minnesota's ethanol plants produced an estimated 3.95 million tons of dried distillers' grain. Due to its high content of fiber and protein, DDGS' primary use is in feeding livestock. For beef cattle, research shows DDGS have 95 percent of the energy value of corn grain.[5]

In the United States, cattle farmers use nearly 80 percent of the DDGS.[6] Farmers also feed DDGS to swine and poultry. Producers can generally replace between 10 and 20 percent of their animal's daily ration with DDGS.[7] One cow can eat 1.5 tons of DDGS in a year, thus a ton can support two-thirds a cow (Chart 6). One ton of DDGS can also provide a valuable food source for four pigs or 250 turkeys.

[5] https://extension.umn.edu/beef-feedlot/feeding-distillers-grains-beef-cattle
[6] https://ethanolrfa.org/ethanol-101/ethanol-co-products
[7] https://www.ers.usda.gov/webdocs/outlooks/36471/12563_fds11i01_2_.pdf?v=8519

Chart 6: Animal's Potential Annual Use of One Ton of Dried Distillers' Grains (DDGS), Source: USDA, Economic Research Service

Based on those ratios, Minnesota's 2022 DDGS supply could support 1.9 million cows, 2.4 million pigs, and 59.3 million turkeys and chickens. For context, Minnesota farms have 2.2 million cattle, 8.6 million pigs, and 37.5 million head of turkeys.[8]

Distillers' corn oil

Distillers' corn oil is the final major co-product made by ethanol plants. In 2022, Minnesota's ethanol plants produced an estimated 409 million pounds of corn oil. The corn oil is mostly used for biodiesel production but is also blended into poultry and swine feed.[9]

If all of Minnesota's 2022 distillers' corn oil had been used in biodiesel production, it would have generated 53.1 million gallons of biodiesel.[10] This represents nearly two-thirds of Minnesota 85.5 million gallons of biodiesel production capacity.[11]

[8] https://www.nass.usda.gov/Statistics_by_State/Minnesota/Publications/Livestock_Press_Releases/index.php and https://www.nass.usda.gov/Statistics_by_State/Minnesota/Publications/County_Estimates/index.php
[9] https://onlinelibrary.wiley.com/doi/abs/10.1002/047167849X.bio007.pub2#:~:text=Distillers%20corn%20oil%20(DCO)%20is,a%20valuable%20poultry%20feed%20ingredient
[10] https://www.fsa.usda.gov/Internet/FSA_File/2002factorsnformulas.pdf
[11] https://www.mda.state.mn.us/environment-sustainability/minnesota-biodiesel

Appendix 1: Methodology

This appendix outlines the basic methods and data sources used to arrive at the ethanol expenditures and revenues found in Tables 1 and 2.

Production

The Minnesota Bio-Fuels Association conducted a survey of ethanol producers to determine total production in 2022. They provided the figures to Extension. Production data for 2020 and 2021 comes from previous analyses of the ethanol industry completed on behalf of the Minnesota Bio-Fuels Association and was collected in a similar manner.

Revenues

Extension calculated revenues from ethanol production primarily by using Iowa State's ethanol plant prices report.[12] In authoring this report, University of Minnesota Extension used the average monthly price of ethanol per gallon for Minnesota, weighted for production by month. This approach yielded an average price of $2.38 per gallon for the year.

Iowa State's report also provides a price for DDGS and corn oil. Extension used that data to estimate DDGS and corn oil revenues in Minnesota, also weighting for monthly production. The average DDGS price using this model was $236.11 per ton and corn oil was $0.74 per pound.

Iowa State gets its price data from USDA's daily ethanol report, produced by the Agricultural Marketing Service.

Expenditures

Extension calculated ethanol plant expenditures primarily using Iowa State's ethanol plant profitability model and its estimates of costs per gallon of ethanol produced. Extension used Iowa State's corn prices, again weighting for production by month, resulting in an average corn price of $2.33 per gallon of ethanol.

In 2021, Extension used an average of $80,000 in salaries, wages, and benefits per job at an ethanol plant. Data from Minnesota's Department of Employment and Economic Development (DEED) shows wages in the chemical manufacturing sector (which includes ethanol plants) were up 7.8 percent in 2022 compared to 2021. Thus, Extension used $86,240 per jobs in wages, salaries, and benefits.

Corn production

This is an economic contribution study, so it examines the relationships and supply chain related to the production of ethanol. Thus, Extension included the impact of corn production. An economic impact study would take a different methodological approach.

[12] https://www.extension.iastate.edu/agdm/energy.html

Appendix 2: Definitions and terms

Special models, called input-output models, exist to conduct economic contribution analysis. There are several input-output models available. IMPLAN is one such model. Many economists use IMPLAN for economic contribution analysis because it can measure output and employment impacts, is available on a county-by-county basis, and is flexible for the user. IMPLAN has some limitations and qualifications, but it is one of the best tools available to economists for input-output modeling. Understanding the IMPLAN tool, its capabilities, and its limitations helps ensure the best results from the model.

One of the most critical aspects of understanding economic contribution analysis is the distinction between the local and non-local economy. The local economy is identified as part of the model-building process. Either the group requesting the study or the analyst defines the local area. Typically, the study area (the local economy) is a county, or a group of counties, that share economic linkages. In this study, the study area is the entire state of Minnesota.

This distinction is important because the model will only capture the impact of spending within the defined region. If an ethanol producer, for example, buys items outside the state of Minnesota, this will not generate indirect effects.

A few definitions are essential to properly read the results of an IMPLAN analysis. These terms and their definitions are provided below.

Output

Output is the quantity of goods or services produced in a given time period by a firm or industry, whether consumed or used for further production. The concept of national output is essential in the field of macroeconomics.

Output represents the value of industry production. In IMPLAN, these are annual production estimates for the year of the data set and are listed in producer prices. Output is measured in dollars and is equivalent to total sales.

Output measures all sales in the economy, and therefore can, in essence, double count. Corn is a good example of this. A farmer sells corn to a local farmer's cooperative. This is one sale, and the value of the corn is counted in output. The farmer's cooperative then grinds that corn into dairy cattle feed and sells to the local dairy farmer. That is a second sale, and the final price again includes the value of the corn. The dairy farmer, in turn, sells the milk produced from the cow fed with the feed. The value of the corn is built into that sale price, too.

Output is the figure most reported in economic contribution studies.

Gross Domestic Product (GDP)

GDP is similar to output, however, as it eliminates the double counting by only counting the value at final demand (or final use of the product).

Employment

In this report, employment is listed in full-time equivalents. Because employment is measured in jobs and not in dollar values, it tends to be a very stable metric. This is particularly true in times of

accelerating inflation—one employee producers the same amount of output, even if the value of that output is rising.

Labor Income

Labor income includes all forms of employment income, including employee compensation (wages, salaries, and benefits) and proprietor income. Labor income measures the value added to the product by the labor component.

Direct Impact

Direct impact is equivalent to the initial activity in the economy. In this study, it is the expenditures of the ethanol producers.

Indirect Impact

The indirect impact is the summation of changes in the local economy that occur due to spending for inputs (goods and services) by the industry or industries directly impacted. For instance, if employment at the ethanol plant increases by 10 jobs, this implies a corresponding increase in output by the plant. As the plant increases output, it must also purchase more inputs, such as electricity, enzymes, and equipment. As the plant increases its purchase of these items, its suppliers must also increase production, and so forth. As these ripples move through the economy, they can be captured and measured. Ripples related to the purchase of goods and services are indirect impacts.

Induced Impact

The induced impact is the summation of changes in the local economy that occur due to spending by labor; that is, spending by employees in the industry or industries directly impacted. For instance, if employment in an ethanol plant increases by 10 jobs, the new employees will have more money to purchase housing, buy groceries, and go out to dinner. As they spend their new income, more activity occurs in the local economy. This can be quantified and is called the induced impact.

Input-Output, Supply and Demand, and Size of Market

Care must be taken when using regional input-output models to ensure they are being used in the appropriate type of analysis. If input-output models are used to examine the impact or the contribution of an industry that is so large that its expansion or contraction results in such major shifts in supply and demand that prices of inputs and labor change, input-output can overstate the impacts or contributions. This may be a concern in this study, as Minnesota's ethanol plants produce nearly 8 percent of national production. If they all were to suddenly stop producing, it may affect the price of ethanol.