Economic Contribution of the Missouri Corn and Ethanol Industry

December 2015

UNIVERSITY OF MISSOURI
Extension
Commercial Agriculture Program

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The "Economic Contribution of the Missouri Corn and Ethanol Industry" report intends to provide background about Missouri's corn farming and ethanol industries. In 2014, Missouri produced nearly 629 million bushels of corn, which was a record high for the state. Recently, yield growth has primarily driven Missouri corn production increases. Missouri corn producers contribute to the state's economy by purchasing inputs and incurring other costs to operate their businesses. Between 2012 and 2014, Missouri corn producers incurred more than an estimated $2.4 billion each year in operating and allocated overhead costs. Corn ranked third after soybeans and cattle/calves in 2014 for generating the most agricultural commodity cash receipts in Missouri. In terms of economic contribution, the Missouri corn farming industry in 2014 supported 22,075 jobs, and it provided $625.7 million in labor income. Value added to Missouri's economy totaled about $1.106 billion.

Currently, six ethanol production facilities operate in Missouri, and their annual ethanol production capacity totals 310.5 million gallons. In 2014, Missouri ethanol production totaled 280 million gallons. In addition to producing ethanol, dry mill ethanol facilities also generate carbon dioxide and distillers grains as co-products. If Missouri ethanol facilities in 2014 produced all dried distillers grains, not wet or modified wet distillers grains, then their annual DDG production was estimated to exceed 741,000 tons. To produce ethanol at dry mill ethanol plants, corn and natural gas are typically the two largest variable expenses. In 2014, Missouri ethanol plants used 89.9 million bushels of corn, and the estimated value of production from these plants totaled about $718 million, which reflects ethanol and distillers grains receipts. In terms of economic impact, the Missouri ethanol industry supported 1,411 jobs and provided $84.2 million in labor income in 2014. Value added or the contribution to Missouri's gross domestic product (GDP) totaled about $163.1 million.

Combined, the Missouri corn farming and ethanol industries contributed nearly $13.4 billion in value to the state's economy and provided $6.2 billion in labor income from 2000 to 2014. These industries can produce other effects, too. Research evidence suggests that the presence of ethanol facilities can improve corn prices and, ultimately, enhance land ownership returns.

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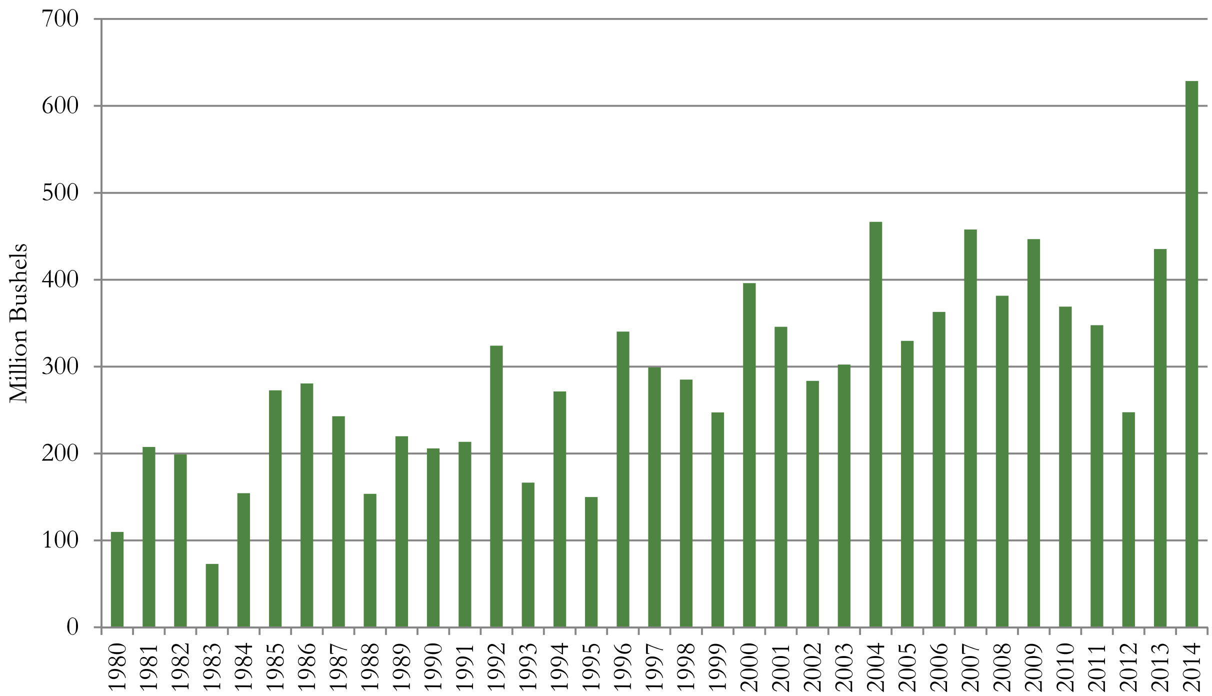
I. Missouri Corn Industry

1.1 Industry Overview

Missouri is a significant corn production state. Exhibit 1.1.1 charts Missouri corn production from 1980 to 2014. During the past five years, Missouri corn production has averaged approximately 406 million bushels per year. In 2014, Missouri's production totaled nearly 629 million bushels, which was a record high for the state.

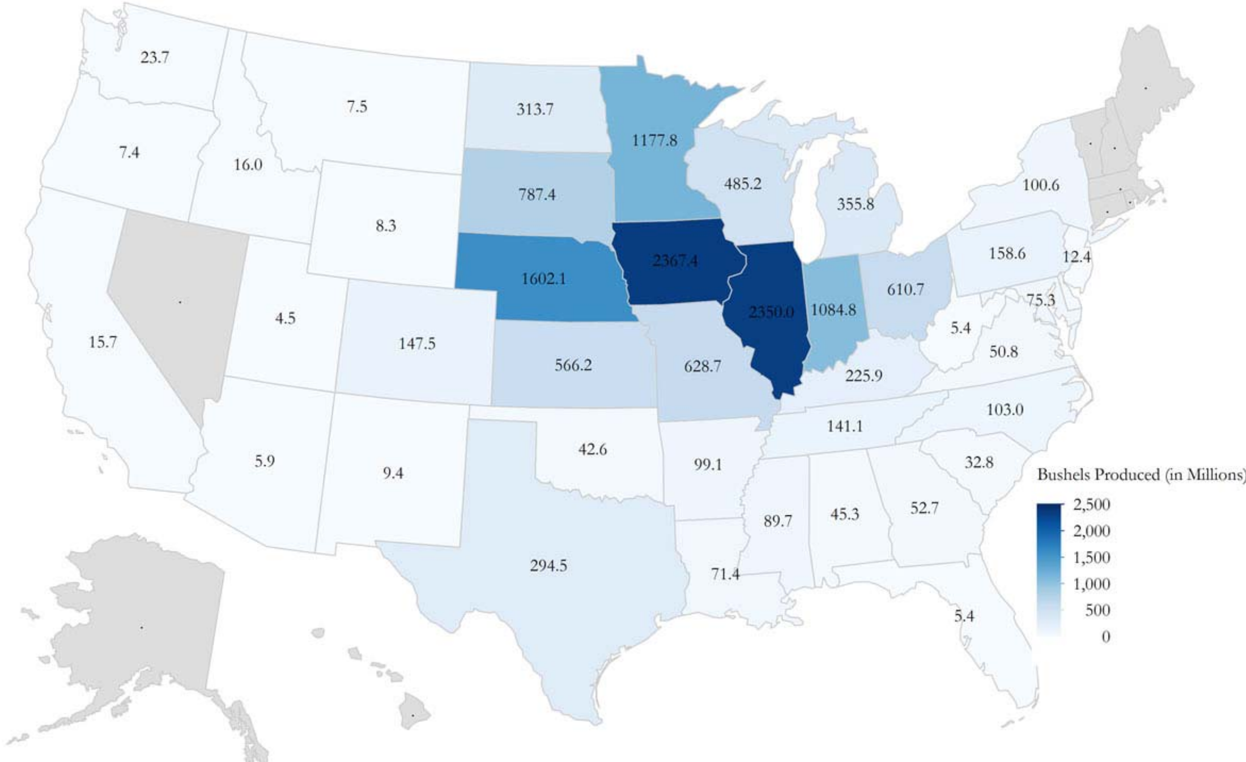
Exhibit 1.1.1 – Missouri Corn Production, Bushels, 1980 to 2014



Source: USDA, National Agricultural Statistics Service

Missouri ranked seventh in corn production relative to other U.S. states in 2014. Exhibit 1.1.2 shares corn production data by state. The three largest U.S. corn production states were Iowa, Illinois and Nebraska. They produced 2.367 billion bushels, 2.35 billion bushels and 1.602 billion bushels, respectively. During 2014, these three states produced 44.5 percent of total U.S. corn output. Missouri's share of U.S. corn production was 4.4 percent in 2014.

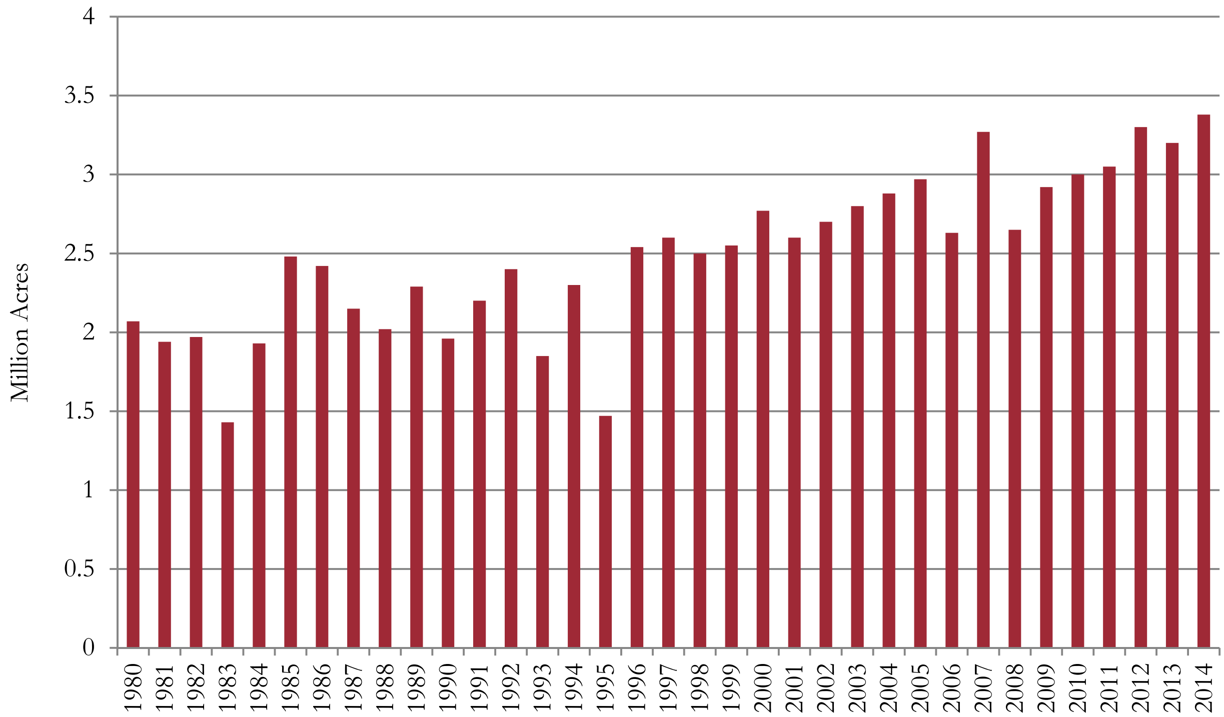
Exhibit 1.1.2 – U.S. State Corn Production, Bushels Produced, 2014



Source: USDA, National Agricultural Statistics Service

Corn is one of the primary crops grown in Missouri. Exhibit 1.1.3 shares Missouri harvested corn acreage data for 1980 to 2014. Harvested corn acreage in Missouri during the past five years has averaged approximately 3.2 million acres per year. Recently, yield improvements per acre have primarily driven corn production growth in Missouri.

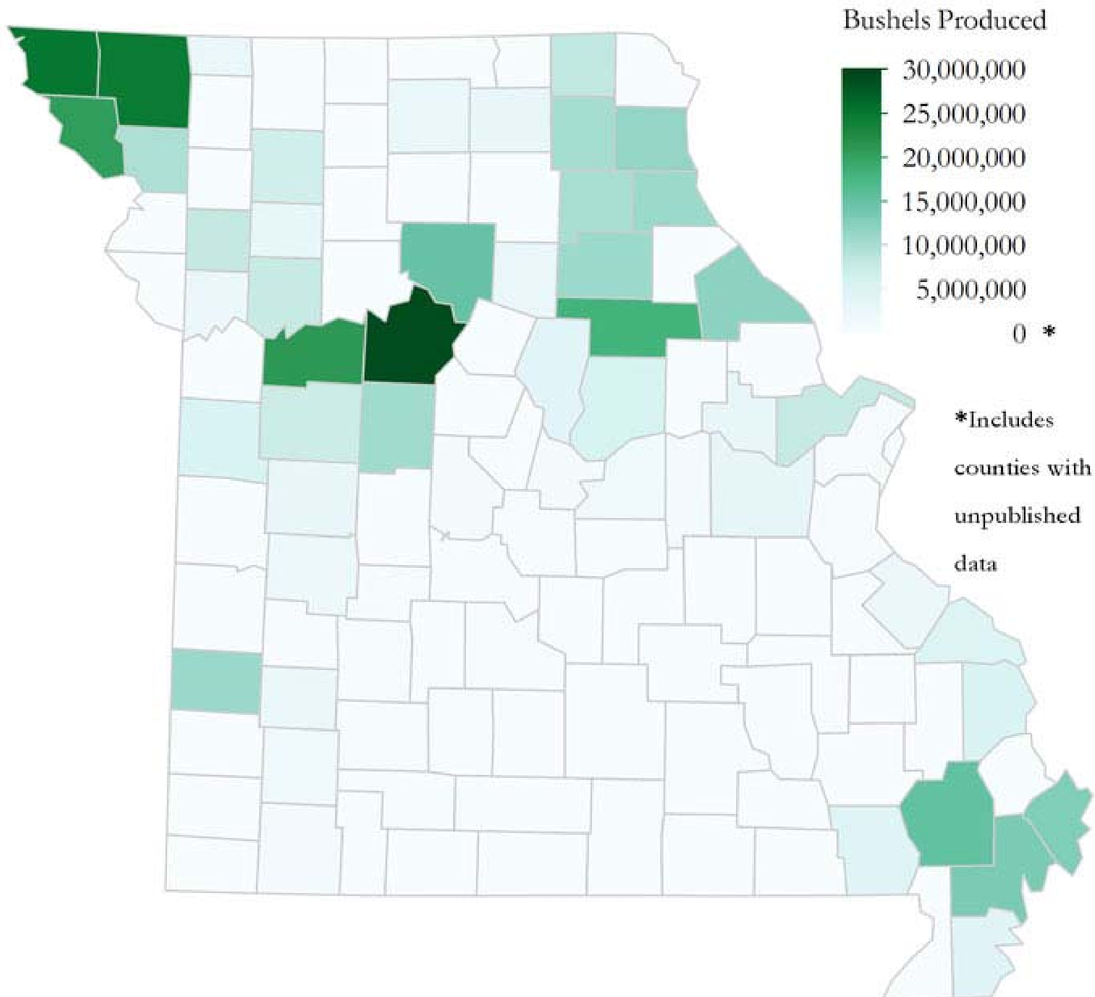
Exhibit 1.1.3 – Missouri Corn Acres Harvested, 1980 to 2014



Source: USDA, National Agricultural Statistics Service

From a geographic perspective, producers in many Missouri counties produce corn, but the state has several pockets of high production. See Exhibit 1.1.4. Shading indicates significant corn production areas in the state. In 2014, Missouri's southeast, northwest and central regions had more significant corn production than other regions. Saline County, followed by Atchison and Nodaway counties, were the top three counties for corn production in 2014. Their production totaled 29.4 million bushels, 25.2 million bushels and 24.9 million bushels, respectively.

Exhibit 1.1.4 – Missouri Corn Production, Bushels by County, 2014



Source: USDA, National Agricultural Statistics Service

1.2 Cost of Production

Missouri corn producers contribute to the state's economy by purchasing inputs and incurring other costs to operate their businesses. Exhibit 1.2.1 presents cost of production data provided by the USDA Economic Research Service for the Heartland Region from 2012 to 2014. The Heartland Region includes parts of Missouri, Iowa, Illinois, Nebraska, South Dakota, Kentucky, Indiana and Ohio. These estimates use 2005 as the survey base year, and they're adjusted each year given new annual price, acreage and production change estimates. To produce corn in Missouri, total operating costs were estimated to average $361.60 per planted acre from 2012 to 2014. Total annual allocated overhead costs were estimated to average $342.36 per planted acre between 2012 and 2014. Multiplying total planted acres by the cost of production estimates projects the indirect impact of Missouri's corn production industry. Between 2012 and 2014, Missouri averaged approximately 3.5 million acres planted into corn. Thus, producers incurred more than an estimated $2.4 billion dollars each year in operating and allocated overhead costs to produce corn in Missouri.

Exhibit 1.2.1 – Missouri Corn Cost of Production, Per Planted Acre and Total State Corn Production Spending

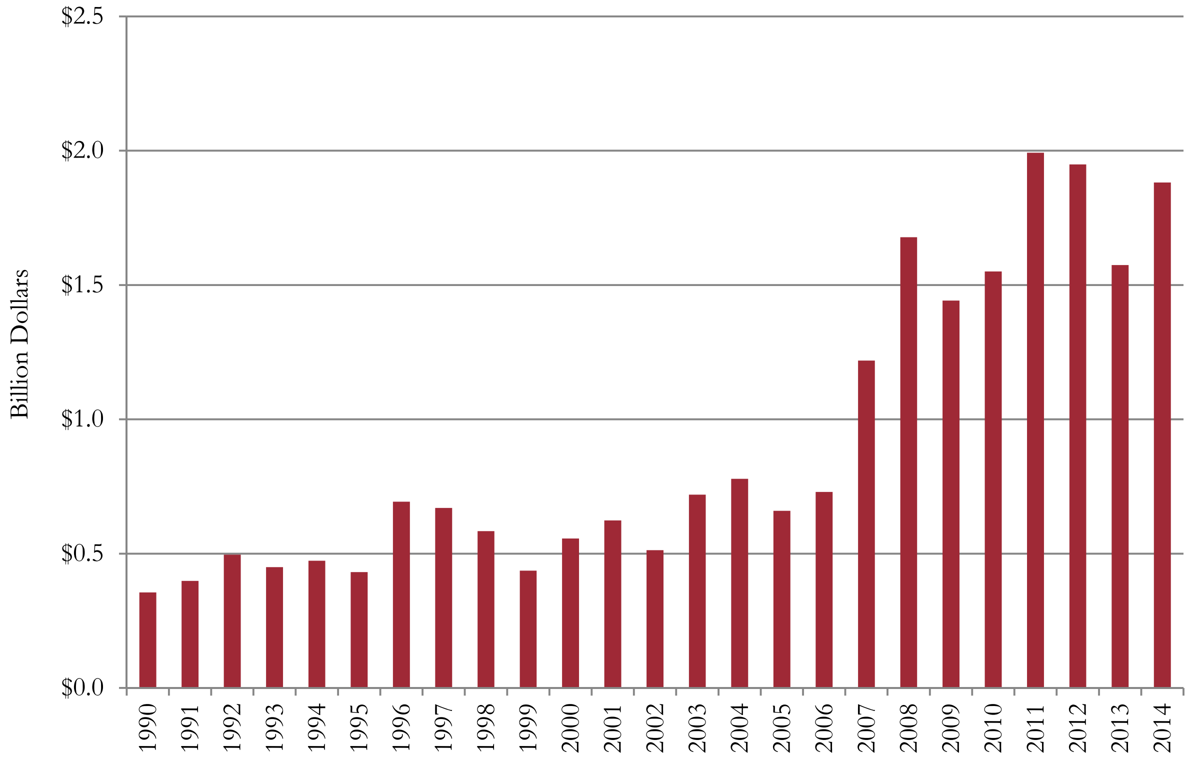
	2012 ($ Per Acre)	**2013** ($ Per Acre)	**2014** ($ Per Acre)	**Three-Year Average** ($ Per Acre)	**Missouri Totals** (Million $)
Operating Costs					
Seed	$98.83	$104.96	$108.41	$104.07	$362
Fertilizer	$164.77	$161.58	$156.78	$161.04	$561
Chemicals	$28.31	$29.40	$29.94	$29.22	$102
Custom operations	$15.84	$16.47	$16.93	$16.41	$57
Fuel, lube and electricity	$25.98	$27.62	$28.20	$27.27	$95
Repairs	$23.12	$23.34	$23.79	$23.42	$82
Interest on operating capital	$0.24	$0.16	$0.12	$0.17	$1
Total operating costs	**$357.09**	**$363.53**	**$364.17**	**$361.60**	**$1,260**
Allocated Overhead Costs					
Hired labor	$2.73	$2.81	$2.86	$2.80	$10
Opportunity cost of unpaid labor	$21.15	$21.76	$22.17	$21.69	$76
Capital recovery of mach. and equip.	$90.47	$93.06	$95.64	$93.06	$324
Opportunity cost of land (rental rate)	$184.42	$200.65	$208.03	$197.70	$689
Taxes and insurance	$8.26	$8.42	$8.58	$8.42	$29
General farm overhead	$18.45	$18.63	$18.98	$18.69	$65
Total, allocated overhead	**$325.48**	**$345.33**	**$356.26**	**$342.36**	**$1,193**
Total, operating costs and allocated overhead	**$682.57**	**$708.86**	**$720.43**	**$703.96**	**$2,453**

Source: USDA, Economic Research Service

1.3 Receipts and Value of Production

Corn production generates cash sales for farmers, and it provides income to pay expenses and provide profits to operators. In 2014, corn ranked third after soybeans and cattle/calves for generating the most agricultural commodity cash receipts in Missouri. During that year, Missouri corn cash receipts totaled nearly $1.9 billion, and they represented 17.2 percent of all commodity cash receipts for Missouri. Exhibit 1.3.1 illustrates the historical trend in Missouri corn cash receipts.

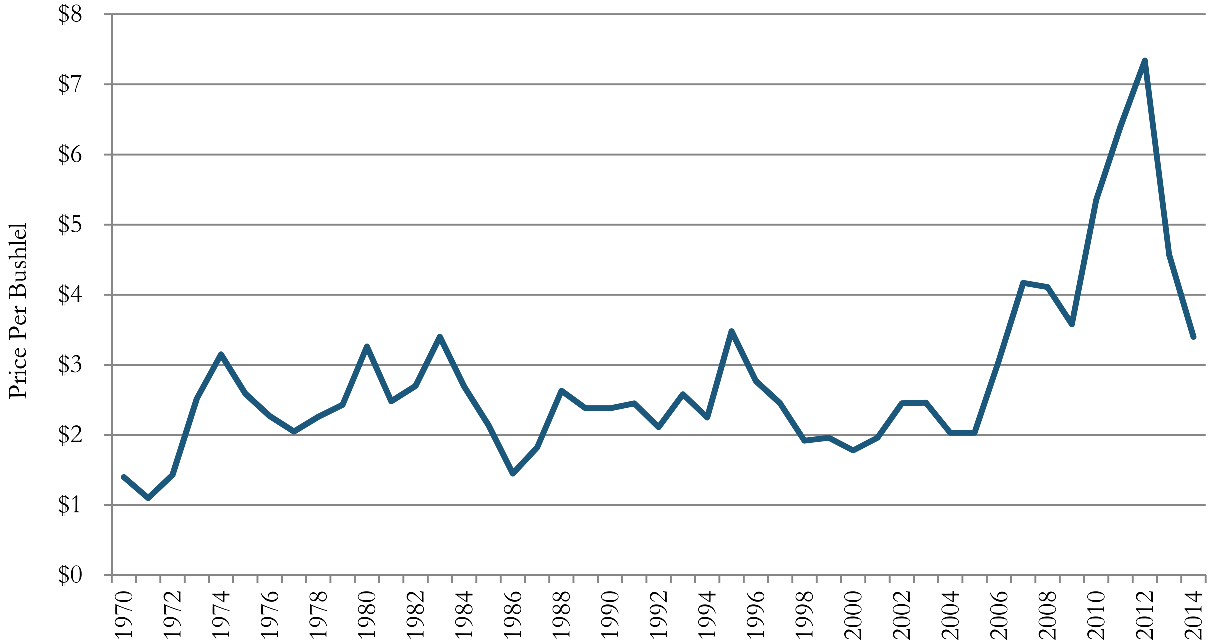
Exhibit 1.3.1 – Missouri Cash Receipts for Corn, 1990 to 2014



Source: USDA, Economic Research Service

A significant factor contributing to Missouri corn cash receipts growth has been an increase in corn prices. Exhibit 1.3.2 shares average Missouri annual corn prices. Between 2006 and 2013, prices increased significantly, but during the past two years, prices have declined. The Missouri reported price for corn in 2014 was $3.40 per bushel, which was a 26 percent decrease relative to the $4.57 per bushel price reported for the previous year.

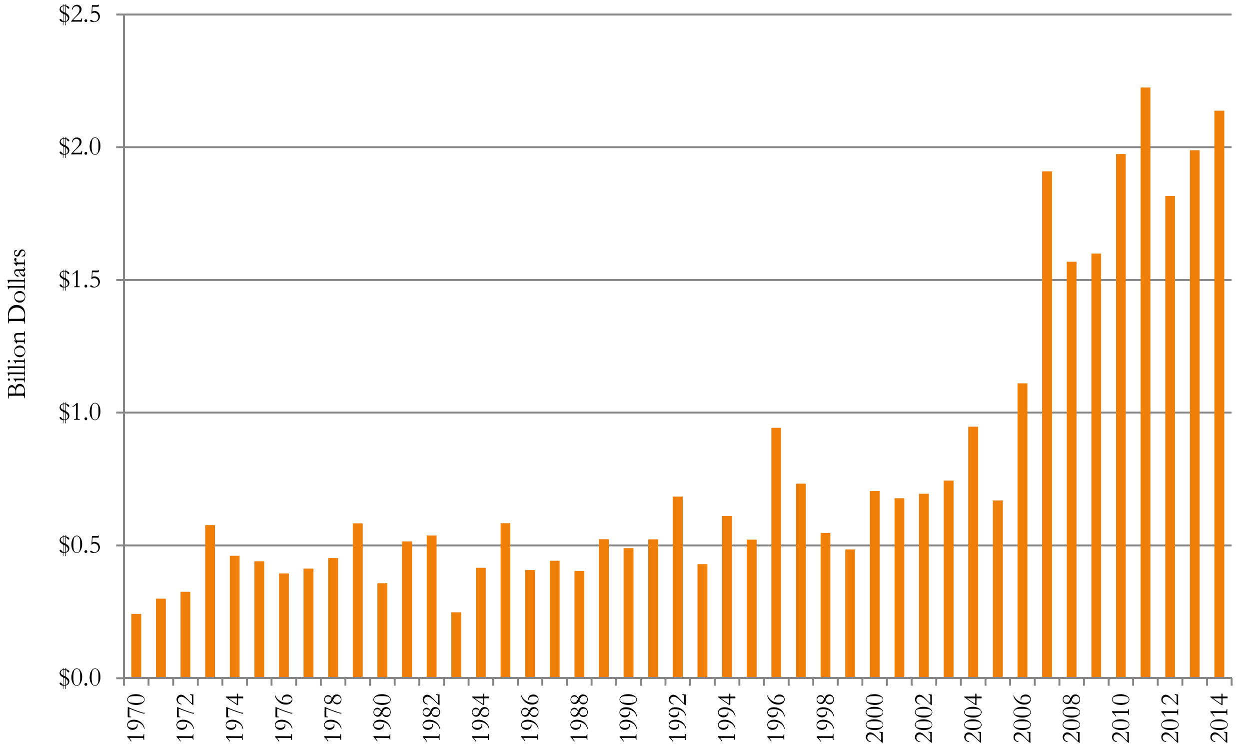
Exhibit 1.3.2 – Missouri Corn Average Annual Price, 1970 to 2014



Source: USDA, National Agricultural Statistics Service

Value of production provides an alternative option to assess the Missouri corn industry's financial importance. Cash receipt figures developed by USDA have had quantity adjustments for on-farm usage (feed) and other inventory/accounting corrections to more accurately represent a commodity's true cash receipts produced in a calendar year. Value of production reflects the overall quantity and value of corn produced for a crop year without these adjustments. In 2014, Missouri corn value of production totaled about $2.1 billion, which was based on the $3.40 average price per bushel and nearly 630 million bushels produced in Missouri. Exhibit 1.3.3 shares historical Missouri corn value of production estimates reported by USDA.

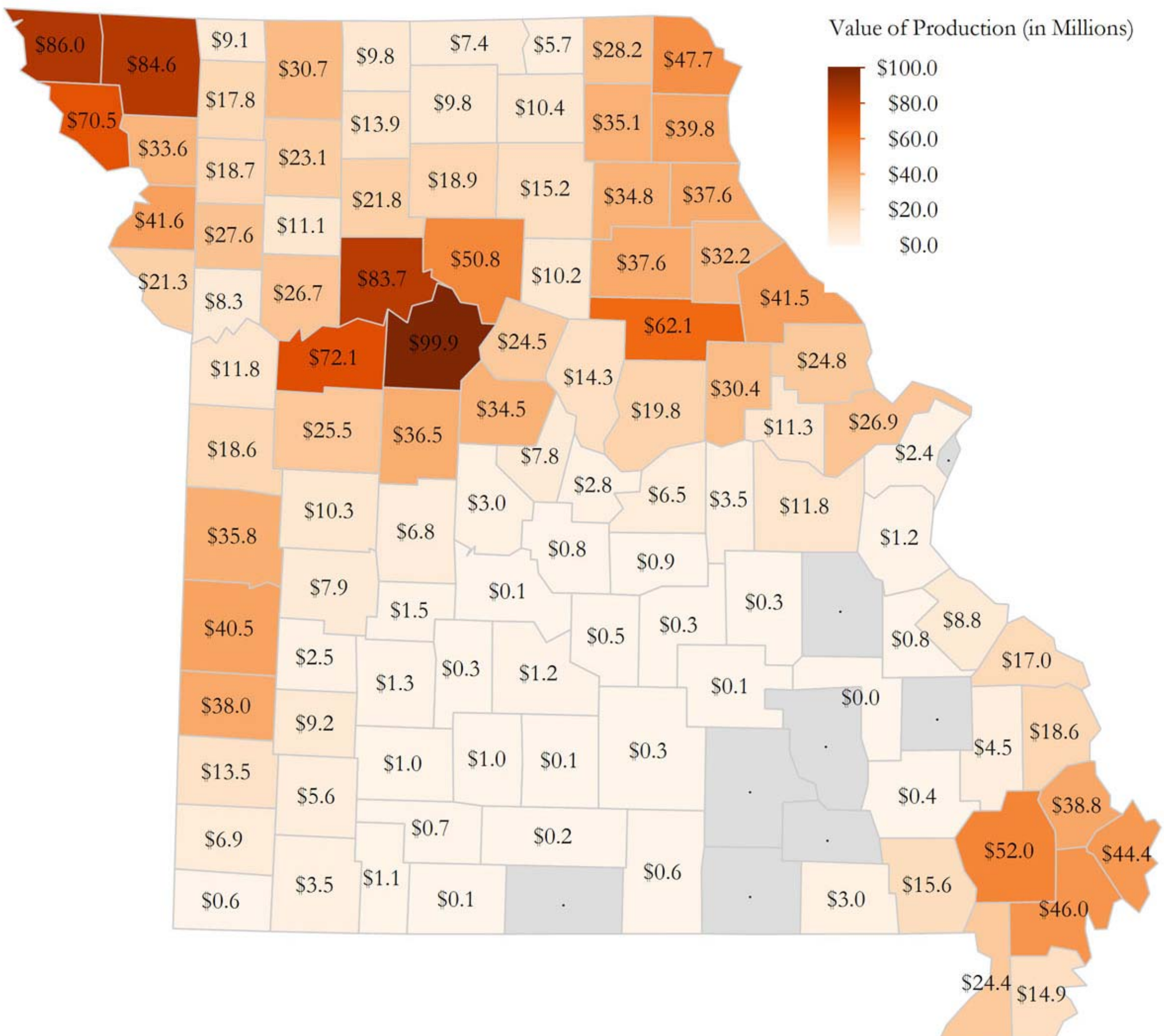
Exhibit 1.3.3 – Missouri Corn Value of Production, 1970 to 2014



Source: USDA, National Agricultural Statistics Service

Exhibit 1.3.4 estimates Missouri's value of production by county for 2014. The USDA National Agricultural Statistics Service reports county corn production data (bushels) for a majority of Missouri counties. However, data for certain counties are not reported due to limited production and/or confidentiality issues. Data for these counties are combined and reported by USDA districts as "other combined counties." For the analysis in Exhibit 1.3.4, counties with no individual production data reported by USDA were derived by using IMPLAN grain farming sector data to determine the appropriate way to distribute the "other counties" value of production and arrive at an estimated value of production by county. Like the production data suggested earlier, several geographic pockets in southeast, northwest and central Missouri contribute significantly to the Missouri corn production industry and the value that it generates.

Exhibit 1.3.4 – Missouri Corn Value of Production, By County, 2014



Source: USDA, National Agricultural Statistics Service and derived from IMPLAN Data

1.4 Economic Contribution of the Missouri Corn Industry

An analysis was prepared for the Missouri corn industry using the IMPLAN economic impact software system. IMPLAN is an input-output model and includes economic data sets, multipliers and demographic statistics for the U.S. economic infrastructure. It is a robust tool that can assess the economic impacts of businesses or contributions from industries. It's widely used by economists and analysts.

The contribution analysis includes three economic effects. The corn industry makes direct contributions through its on-farm production. Indirect contributions result when corn farmers purchase materials and services from other Missouri businesses. Induced contributions are created when employees or suppliers of these businesses spend their income dollars within the state.

Three terms are used to explain economic contribution. Employment refers to monthly jobs, either full-time or part-time, as an annual average. Labor income refers to employment income. It includes proprietor income and employee compensation, such as wages and benefits. Value-added consists of labor income; indirect taxes; and other income such as corporate profits, net interest and rent. Additionally, value-added is a measure of gross domestic product (GDP) generated by the industry.

Exhibit 1.4.1 details Missouri corn farming's contribution to the state's economy in 2014. The corn farming industry supported a total of 22,075 jobs, and it provided $625.7 million in labor income. Total value added to Missouri from the corn farming industry was approximately $1.1 billion for 2014.

Exhibit 1.4.1 – Economic Contribution of Missouri Corn Farming, 2014

Type	Employment	Labor Income	Value-Added
Direct contribution	10,655	$163.5 million	$292.2 million
Indirect contribution	8,190	$328.4 million	$575.2 million
Induced contribution	3,231	$133.7 million	$238.7 million
Total contribution	22,075	$625.7 million	$1,106.0 million

Note: Totals may not sum due to rounding
Source: University of Missouri Extension, Commercial Agriculture Program, using data from USDA and IMPLAN

Exhibit 1.4.2 shares a historical account of the Missouri corn industry's economic contributions by year. The contributions illustrated include all direct, indirect and induced contribution effects from the corn industry to Missouri's economy. From 2000 to 2014, the Missouri corn farming industry added $12.2 billion to Missouri's gross domestic product and provided $5.5 billion in labor income to Missouri's workforce and proprietors.

Exhibit 1.4.2 – Missouri Corn Farming Industry, Economic Contributions, by Year

Year	**Employment** (jobs)	**Value-Added** (millions)	**Labor Income** (millions)
2000	30,214	$549	$221
2001	28,703	$522	$210
2002	34,032	$518	$141
2003	31,625	$620	$257
2004	31,604	$859	$457
2005	22,064	$600	$319
2006	31,216	$729	$315
2007	58,502	$1,367	$590
2008	30,119	$1,163	$287
2009	29,216	$1,145	$282
2010	30,392	$752	$453
2011	31,796	$877	$498
2012	24,950	$676	$438
2013	19,754	$713	$435
2014	22,075	$1,106	$626
	Total	**$12,196**	**$5,529**

Note: totals may not add due to rounding
Source: University of Missouri Extension, Commercial Agriculture Program, using data from USDA and IMPLAN

II. Missouri Ethanol Industry

2.1 Industry Overview

Missouri's ethanol industry has provided a new value-added processing opportunity for corn producers in the state. Prior to ethanol plants operating, Missouri-produced corn was marketed primarily for livestock feeding, non-ethanol processing or exporting. After years of planning and support by local farmers, ethanol plants began being built in Missouri. Currently, Missouri's six ethanol plants have the capacity to produce 310.5 million gallons of ethanol each year. Plant names, locations, capacities and first-year of ethanol production can be found in Exhibit 2.1.1.

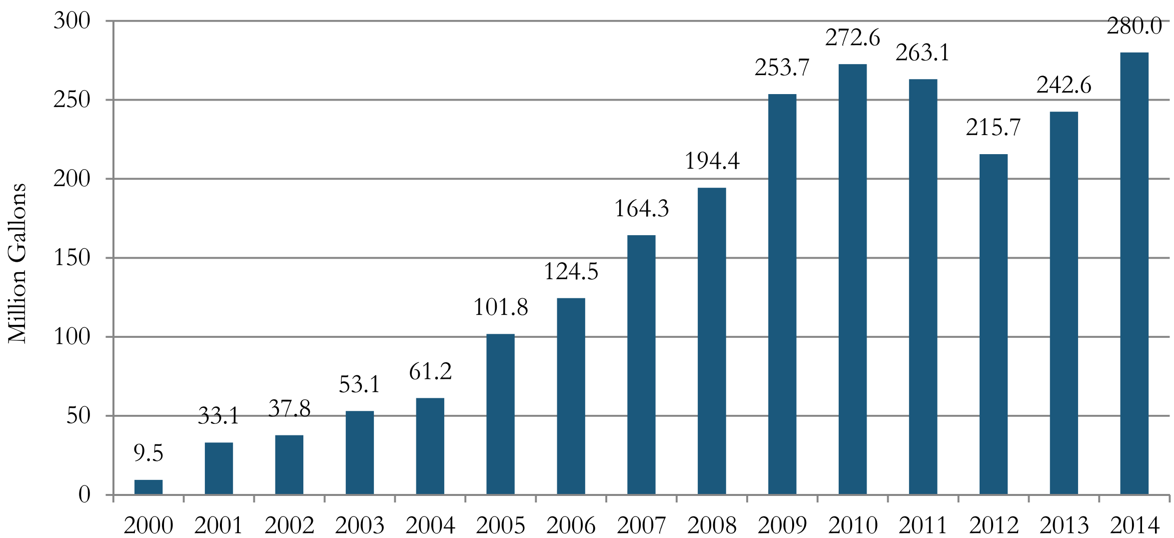
Exhibit 2.1.1 – Missouri Corn Ethanol Production Facilities, 2015

Facility	Location	Capacity (mgy)	First Year of Ethanol Production
POET Biorefining – Macon	Macon, MO	50.0	2000
Golden Triangle Energy, LLC	Craig, MO	22.0	2001
Mid-Missouri Energy, Inc.	Malta Bend, MO	60.0	2005
POET Biorefining – Laddonia	Laddonia, MO	68.0	2006
Lifeline Foods	St. Joseph, MO	50.0	2008
Show Me Ethanol	Carrollton, MO	60.5	2009

Source: Missouri Department of Natural Resources (2015)

Actual ethanol production from these plants between 2000 and 2014 is reported in Exhibit 2.1.2. Significant growth occurred as plants began operating and grew their ethanol production. In 2014, Missouri reached its highest ethanol output level – 280 million gallons – of the observed period.

Exhibit 2.1.2 – Missouri Ethanol Production, 2000 to 2014



Source: Missouri Department of Natural Resources (2015)

Distillers grains are produced as a co-product of the dry mill ethanol industry. Dry mill ethanol production uses corn to produce ethanol, carbon dioxide and distillers grains. Several forms of distillers grains co-products are available to livestock producers depending on the ethanol plant production system, marketing objectives and proximity to livestock feeding operations. Distillers grains products differ due to variation in production and drying methods. The largest difference is related to dry matter of the finished product and oil content.

Dried distillers grains (DDG) are generally more expensive on a dry matter basis than wetter forms of distillers grains, but they will not spoil as rapidly when stored under cover. DDG can be marketed worldwide like other dry commodity feeds because the product has fewer spoilage issues.

Wet distillers grains (WDG) are a high-moisture, palatable product that can be used in conditioning feedlot rations. WDG will spoil in 10 days to 14 days during the winter and five days to seven days during the summer. Therefore, they must be used quickly or ensiled with roughage for preservation.

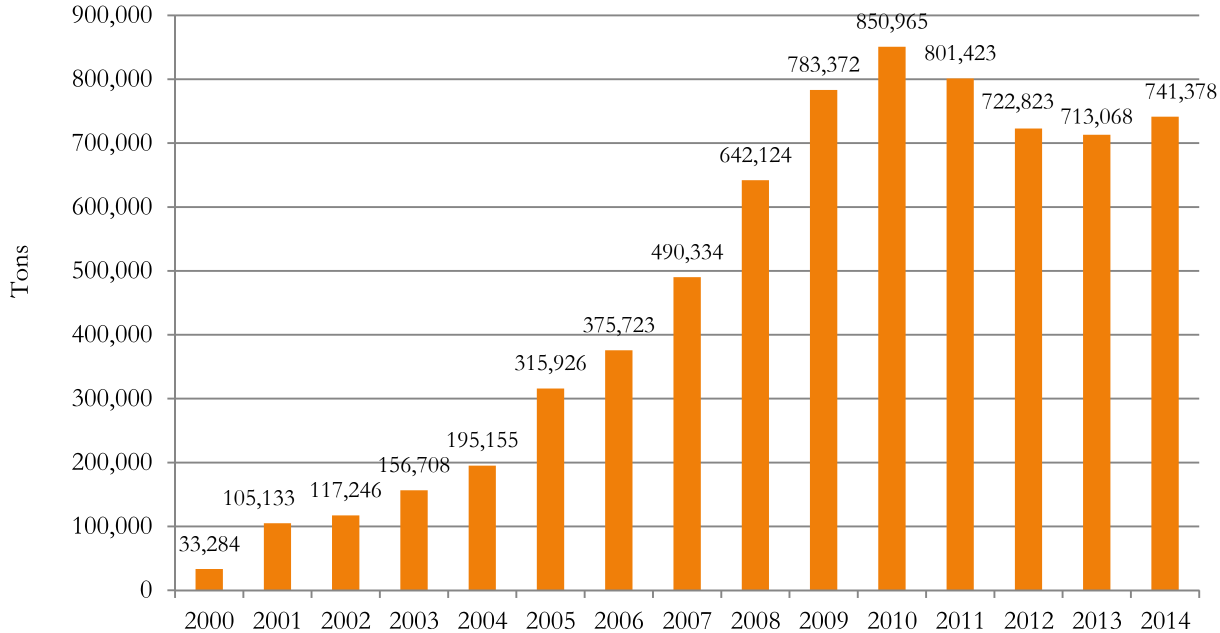
Condensed distillers solubles (CDS) is the dried syrup centrifuged from whole stillage after the distilling process. CDS is a liquid feed that can be added to distillers grains to make distillers grains with solubles, or it can be marketed separately. Exhibit 2.1.3 compares the nutrient content for various distillers grains co-products.

Exhibit 2.1.3 – Comparative Nutrient Content for Various Feeds

Co-Products as Feedstuffs (common abbreviation)	**Dry Matter %**	**Protein %**	**Total Digestible Nutrients %**
Dry distillers grains + solubles (DDGS)	88-90	25-32	85-90
Wet distillers grains + solubles (WDGS)	25-35	28-32	70-110
Condensed distillers solubles (CDS or syrup)	30-50	20-30	75-120
Corn	88	9	88
Soybean meal (44%)	89	49	84

Exhibit 2.1.4 charts Missouri's DDG production from 2000 to 2014. This analysis was based on actual corn usage reported from Missouri ethanol plants, and it uses a conservative industry conversion factor of 16.5 pounds of DDG per bushel of corn. Additionally, some plants have sold wet or modified wet distillers grains, but no reported data are available. Thus, the estimation in Exhibit 2.1.4 assumes that all plants were selling DDG. In 2014, Missouri was estimated to produce more than 741,000 tons of DDG from its corn-based ethanol plants.

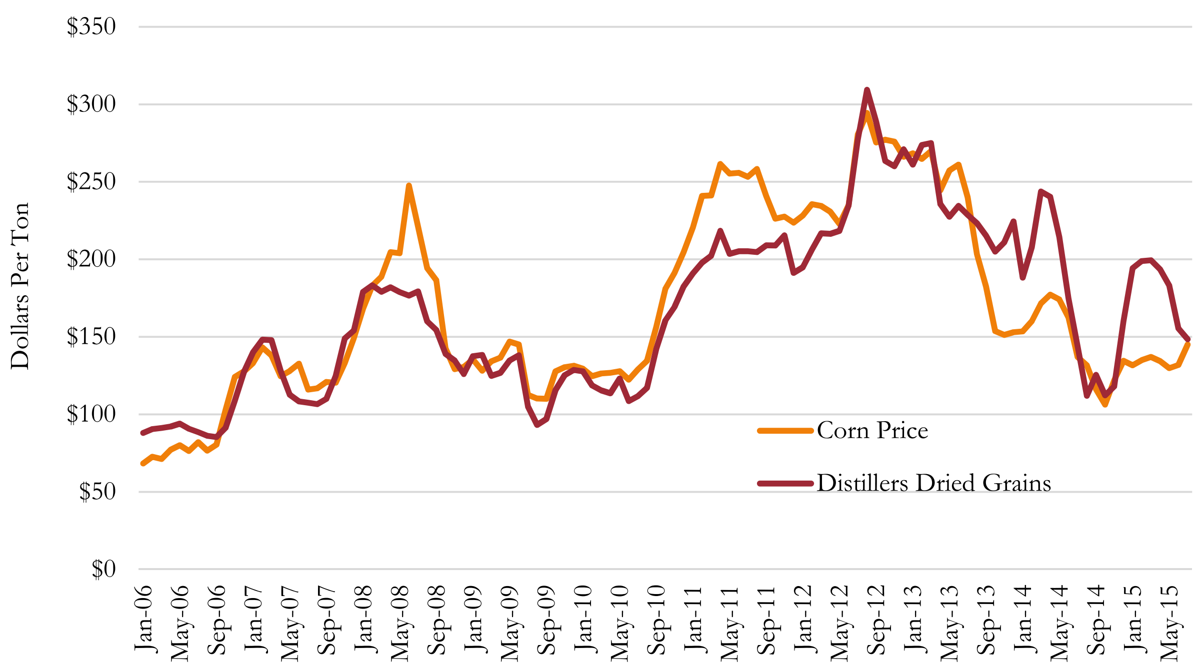
Exhibit 2.1.4 – Missouri Estimated Dried Distillers Grains Production, 2000 to 2014



Source: Derived from Missouri Department of Natural Resources Data (2015)

Exhibit 2.1.5 demonstrates the trend in Missouri corn prices (Kansas City cash price) and dried distillers grains prices (Northern Missouri) from the past 10 years. Note that these prices follow closely on a per ton basis, and they have varied considerably during the observed period.

Exhibit 2.1.5 – Missouri Corn Prices and Dried Distillers Grains Prices

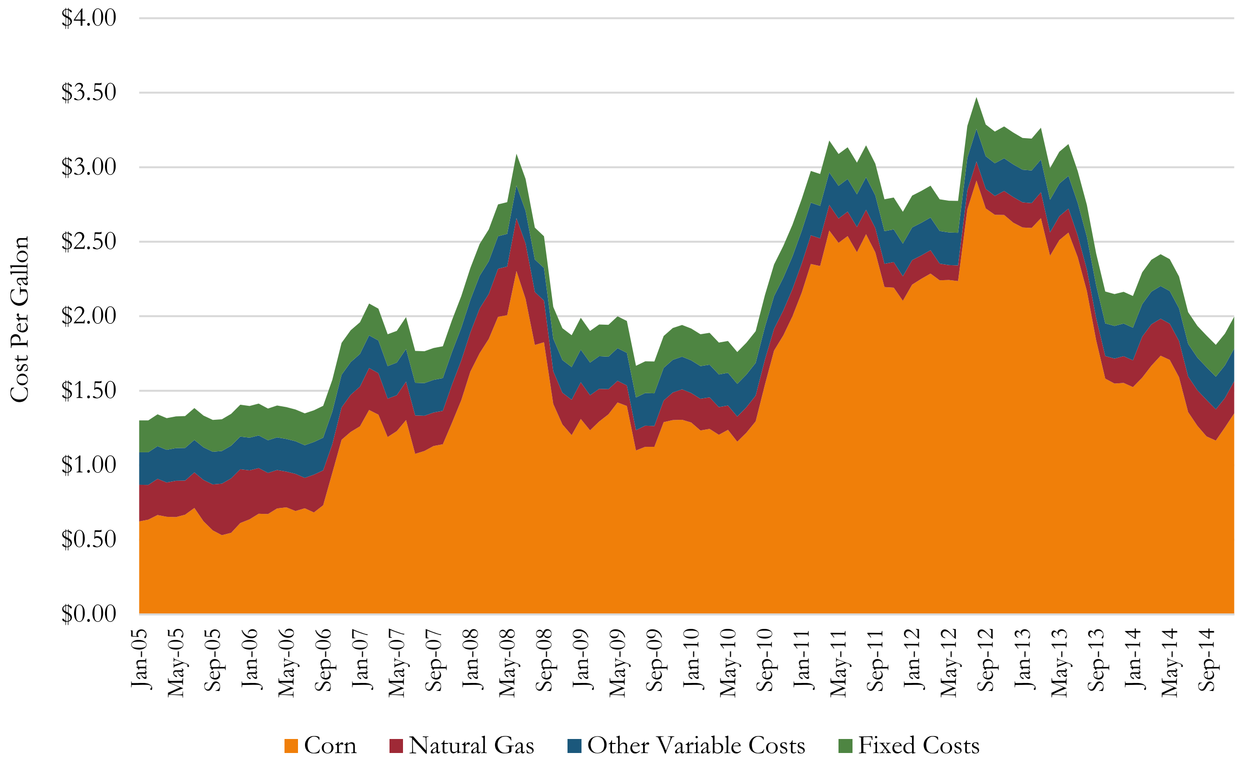


Source: Livestock Marketing Information Center (2015)

2.2 Cost of Production

Cost of production information from Missouri plants is not reported or publically available. Iowa State University Extension (Hofstrand, 2015) developed an economic model of a dry mill ethanol plant and estimated cost of production information by month. The data are representative of northern Iowa ethanol plants. See Exhibit 2.2.1 for the estimated monthly cost of ethanol production from 2005 to 2014. In mid-2012, note that ethanol production costs peaked at nearly $3.50 per gallon. Since then, ethanol production costs per gallon have receded.

Exhibit 2.2.1 – Estimated Monthly Cost of Ethanol Production, Iowa, 2005 to 2014



Source: Hofstrand (2015)

Exhibit 2.2.2 estimates annual production expenditures for Missouri plants. The estimates are based on Iowa cost of production data and Missouri corn prices. Additionally, total Missouri expenditures were estimated based on the state's 2014 reported ethanol production, which was 279,985,530 gallons. Corn cost per gallon of ethanol produced was based on the market price for corn in Kansas City and not on actual cost of production. Corn and natural gas are typically the two largest variable expenses for dry mill ethanol plants. Other variable costs include chemicals, repairs/maintenance, transportation, water, electricity and miscellaneous costs. Fixed costs represent depreciation, insurance, labor/management and property taxes. The Missouri ethanol industry spent about an estimated $553 million in production costs during 2014. Corn purchases represented an estimated 66.5 percent of total 2014 ethanol production costs.

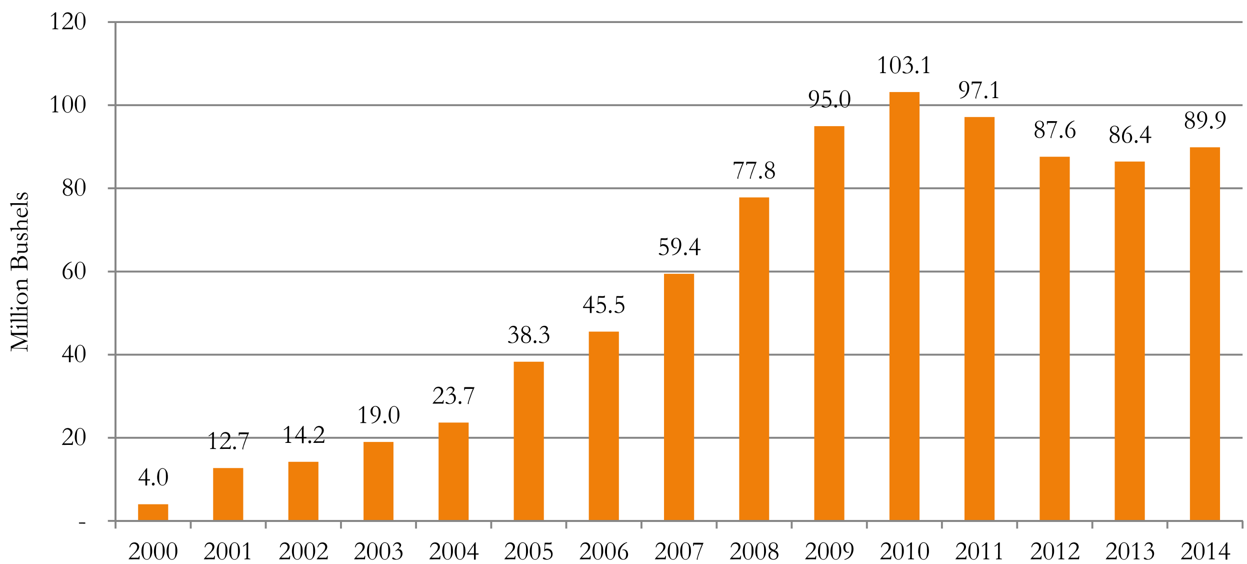
Exhibit 2.2.2 – Estimated Missouri Cost and Yearly Expenditures for Ethanol, 2014

Production Costs	Cost per Gallon ($)	% of Total	Estimated Missouri Plant Expenditures
Corn	$1.31	66.5%	$366,134,924
Natural gas	$0.23	11.7%	$65,572,611
Other variable costs	$0.22	11.2%	$61,358,829
Fixed costs	$0.21	10.6%	$59,785,270
Total costs	**$1.97**	**100.0%**	**$552,851,634**

Source: Hofstrand (2015), Livestock Marketing Information Center (2015), Missouri Department of Natural Resources (2015)

Actual corn bushels that were consumed by the Missouri ethanol industry are reported in Exhibit 2.2.3. As Missouri ethanol plants began operating and increased their output, their corn utilization increased significantly. Usage peaked at 103.1 million bushels in 2010. From 2011 to 2013, corn utilization and overall ethanol production decreased. In 2014, Missouri ethanol plants consumed 89.9 million bushels of corn, which was a 4 percent increase from the previous year.

Exhibit 2.2.3 – Corn Bushel Usage by Missouri Ethanol Plants, 2000 to 2014

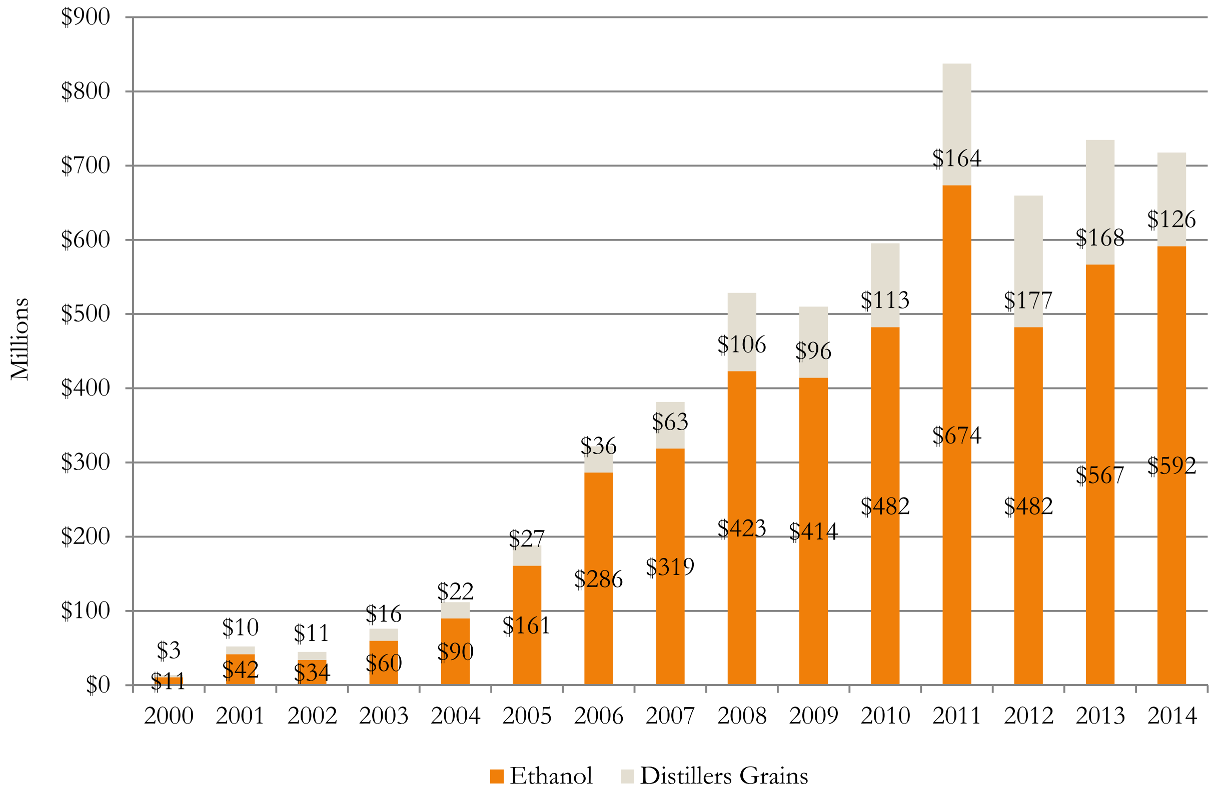


Source: Missouri Department of Natural Resources (2015)

2.3 Value of Production

Value of production for the Missouri ethanol industry depends on ethanol and distillers grains production. Exhibit 2.3.1 shares value of ethanol production estimates for Missouri from 2000 to 2014. The estimates are based solely on ethanol and distillers grains receipts. In 2014, the estimated value of production from Missouri corn-based ethanol plants was about $718 million. A majority of the value originates from ethanol sales, which represented 83 percent of the 2014 total value.

Exhibit 2.3.1 – Estimated Value of Production for Missouri Ethanol Plants, 2000 to 2014



Sources: Missouri Department of Natural Resources (2015), Nebraska Ethanol Board (2015), University of Missouri (2015), Livestock Marketing Information Center (2015)

In this analysis, ethanol production and corn utilization at Missouri plants was used from data reported to the Missouri Department of Natural Resources (2015). It was assumed that these plants produced 16.5 pounds of distillers grains for each bushel of corn consumed and that each plant sold only dried distillers grains. Ethanol and distillers grains sales prices were estimated from various sources. Ethanol prices at Iowa plants (Livestock Marketing Information Center, 2015) were used from 2005 to 2014. Earlier years were estimated based on the relationship between these ethanol prices and the Omaha, Nebraska, ethanol rack prices (Nebraska Ethanol Board, 2015). Distillers grains prices were based on Missouri-reported prices from the University of Missouri By-Product Feed Price listings in earlier years (2000-2005) and the USDA Marketing Service (Livestock Marketing Information Center, 2015) in later years.

2.4 Economic Contribution of the Missouri Ethanol Industry

Using the IMPLAN economic impact software, an impact analysis was prepared for the Missouri ethanol industry. IMPLAN is an input-output model, and it includes economic data sets, multipliers and demographic statistics for the entire U.S. economic infrastructure. IMPLAN doesn't provide a specific individual sector for the ethanol industry. Thus, sector data for the milling industry was adjusted to reflect the inputs relevant for ethanol facilities.

The results from this ethanol industry analysis can be separated into three categories: direct, indirect and induced effects. A direct effect can be defined as a direct change to a respective industry. For example, the revenue generated from selling ethanol and distillers grains would be considered a direct effect. Indirect effects measure the impact of buying goods and services from other local industries. As an example, ethanol plants purchasing supplies from other industries (e.g., chemicals, natural gas, water) creates an indirect effect. Although purchasing and transporting corn to these plants would technically produce an indirect impact, this function was not included in this analysis to avoid double counting issues, considering that this function was included in the earlier Missouri corn farming industry analysis. Induced effects are the responses in the local economy that stem from proprietors and employees spending their income. For instance, managers and hired labor will spend earnings at local grocery stores, restaurants and other retailers. This spending will create further economic ripples. Total effects combine the direct, indirect and induced effects.

Exhibit 2.4.1 details the Missouri ethanol industry's 2014 impact on the state economy. The ethanol industry supported 1,411 jobs and provided $84.2 million in labor income. Value-added impact or the contribution to Missouri's gross domestic product (GDP) totaled about $163.1 million.

Exhibit 2.4.1 – Economic Impact of Missouri Ethanol Industry, 2014

Type	Employment	Labor Income	Value-Added
Direct effect	139	$10.9 million	$34.2 million
Indirect effect	830	$54.8 million	$96.6 million
Induced effect	443	$18.5 million	$32.3 million
Total impact	1,411	$84.2 million	$163.1 million

Note: May not sum due to rounding
Source: University of Missouri Extension, Commercial Agriculture Program, using data from USDA and IMPLAN

Exhibit 2.4.2 shares estimated economic impacts for the Missouri ethanol industry by year; it assesses 2000 to 2014. The results presented include all direct, indirect and induced economic effects from the ethanol industry. Between 2000 and 2014, the Missouri ethanol and supporting industries provided $1.202 billion in added value to the state's economy and $675 million in labor income.

Exhibit 2.4.2 – Missouri Ethanol Industry Impacts by Year

Year	**Employment** (jobs)	**Value-Added** (millions)	**Labor Income** (millions)
2000	65	$4	$2
2001	252	$15	$9
2002	261	$18	$11
2003	378	$27	$16
2004	474	$34	$20
2005	798	$58	$34
2006	717	$61	$38
2007	850	$73	$45
2008	901	$87	$50
2009	866	$85	$49
2010	1,069	$108	$57
2011	1,575	$162	$86
2012	1,561	$138	$87
2013	1,465	$169	$87
2014	1,411	$163	$84
	Total	**$1,202**	**$675**

Note: totals may not add due to rounding
Source: University of Missouri Extension, Commercial Agriculture Program, using data from USDA and IMPLAN

2.5 Missouri's Net Benefit from the Ethanol Industry

Missouri has been actively involved in encouraging the ethanol industry to develop in the state. To facilitate ethanol production, ethanol plants and investors had several forms of financial support available. For example, the Missouri Ethanol Producer Incentive Fund was established in 1988 to encourage ethanol production within the state. This program was administered by the Missouri Department of Agriculture. Given the grant program's guidelines, eligible facilities must be majority owned by farmers (51 percent or greater) and use Missouri grain feedstocks. The financial support provided would equal 20 cents per gallon for the first 12.5 million gallons produced and 5 cents for the next 12.5 million gallons. A maximum annual grant would total $3.1 million. This program's financial support would only be provided for 60 months of operation. According to the Missouri Department of Agriculture, the cumulative total of producer incentive payments made under this program totaled $101.6 million through the end of the program in January 2013.

Another program that has benefited the Missouri ethanol industry is the New Generation Cooperative Incentive Tax Credit Program. These tax credits were used to induce farmer investment in new generation processing entities such as ethanol plants. Before tax credits could be issued, the processing entity must be organized, file an application and receive approval from the Missouri Agricultural and Small Business Development Authority (MASBDA). Up to $15,000 of tax credits (50 percent of a maximum $30,000 investment) could be received by a member of the new generation entity. As of August 2015, 4,117 tax credits had been issued to farmers investing in these new generation, Missouri farmer-owned ethanol projects. The value of tax credits issued to farmers totaled $12.7 million, according to MASDBA.

The Missouri Value-Added Grant program also provided grants for feasibility studies and other types of assistance to ethanol plants. Between 2000 and 2014, this program distributed $1.4 million to ethanol industry stakeholders, which used the funds for assistance in developing ethanol plants.

After considering the value added by Missouri's ethanol industry and the cost of programs created to support it, Exhibit 2.5.1 estimates the net benefit generated by the industry. Between 2000 and 2014, the ethanol industry created a total net benefit in Missouri that was estimated to be $1.086 billion, based on costs of the Missouri financial assistance programs and value added by the state's ethanol industry.

Exhibit 2.5.1 – Missouri's Benefits and Costs Related to the Ethanol Industry, 2000 to 2014

	Total (Millions)
Benefits	
Value added by ethanol industry	$1,202.0
Costs	
Ethanol Producer Incentive Fund	$101.6
New Generation Coop. Tax Credits	$12.7
Value-Added Grant Program	$1.4
Net benefit to Missouri	**$1,086.3**

2.6 Ethanol's Influence on Corn Prices, Land Values and Cash Rent Rates

Multiple studies have sought to quantify ethanol production's influence on land and cash rent values. This section summarizes research findings that suggest the extent to which the ethanol industry has influenced corn prices and, consequently, altered land value assumptions.

2.6.1 Ethanol Production and Corn Prices

As the ethanol industry opened markets for U.S. corn, research has indicated that corn prices responded positively to the new demand source. Corn price premiums and, consequently, the associated improved farmland ownership incomes represent one of four contributions that a new ethanol facility can make within a local economy, according to a University of Illinois paper. The other three contributions of a new ethanol facility are using local inputs to produce ethanol, allocating more land toward corn production and enabling greater cattle production (Low and Isserman, 2007). A 2012 study from Iowa State University summarized multiple research findings meant to measure corn price appreciation that could be attributed to ethanol production. Based on the findings analyzed, the Iowa State study referenced literature that suggested that 20 percent to 36 percent of total corn price growth could be attributed to the ethanol industry. Considering that USDA-reported average national corn prices increased by $2.37 per bushel between 2000 to 2005 and 2006 to 2011, these findings suggest that ethanol was responsible for $0.47 per bushel to $0.85 per bushel of the U.S. corn price increase. Based on five-year average U.S. corn production that totaled 12.6 billion bushels, ethanol production increased U.S. corn crop value by $5.9 billion to $10.7 billion (Hart, Otto and Hudak, 2012).

Within given locales, ethanol production has also created a noticeable change in corn prices. In Iowa, ethanol production capacity grew substantially as the renewable fuel industry developed. This new opportunity to deliver corn to ethanol facilities changed the relationship between Iowa and national corn prices. Traditionally, Iowa producers sold corn at a discount relative to average U.S. corn prices. From 2000 to 2005, the national corn price was $0.08 per bushel higher on average than the Iowa price. Between 2006 and 2011, however, the average U.S. corn price recorded a $0.03 discount per bushel relative to the Iowa average price. In 2011, the national average price had returned to a premium relative to the Iowa corn price, though (Hart, Otto and Hudak, 2012).

The extent to which ethanol facilities can pay well for ethanol production inputs, such as corn, depends on ethanol prices. To produce ethanol, facilities incur the greatest input expense when they buy corn. As a result, changes in ethanol prices and corn costs can sharply influence the ability for ethanol facilities to earn profit and maintain a positive cash flow (Ellinger, 2007). For an ethanol facility with 50 million gallon capacity per year, it would have a $1.57 per bushel breakeven point for corn purchases when ethanol is $1.10 per gallon, a $3.16 per bushel breakeven point for corn purchases when ethanol is $1.50 per gallon, a $4.74 per bushel breakeven point for corn purchases when ethanol is $1.90 per gallon and a $6.32 per bushel breakeven point for corn purchases when ethanol is $2.30 per gallon. Thus, ethanol prices increasing by $1.20 per gallon – from $1.10 per gallon to $2.30 per gallon – would elevate the facility's breakeven corn purchase price by $4.75 per bushel for a facility that can annually produce 50 million gallons of ethanol, given the assumptions set in this particular study (Eidman, 2007).

A given ethanol facility's production capacity also influences its ability to pay premiums for corn inputs. Based on the previous analysis that evaluated corn breakeven prices at varying ethanol price levels, a facility with twice the capacity could justify paying $0.20 more per bushel for corn than the smaller facility with 50 million gallon annual capacity could pay and still break even. The additional $0.20 per bushel for corn would apply to each ethanol price level evaluated (Eidman, 2007).

As corn prices have increased, producers have had renewed incentive to raise corn and capture the added value potential. For example, Iowa producers increased their corn production output by 36.3 percent between 2000 and 2011. During that same time period, Iowa ethanol production grew by nearly 741 percent. Typically, such production growth would have depressed prices. For the observed time at least, ethanol and corn demand maintained enough strength to continue to support high prices for both products (Hart, Otto and Hudak, 2012). The next section discusses the effect that corn price premiums realized from ethanol production will have on landowners.

2.6.2 Ethanol Production Effect and Land Values

Several explanations articulate the effect that corn prices and the ethanol value chain may have on land values. For example, authors from the Federal Reserve Bank of Kansas City-Omaha branch and Cornell University describe that land value determinations are based on the land's discounted future earnings due to land being a long-term capital asset. Because ethanol production creates a greater need for corn, a producer's expected corn returns increase when ethanol companies demand corn at their facilities. Farmland competition heightens as producers must choose to grow the higher priced corn or other crops. Ultimately, this competition strengthens prices for multiple commodity crops, not corn exclusively. If the industry has confidence that crop price gains will continue into the foreseeable future, then those increased expected returns will be capitalized and reflected in farmland values (Henderson and Gloy, 2008). Additionally, when producers earn higher corn prices, they may operate more profitably, which creates an incentive to produce more corn. Eventually, because corn production areas have finite farmland available – land is the limiting resource – Du (2008) reports that land values begin to reflect the elevated corn prices and profits.

Historically, ethanol production didn't immediately trigger strengthened land values. An Iowa State University analysis clearly articulated the influence that corn prices have had on cash rent and farmland values. It also explains that value capture shifts as the ethanol industry matures. In other words, the specific value chain stakeholders who realize great gains from ethanol production change as the ethanol industry and its value chain's limiting resources evolve. Because ethanol and crop production are commodity industries, their production tends to grow until producers no longer have the opportunity to profit significantly, and ultimately, profits accrue to those who have access to the resource most limiting in the value chain. When ethanol production first began, the industry had limited capacity. Operators who entered the ethanol production industry early earned good profits, but their successes attracted new entrants and enlarged the industry's capacity. At some point, however, production reaches a maximum and its price recedes, or the ethanol industry continues to demand corn and increases the crop's price (Hofstrand, 2008).

When too little corn is available, the ethanol value chain's limiting resource transitions from ethanol capacity to input corn supplies, and corn prices rise. Because ethanol facilities must pay more for corn, their profits weaken. Crop producers respond to higher corn prices by increasing production and requiring more production inputs, including seed, fertilizer and chemicals. At this stage, input suppliers benefit from heightened input use. Temporarily, they may charge more for inputs, but when competition rises and the industry increases production of inputs, prices for inputs are pressured in many cases. Ultimately, cropland is the ethanol value chain's limiting resource because producers can only grow corn to the extent that they have farmland available. As a result, producers compete for land on which to grow crops, and cash rental rates increase. By land owners earning greater returns for their cropland, the farmland that they own has greater value (Hofstrand, 2008).

An Iowa State University analysis illustrated the transition in ethanol profit allocation by reviewing data from late 2005 to mid-2008. The analysis indicates that ethanol production facilities earned their greatest revenue between late 2005 and late 2006. Later, producers began earning much greater prices for their corn. The analysis projected that long-term value created from ethanol production would benefit land owners, who could justify charging higher cash rental rates. If the ethanol industry were to constrict, then the Iowa State University publication suggests that a similar chain reaction would occur; however, value chain stakeholders would incur losses instead of earn profits. Ethanol facilities would first experience losses, and their losses would weaken corn demand and prices, which directly influence producers. Over time, landowners would absorb the losses as cash rental rates drop. If other corn demand sources, such as export markets, materialize as the ethanol market hypothetically weakens, however, then pursuing those new markets could blunt losses with which value chain stakeholders would otherwise need to contend (Hofstrand, 2008).

2.6.3 Land Returns by Geography

The previously cited literature explains a link between strengthened crop prices and higher land values. The following subsections organize research findings that describe the extent to which ethanol production has changed land values in various geographic areas.

Missouri

In Missouri, a 2006 study sought to articulate the effect that a northeastern Missouri producer-owned ethanol facility had on nearby corn prices and land values. Since 2000, the Northeast Missouri Grain Processors (NEMO) group has operated an ethanol facility near Macon, Mo. Structured as a new generation cooperative, NEMO Grain originally accepted members who would supply corn to the ethanol plant. Producer-owners would earn profit depending on the share of corn that they delivered to the facility. In 2002, NEMO Grain's denatured ethanol and distilled dried grains output totaled 22 million gallons and 66,000 tons, respectively (Fort and Parcell 2006).

The NEMO Grain case reflects a scenario when corn prices were estimated to increase because of an operational ethanol plant. Ultimately, the improved corn revenue potential available to producers would result in the marketplace capitalizing those higher corn prices into land. Farmers, too, would be willing to pay higher cash rents because they could realize more revenue per acre. Specifically, the study estimated direct and indirect price effects and arrived at a weighted average of the two. Relative to prices paid by the nearby Macon elevator, NEMO Grain paid $0.09 per bushel more on average during the observed period. This would be a direct price impact. The indirect effect addresses differences between elevators in Macon and Kansas City, Mo. The analysis found that operating an ethanol plant improved corn prices by more than $0.10 per bushel for the area surrounding Macon. When considering combined direct and indirect price impacts, corn prices increased $0.12 per bushel based on a weighted average (Fort and Parcell 2006).

Using several assumptions, including the $0.12 per bushel weighted average corn price increase, the study's authors built a model to estimate the extent to which land values in the nine-county area surrounding the ethanol facility would change because of ethanol production. The model estimated that land values would increase by $161 per acre in a year to three years after the facility began operating. Assumptions guiding this estimate were corn yields that average 110 bushels per acre, a trend yield that improves by one bushel per acre every three years, a 15-year facility life expectancy, a 6.5 percent interest rate and a 3 percent inflation rate. The study also evaluated actual land price changes based on Missouri land values survey data. Between 1999 and 2003, the net land value appreciation recorded in the nine-county region relative to comparison land totaled $169 per acre, which is similar to the previously mentioned estimate (Fort and Parcell, 2006).

Iowa

In many cases, Iowa led the country's ethanol boom, and land values have benefited from the ethanol industry's presence. An Iowa State University study assumes that ethanol production facilitated 22 percent to 39 percent of total Iowa farmland appreciation in the late 2000s into the early 2010s. In dollar terms, the ethanol industry's presence added an estimated $700 per acre to $1,260 per acre to Iowa farmland values (Hart, Otto and Hadak, 2012).

Indiana

A 2014 study from ABF Economics sought to measure Indiana's farmland value appreciation that could be traced to an ethanol production effect. In the previous two decades, Indiana agricultural land values had increased markedly, and growth was especially strong after the 2007 Renewable Fuel Standard took effect. ABF Economics created a model that quantified land value growth attributed to ethanol production. Between 2007 and 2013, the model estimated that ethanol production caused average Indiana farmland values to increase by $198 per acre. The model made this estimate by creating a back-cast that eliminated ethanol output and adjusted corn prices accordingly to reflect the ethanol industry's absence (Urbanchuk and Norvell, 2014).

The model used a regression equation that assessed Indiana farmland values from 1990 to 2012 and related them to the state's ethanol production, average corn yields, corn market price lagged by one year and the 10-year Treasury bill interest rate. The farmland value, corn price and interest rate data sets were adjusted for inflation, and the model also made adjustments for drought conditions during 1995 and 2012 and an ethanol production reduction during 1996 (Urbanchuk and Norvell, 2014).

2.6.4 Land Returns by Proximity to Ethanol Facility

If an ethanol facility operates near a given cropland tract, then that cropland area may experience elevated agricultural land values. This relationship is due to local crop basis patterns and transportation costs influencing farmland values (Henderson and Gloy, 2008). Thus, proximity could act as a variable that triggers a change in land values. Several studies further explore the issue.

To quantify whether land values change because of a nearby ethanol facility operating, the Illinois Society of Professional Farm Managers and Rural Appraisers assessed land values for northwest Illinois properties located near ethanol facilities. The 2007 study concluded that close proximity to an ethanol facility would increase land values by $250 per acre to $500 per acre. On a bushel basis, the premium would range from $0.05 to $0.10. If land located near an ethanol plant has more value, then the cash rent premium would be an estimated 3.5 percent of that higher value (Low and Isserman, 2007).

In Ohio, research indicates that proximity to an ethanol facility relatively recently was noted as a significant variable to affect land values. Before 2007, the model created by Ohio State University and USDA Economic Research Service researchers indicated that landowners couldn't expect that land assets near an ethanol facility would have any greater value. After 2007, however, land located within 5 kilometers to 13 kilometers – about 3.1 miles to 8.1 miles – of an ethanol facility had a marginal value that was $419 per acre greater, based on the study's modeling methods. The study also concluded that close proximity to a grain elevator or agricultural terminal would also have a positive marginal value for properties, and the data indicated such a relationship throughout the 2000s (Zhang, Irwin and Nickerson, 2012).

Another study used banker-reported land values from third quarter 2006 to second quarter 2007. Specifically, the research evaluated land value estimations from quarterly Agricultural Credit Survey responses collected within the Federal Reserve Bank of Kansas City's service area. Areas represented in the data set were Nebraska, Kansas, Oklahoma, Colorado, Wyoming, western Missouri and northern New Mexico. The area being studied had 30 ethanol plants and 18 percent of the U.S. ethanol production capacity in April 2007. One analysis included in the study measured the extent to which land values would change for each additional mile inserted between a given land location and an operational ethanol facility. For non-irrigated cropland, land values decreased by $1.44 per acre, or 0.13 percent, for each additional mile between the land itself and the ethanol facility during third quarter 2006. The drop in value per mile of distance increased to $2.14 per acre, or 0.16 percent, during second quarter 2007. For irrigated cropland, distance to an ethanol plant and irrigated cropland values had a significant relationship only in first quarter 2007 and second quarter 2007. During second quarter 2007, moving one mile from an operational ethanol production facility would reduce irrigated cropland values by $2.62 per acre, or 0.13 percent. Note the difference between these location effects for non-irrigated and irrigated land. For each mile removed from an ethanol production facility, irrigated cropland values would drop by $0.48 per acre more than non-irrigated cropland values, based on the second quarter 2007 data analysis. As a percentage, however, the drop was slightly larger for the non-irrigated cropland (Henderson and Gloy, 2008).

As another way to measure the effect of land location relative to ethanol facility location, the study that included price data from the Federal Reserve Bank of Kansas City region evaluated land prices for tracts located within 25-mile increments of an ethanol facility. Between first quarter 2006 and first quarter 2007, non-irrigated land values for areas within 50 miles of an operational ethanol production facility grew 12.6 percent. Value gains showed significant differences for land areas within 50 miles to 75 miles of an ethanol facility but little difference for land areas within 25 miles to 50 miles of a facility (Henderson and Gloy, 2008).

Competition represents another factor that possibly influences cropland values. As an example, if a given area has multiple ethanol facilities that operate, then cropland values in that area may benefit from greater value appreciation because those multiple facilities would compete for purchasing corn feedstock material. To simulate competition, the study assessing land value data from the Federal Reserve Bank of Kansas City's service area measured whether the variable "number of ethanol plants operating within 50 miles of the banker respondent" had an effect on cropland values. For both non-irrigated and irrigated cropland, the number of plants variable had a positive and significant effect on cropland values (Henderson and Gloy, 2008). This finding indicates that cropland in an area with multiple ethanol facilities would likely be more expensive than cropland in an area with a single ethanol facility.

Despite several studies identifying a connection between ethanol production and land values, other studies haven't found such linkages. For example, using 2004 to 2008 sales data, one study assessed values for 961 farmland tracts located in eight northeastern Nebraska counties. Two corn ethanol plants operated within this area. The study's authors hypothesized that farmland parcels located near ethanol production facilities would have greater values than equivalent parcels with increased distance from ethanol plants. The models created for the study didn't support the hypothesis, however (Blomendahl, Perrin and Johnson, 2011). Thus, the degree to which ethanol facilities may alter nearby land values may vary by location.

2.6.5 Ethanol Production and Cash Rental Rates

As suggested earlier, when producers have a greater opportunity to profitably produce corn, they may increase their cash rent bids in order to have enough land to expand their production output and capture additional profits. A study conducted at Iowa State University used the variable profit function to assess county-by-county cash rental rates from 1987 to 2007. The results communicate the extent to which cash rental rates may rise in the short term and long term given a $1 increase in the corn price. If the corn price were to increase by $1 per bushel in the short run, then the study estimates a corresponding $50 per acre increase in the cash rental rate. From a long-run perspective – an estimated four-year period – increasing corn prices by $1 per bushel would facilitate cash rental rate increases that range from $103 per acre to $112 per acre. Local rental markets would be primarily influenced by the national futures price; the plants operating wouldn't likely have a significant local influence on cash rents (Du, 2008).

The Du (2008) paper suggests that monitoring cash rental rates has had growing importance because land tenure has increasingly evolved to involve more tenant operators who rent properties. Because land owners may not necessarily reside locally, higher land returns may only partially benefit the local economy (Low and Isserman, 2007). Additionally, unlike land values, cash rental rates would be less prone to having an asset bubble develop, and transaction costs aren't as significant. Thus, rental rates may more closely "reflect optimal pricing behavior" (Du, 2008).

2.6.6 Missouri's Cropland Value

Missouri has seen a significant increase in cropland value during the past fifteen years (Exhibit 2.6.6.1). Year to year cropland value increases were the greatest in 2006/2007, 2011/2012 and 2012/2013 years, which reflected a 15.9 percent, 11.8 percent and 12.2 increase in land value, respectively. In 2015, Missouri's average cropland value was $3,810 per acre, which was the same in the prior year.

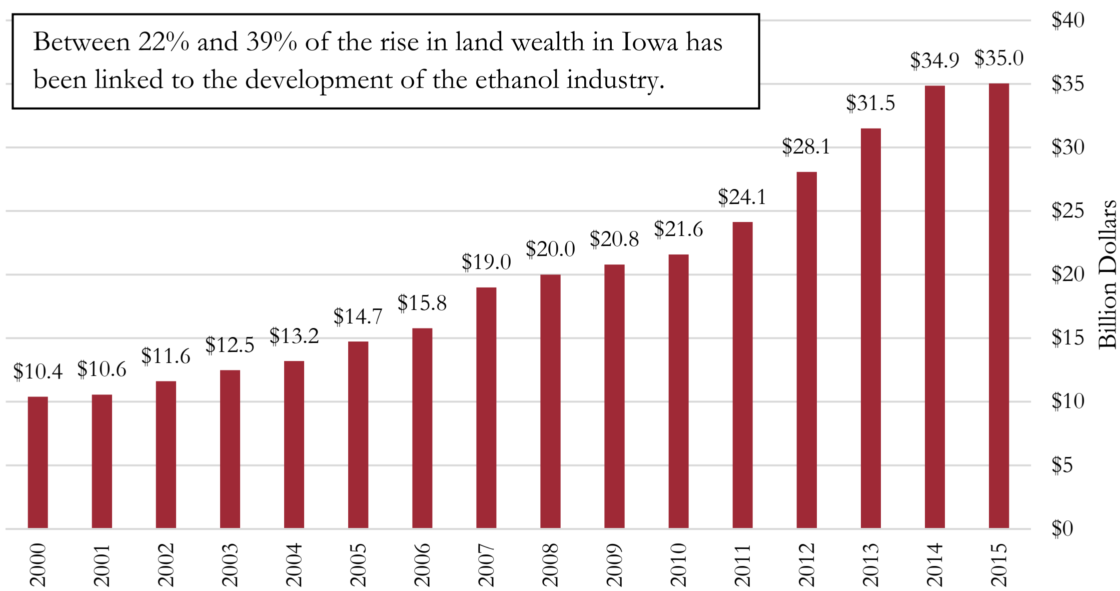
Exhibit 2.6.6.1 – Missouri Cropland Value per Acre, 2000 to 2015

Source: USDA, National Agricultural Statistics Service

Farmers have benefited from increased wealth as land prices have increased. Exhibit 2.6.6.2 shows the value of Missouri's corn and soybean cropland. In 2015, Missouri corn and soybean acreage was estimated to be worth $35 billion dollars, up from $10.4 billion dollars in 2000.

Iowa State University (Hart, Otto and Hadak, 2012) estimated Iowa's farmland appreciated 22 percent to 39 percent due to ethanol production between the late 2000s into the early 2010s. If one assumes the impact of the ethanol industry buildout in Missouri has similarly accounted for approximately 30% of the increase in the value of Missouri's corn and soybean farmland, then the ethanol industry may be responsible for a $5 billion to $7 billion dollar rise in wealth for Missouri cropland owners during this period.

Exhibit 2.6.6.2 – Missouri Corn and Soybean Land, Total Value, 2000 to 2015



Source: USDA, National Agricultural Statistics Service and Farm Service Agency

III. Economic Contribution of Missouri Corn and Ethanol Industries

Collectively, the corn farming and ethanol industries are significant economic contributors to Missouri's economy. Previous chapters of this report discussed both industries independently. This section, however, will summarize their combined impact because they're interlinked.

From 2000 to 2014, the combined Missouri corn farming and ethanol industries contributed nearly $13.4 billion in value to the state's economy and provided $6.2 billion in labor income.

Exhibit 3.1 – Total Economic Contribution of the Missouri Corn and Ethanol Industries

Year	Employment (jobs)	Value-Added (millions)	Labor Income (millions)
2000	30,279	$553	$223
2001	28,955	$537	$219
2002	34,294	$536	$152
2003	32,002	$647	$273
2004	32,078	$893	$477
2005	22,861	$658	$353
2006	31,933	$791	$352
2007	59,352	$1,440	$634
2008	31,019	$1,251	$337
2009	30,082	$1,231	$332
2010	31,461	$860	$510
2011	33,371	$1,039	$584
2012	26,511	$814	$525
2013	21,219	$882	$522
2014	23,486	$1,269	$710
	Total	**$13,401**	**$6,203**

Note: totals may not add due to rounding
Source: University of Missouri Extension, Commercial Agriculture Program, using data from USDA and IMPLAN

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