UNIVERSITY OF MINNESOTA EXTENSION

DEPARTMENT OF COMMUNITY DEVELOPMENT

Economic contribution of Minnesota's ethanol industry, 2023

A report of the Economic Impact Analysis Program

Authored by Brigid Tuck

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Editor:
Elyse Paxton, Senior Editor, Department of Community Development

Report Reviewers:
Bruce Schwartau, Program Leader, Department of Community Development
Ashwin Raman, Vice President of Communications and Education, Minnesota Bio-Fuels Association

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Authored by Brigid Tuck, senior economic impact analyst

Executive summary: Economic contribution of Minnesota's ethanol industry in 2023

Minnesota, home to 19 ethanol plants, continues to be a national leader in the ethanol industry. In the late 1980s, farmers recognized the value of a new market for their corn and began to form farmer-owned ethanol production plants. An industry that started with less than 1 million gallons of ethanol production has grown to nearly 1.4 billion gallons in 2023.

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 2023: In 2023, Minnesota's ethanol industry generated $6.6 billion of economic activity through sales. This includes $1.3 billion of income for Minnesota residents. The industry supported 20,914 jobs. It also contributed $2.5 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), utilities, and crop production.

Tax contribution: Minnesota's ethanol industry generated an estimated $182.9 million in state and local tax collections. Collections were relatively evenly distributed between property ($55 million), sales ($60.5 million), and income taxes ($56.5 million).

Ethanol production: Minnesota's ethanol production increased to 1,353.4 million gallons in 2023—a 1 percent increase from 2022.

Revenues and expenditures: Overall, ethanol plants experienced a slight decline in net return per gallon of ethanol, from $0.35 per gallon in 2022 to $0.31 in 2023. Production expenses per gallon declined, primarily driven by lower corn prices.

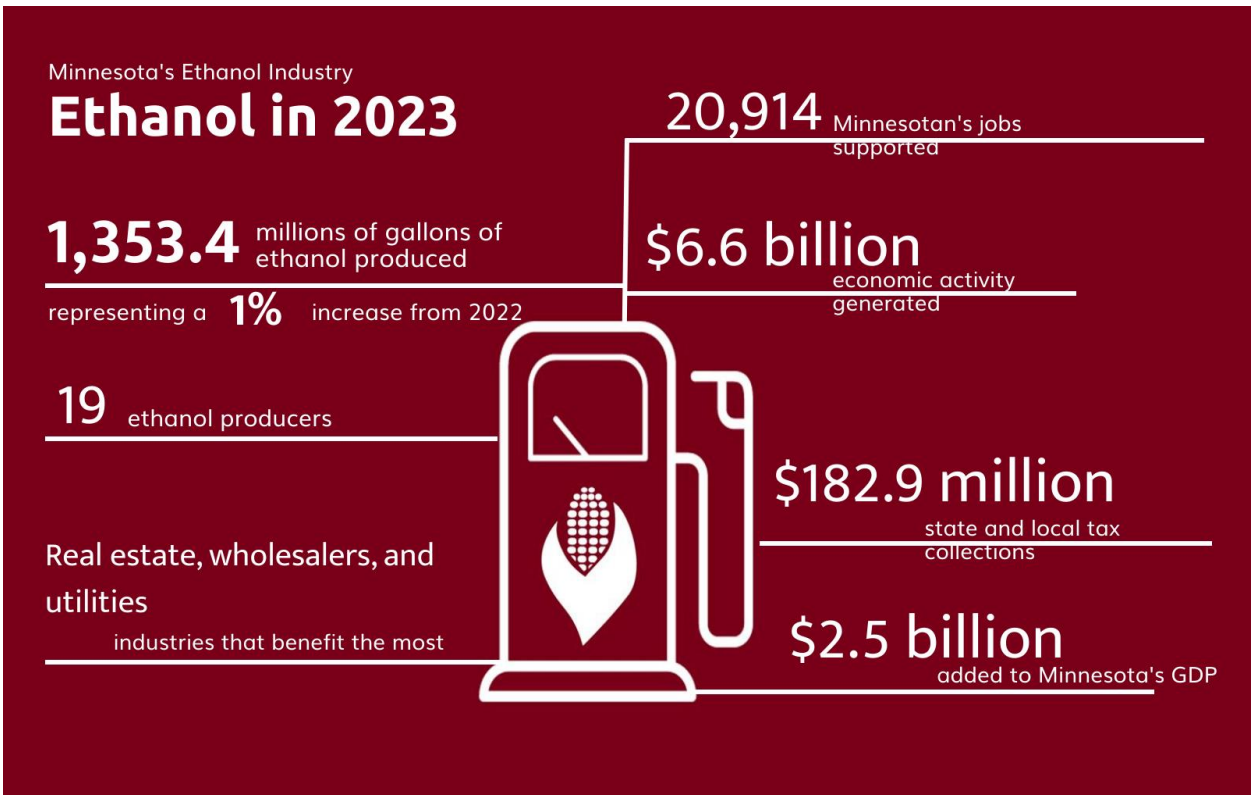
Revenues per gallon also decreased compared to 2022. While prices for ethanol were fairly stable for the majority of 2023, they declined toward the year's end. Ethanol, DDGS, and corn oil prices all finished lower at the end versus the beginning of the year.

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 2023 DDGS supply of 3.99 million tons could support nearly 2 million cows, 2.4 million pigs, and 59.8 million turkeys. For context, Minnesota farms have 2.2 million cattle, 9.1 million pigs, and 39 million head of turkeys.

In 2023, Minnesota's ethanol plants produced an estimated 426 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 2023 distillers' corn oil had been used in biodiesel production, it would have generated 55.3 million gallons of biodiesel. This represents nearly two-thirds of Minnesota 85.5 million gallons of biodiesel production capacity.

A year in review: In many ways, 2023 was a year of stability and growth in the ethanol industry. Production increased compared to 2022, driven in part by the increased consumption of gasoline by American travelers, and in part by changes in amount of ethanol blended into fuel. Prices for ethanol and its co-products, while down slightly, did not experience sudden or significant swings. Additionally, many of the supply issues faced during the pandemic also eased.

Industry challenges: Ethanol producers continue to watch changes in national policy. Two priorities have emerged at the national level. One is the approval of E15 for year-round use. The other is the move toward sustainable aviation fuel and the corresponding tax credit provided for in the Inflation Reduction Act.

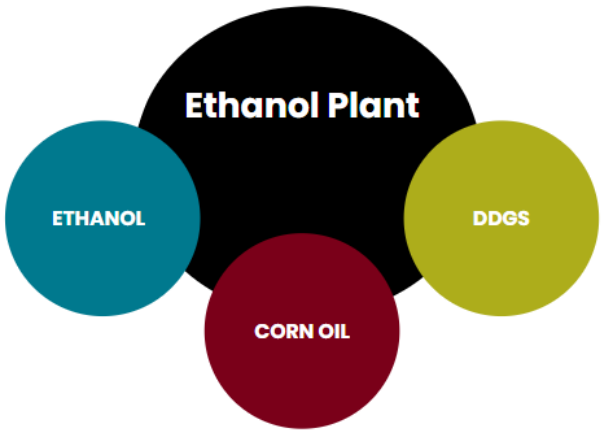


Introduction

Minnesota, home to 19 ethanol plants, continues to be a national leader in the ethanol industry. In the late 1980s, farmers recognized the value of a new market for their corn and began to form farmer-owned ethanol production plants.[1] An industry that started with less than 1 million gallons of ethanol production has grown to nearly 1.4 billion gallons in 2023.

Ethanol plants produce ethanol as an alternative to petroleum-based fuels. The 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 further produce corn oil.[2] These byproducts—DDGS and corn oil— help diversify revenue streams and provide revenue stability for ethanol producers (Chart 1).

Chart 1: Ethanol Plant Products

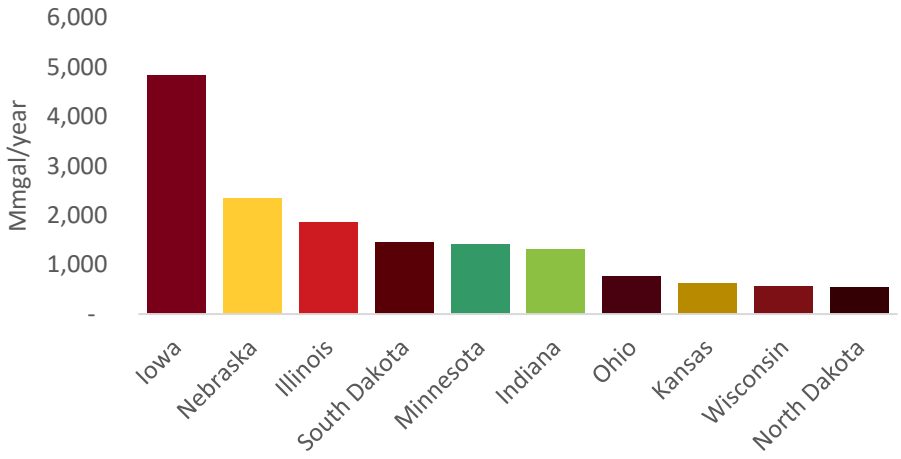


Minnesota continues to be the fifth-largest ethanol producing state in the nation, as measured by production capacity. In 2023, the nation's total production capacity was nearly 17.7 billion gallons. Iowa leads the country with a production capacity of 4.8 billion gallons per year (Chart 2). In the United States, ethanol capacity was up 1.6 percent in 2023 compared to 2022.

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 ethanol plant capacity ranges from the smallest plant at 30 million gallons per year to the largest plant with capacity for 164 million gallons per year.

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

Chart 2: Top 10 States: Fuel Ethanol Production Capacity, January 2023, Source: US Energy Information Administration

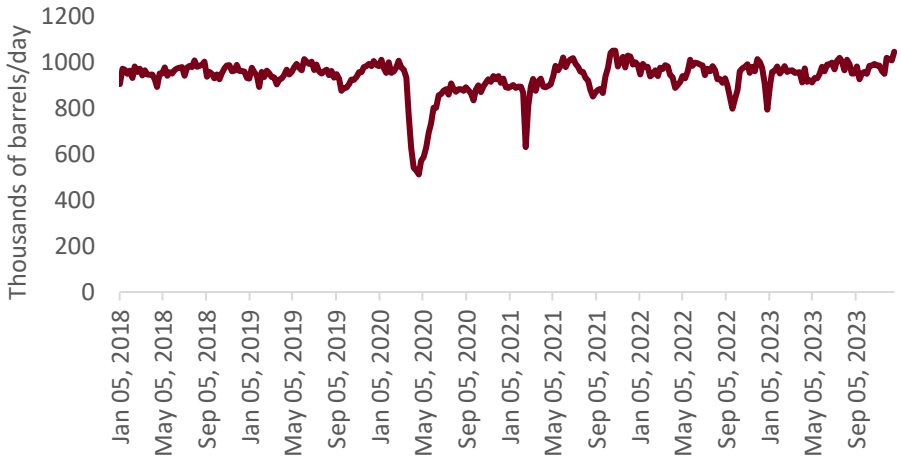


The ethanol industry in 2023

After several years of production uncertainty and volatility, ethanol production in the Midwest stabilized in 2023 (Chart 3). Average weekly production in 2023 was 969 thousand barrels per day, up 2.2 percent from 2022. The five-year average, for comparison, was 937 million barrels per day.

Production was driven, in part, by increases in demand. Gasoline use continued to rebound from pandemic levels into 2023. In addition, blend rates were favorable to the industry. This year's ethanol consumption is likely to rank in the top five in history.[3]

Chart 3: Weekly Midwest Plant Production of Fuel Ethanol, 2018-2023, Source: US Energy Information Administration



[3] Zimmerman, C. (Host). (2023, December 26). Ethanol Report 12-26-23 [Audio podcast episode]. In *The Ethanol Report.* Renewable Fuels Association. https://ethanolreport.libsyn.com/ethanol-report-12-26-23

In the first half of 2023, Midwest ethanol production remained at levels that, when compared to the same week of the previous year, were similar. By late August and September, however, production began to tick upward. For two weeks in September, for example, production was up nearly 20 percent compared to the same week in 2022. The lowest number of barrels per day in 2023 was recorded in January and the highest in December.

Compared to the uncertainty faced by the ethanol industry during and immediately after the COVID-19 pandemic, 2023 was a relatively steady year for Minnesota's producers. Minnesota's plants produced 1,353.4 million gallons of ethanol, up 1 percent from 2022 (Table 1).

Overall, both revenues and costs per gallon fell during 2023. The price of corn, the main input into the production process, decreased. This led to an 11 percent drop in expenses for corn. It also translated into total operating costs per gallon declining.

Table 1: Minnesota's Ethanol Industry Statistics

Category	2020	2021	2022	2023	Percent change 2022-2023
Production (mill gallons)	955.5	1,271.5	1,341.9	1,353.4	1%
Feedstock/corn (millions)	$1,090.6	$2,454.2	$3,126.6	$2,788.0	-11%
Operating costs per gallon	$1.55	$2.40	$2.95	$2.66	-10%
Revenue per gallon	$1.65	$2.93	$3.30	$2.98	-10%
Net returns per gallon	$0.11	$0.53	$0.35	$0.31	-11%

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

On the revenue side, ethanol prices were higher during the spring and early summer months, but fell during the fall and winter, helping lead to an overall decrease in revenues per gallon of ethanol for the year. Minnesota ethanol prices ranged between $2.00 and $2.50 per gallon from January through the end of October (Chart 4). Prices then began to drop and ended at $1.48 per gallon on December 22. This resulted in a lower average price per gallon of ethanol in 2023 compared to the previous year.[4]

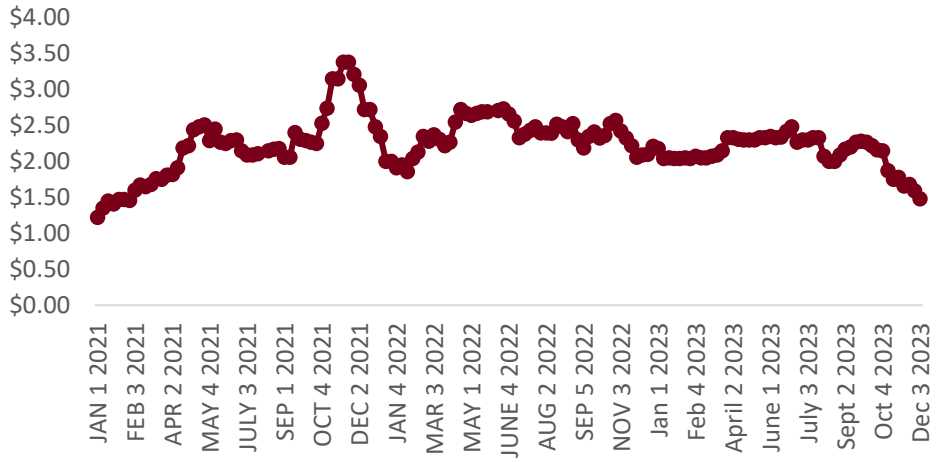
Meanwhile, the price for DDGS, on a month-over-month basis, declined for most of the year. DDGS prices in Minnesota started at $276 per ton on January 6 and ended at $205 per ton on December 22. Corn oil prices ended the year at $0.51 per pound, down from the January price of $0.68 per pound.

These trends resulted in a slightly lower net return per gallon in 2023 as compared to 2022. Net returns for the year were positive at $0.31 per gallon.

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

[4] Trading Economics. (n.d.). Ethanol. https://tradingeconomics.com/commodity/ethanol

Chart 4: Minnesota Ethanol Prices, 2021-2023 (date format is month, week, year), Source: US Department of Agriculture



In 2023, an estimated 483.4 million bushels of corn went into ethanol production in Minnesota, representing 33 percent of the 1.5 billion bushels harvested in the state.

In many ways, 2023 was a year of stability and growth in the ethanol industry. Production increased, driven in part by the increased consumption of gasoline by American travelers, and in part by changes in amount of ethanol blended into fuel. Prices for ethanol and its co-products, while down slightly, did not experience sudden or significant swings. Additionally, many of the supply issues faced during the pandemic also eased.

Ethanol producers continue to watch changes in national policy. Two priorities have emerged at the national level. One is the approval of E15 for year-round use. The other is the move toward sustainable aviation fuel and the corresponding tax credit provided for in the Inflation Reduction Act.

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 the 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 2023, Minnesota's ethanol producers spent an estimated $3.6 billion to operate (Table 2). The most significant expense (accounting for 77 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 $2.66 to produce a gallon of ethanol.

Table 2: Direct Effects of Minnesota's Ethanol Industry: 2023

Operating Costs	2023 (Millions)
Production (mill gallons)	1,353.4
Feedstock (corn)	$2,788.0
Enzymes, yeasts, and chemicals	$93.8
Denaturant	$63.1
Utilities	$443.0
Direct labor	$94.5
Maintenance and repairs	$33.8
Transportation	$10.2
General & administrative expenses	$80.4
Total operating costs	$3,606.7
$/Gallon	$2.66

Revenues	2023 (Millions)
Ethanol	$2,923.3
Dried Distillers' Grain (DDGS)	$826.5
Corn oil	$245.4
Total revenue	$4,031.3
$/Gallon	$2.98
Net return over operating costs	$424.6
$/Gallon	$0.31

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

On the revenue side, Minnesota's ethanol producers realized an estimated $4.0 billion in revenues or $2.98 per gallon. Ethanol sales accounted for 73 percent of revenues in 2023.

All in all, revenues exceeded costs and ethanol producers made an estimated $0.31 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 previously explained, a business or industry creates indirect and induced effects when they make direct expenditures. Indirect effects are associated with the spending on 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 2023, Minnesota's ethanol industry generated an estimated $6.6 billion of economic activity in Minnesota (Table 3). This includes $1.3 billion in labor income, or wages for Minnesota workers. The industry supported 20,914 jobs.

Table 3: Total Economic Contribution of Minnesota's Ethanol Industry: 2023, Dollar Values Are All in Millions

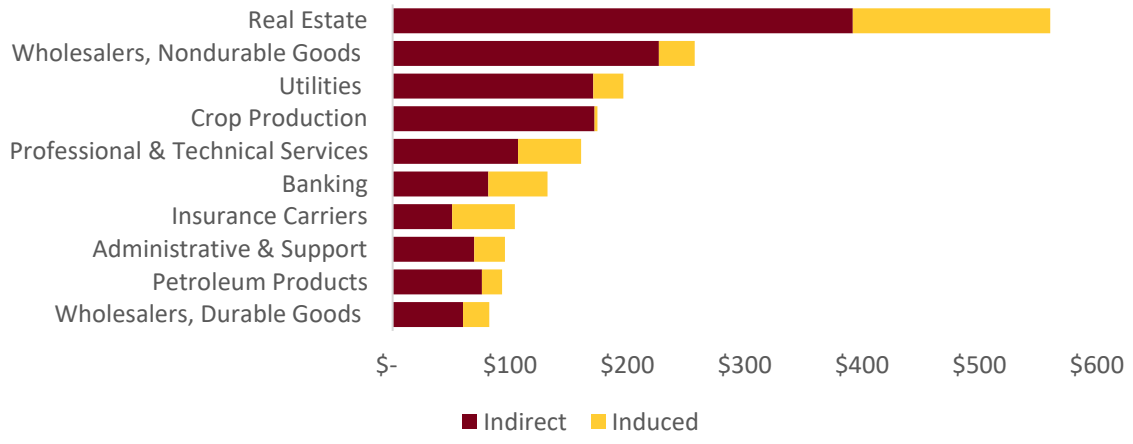
Category	Employment (FTE)	Output	Gross Domestic Product	Labor Income
Direct	8,434	$3,606.7	$939.2	$460.9
Indirect	7,550	$1,950.9	$929.5	$504.7
Induced	4,930	$1,050.8	$612.8	$347.6
Total	20,914	$6,608.4	$2,481.5	$1,313.2

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 $6.6 billion of economic activity, $3 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 utilities. 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, 2023 (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 2023, ethanol production generated an estimated $182.9 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: 2023, Dollar Values Are All in Millions

Category	Taxes
Property	$55.0
Sales	$60.5
Income	$56.5
Other	$10.9
Total	$182.9

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 $818.7 million on inputs beyond feedstock in 2023 (Table 5). This created $1.5 billion of economic activity in the state, including $292.1 million of labor income. The purchases supported 3,474 jobs.

Table 5: Economic Contribution of Minnesota's Ethanol Production (Excluding Corn): 2023, Dollar Values Are All in Millions

Category	Employment	Output	Gross Domestic Product	Labor Income
Direct	1,034	$818.7	$207.5	$94.5
Indirect	920	$345.0	$164.7	$89.9
Induced	1,520	$324.2	$189.0	$107.7
Total	3,474	$1,487.9	$561.2	$292.1

Sources: Extension estimates

Impact of corn production

Growing corn is a major contributor to the economic contribution of ethanol. In 2023, ethanol producers paid an estimated $2.8 billion to farmers for their corn (Table 6). This supported $5.1 billion of economic activity in the state. Corn growing for ethanol production supported 17,440 workers who earned $1.0 billion for their labor.

Table 6: Economic Contribution of Minnesota's Corn Produced for Ethanol: 2023, Dollar Values Are All in Millions

Category	Employment	Output	Gross Domestic Product	Labor Income
Direct	7,400	$2,788.0	$731.7	$366.4
Indirect	6,630	$1,605.9	$764.9	$414.8
Induced	3,410	$726.6	$423.8	$239.9
Total	17,440	$5,120.5	$1,920.4	$1,021.1

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 has value within the economy.

DDGS as animal protein

In 2023, Minnesota's ethanol plants produced an estimated 3.99 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.

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

[5] DiCostanzo, A. (2021). Feeding distillers grains to beef cattle. University of Minnesota Extension. https://extension.umn.edu/beef-feedlot/feeding-distillers-grains-beef-cattle
[6] Renewable Fuels Association. (n.d.). Ethanol co-products. Renewable Fuels Association. https://ethanolrfa.org/ethanol-101/ethanol-co-products
[7] Hoffman, L., & Baker, A. (2011). Estimating the substitution of distillers' grains for corn and soybean meal in the U.S. feed complex. United States Department of Agriculture. https://www.ers.usda.gov/webdocs/outlooks/36471/12563_fds11i01_2_.pdf?v=8519

Based on those ratios, Minnesota's 2023 DDGS supply could support nearly 2 million cows, 2.4 million pigs, and 59.8 million turkeys and chickens. For context, Minnesota farms have 2.2 million cattle, 9.1 million pigs, and 39 million head of turkeys.[8]

Distillers' corn oil

Distillers' corn oil is the final major co-product made by ethanol plants. In 2023, Minnesota's ethanol plants produced an estimated 426 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 2023 distillers' corn oil had been used in biodiesel production, it would have generated 55.3 million gallons of biodiesel.[10] This represents nearly two-thirds of Minnesota 85.5 million gallons of biodiesel production capacity.[11]

[8] United States Department of Agriculture. (2023). Livestock press releases. United States Department of Agriculture National Agricultural Statistics. https://www.nass.usda.gov/Statistics_by_State/Minnesota/Publications/Livestock_Press_Releases/index.php and Ye, S. (2023). Minnesota turkey fact sheet. Minnesota Department of Agriculture. https://www.mda.state.mn.us/sites/default/files/inline-files/MN%20turkey%20fact%20sheet%20%282023%29.pdf
[9] Moreau, R. & Hums, M. (2020). Corn oil and distillers corn oil. In F. Shahidi (Ed.), *Bailey's industrial oil and fat products.* https://onlinelibrary.wiley.com/doi/abs/10.1002/047167849X.bio007.pub2#:~:text=Distillers%20corn%20oil%20(DCO)%20is,a%20valuable%20poultry%20feed%20ingredient
[10] United States Department of Agriculture (n.d.). Ethanol conversion factors. United States Department of Agriculture Farm Service Agency. https://www.fsa.usda.gov/Internet/FSA_File/2002factorsnformulas.pdf
[11] Minnesota Department of Agriculture. (n.d.). Minnesota biodiesel. Minnesota Department of Agriculture. 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 2023. They provided the figures to Extension. Production data for 2020, 2021, and 2022 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 $2.16 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 weighing for monthly production. The average DDGS price using this model was $216.30 per ton and corn oil was $0.60 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 weighing for production by month, resulting in an average corn price of $2.06 per gallon of ethanol.

Data from Minnesota's Department of Employment and Economic Development (DEED) indicates wages in the chemical manufacturing sector (where ethanol production is categorized) rose by 6 percent between 2022 and 2023, thus the wage figure reflects this increase.

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] Iowa State University (n.d.). Ag decision maker. Iowa State University Extension and Outreach. 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.