

# Introduction

## *tenfold increase in production, 1995-2014*

The U.S. Department of Energy data on Nebraska's ethanol production started in 1985 at 9 million gallons per year. Ten years later in 1995 it was 200 million gallons as shown below. A little over ten years later starting in 2007, the big jump in production was 858 million gallons, and five years later by 2011 it was 2,062 million. The twenty year growth from 1995 to 2014 was approximately tenfold. Since 2007 the effects on Nebraska's economy and rural areas have been both sustained and substantial.

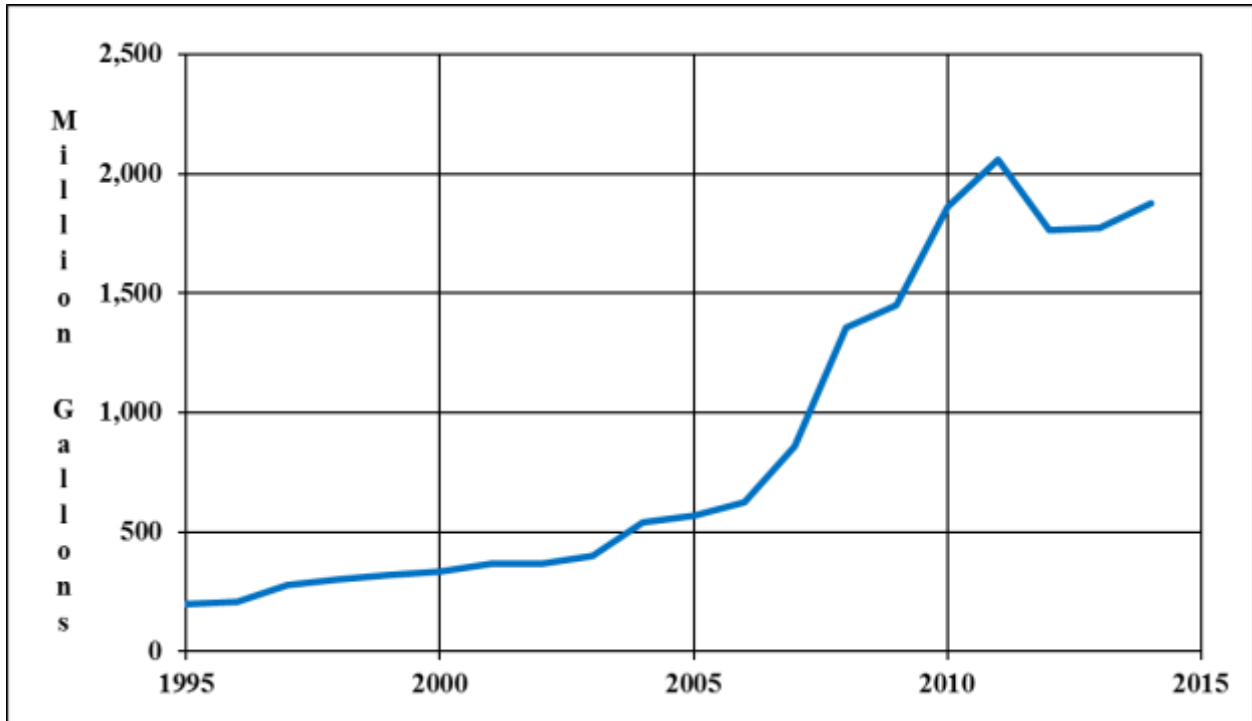


Figure 1. Ethanol Production in Nebraska, 1995-2014<sup>1</sup>

The purpose of this economic study is to estimate for a five year period the value of production and compare that value to major commodity production values in Nebraska. In addition, the study will measure productive capacity, employment, net returns, in-state utilization and out-of-state shipments. The economic impacts are composed of direct and indirect effects associated with output, employment, labor and indirect business taxes.<sup>2</sup>

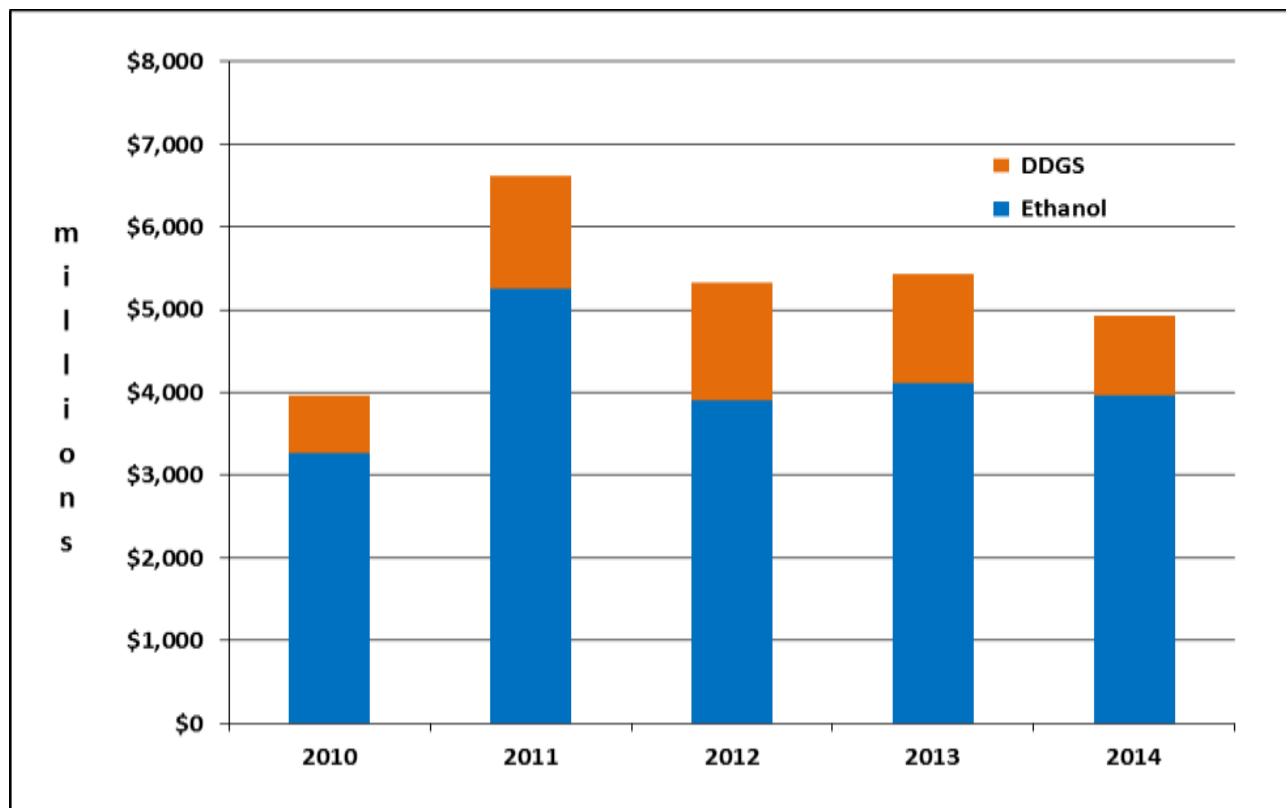
<sup>1</sup> Sources of data and information for all tables and figures are documented in Appendix 2.

<sup>2</sup> The economic impacts are based on the business operations that take place inside the ethanol plant gate. No impacts were estimated by reaching down to the farm level that would be based on higher prices for corn, an improved cash-futures basis, higher farm incomes and land values and their effects on the local economy, etc.; or reaching upward to the retail level and estimating the effects of price savings from having ethanol in the motor fuel supply and being less dependent on foreign oil.

## Value of Production

**\$5 billion per year**

In the U.S., Nebraska is the second largest ethanol-producing state with Iowa being first. As shown in *Figure 2* for the past five years, Nebraska’s value of production for ethanol and dried distillers’ grain with solubles (DDGS) ranged from slightly under \$4 billion to over \$6.6 billion with the last three years averaging close to \$5 billion per year.



**Figure 2. Value of Production for Ethanol and Dried Distillers’ Grain**

**2,062 million gallons in 2011**

Annual ethanol and distillers’ grain production peaked in 2011 at 2,062 million gallons and 6.54 million tons, respectively, as shown in *Table 1*. With the drought of 2012, a reduction in the corn supply caused higher corn prices and increased input costs for the production of ethanol and distillers’ grain. Ethanol production fell to a five-year low of 1,763 million gallons along with a low of 5.59 million tons for distillers’ grain.

**Table 1. Value of Production for Ethanol and Dried Distillers' Grain<sup>3</sup>**

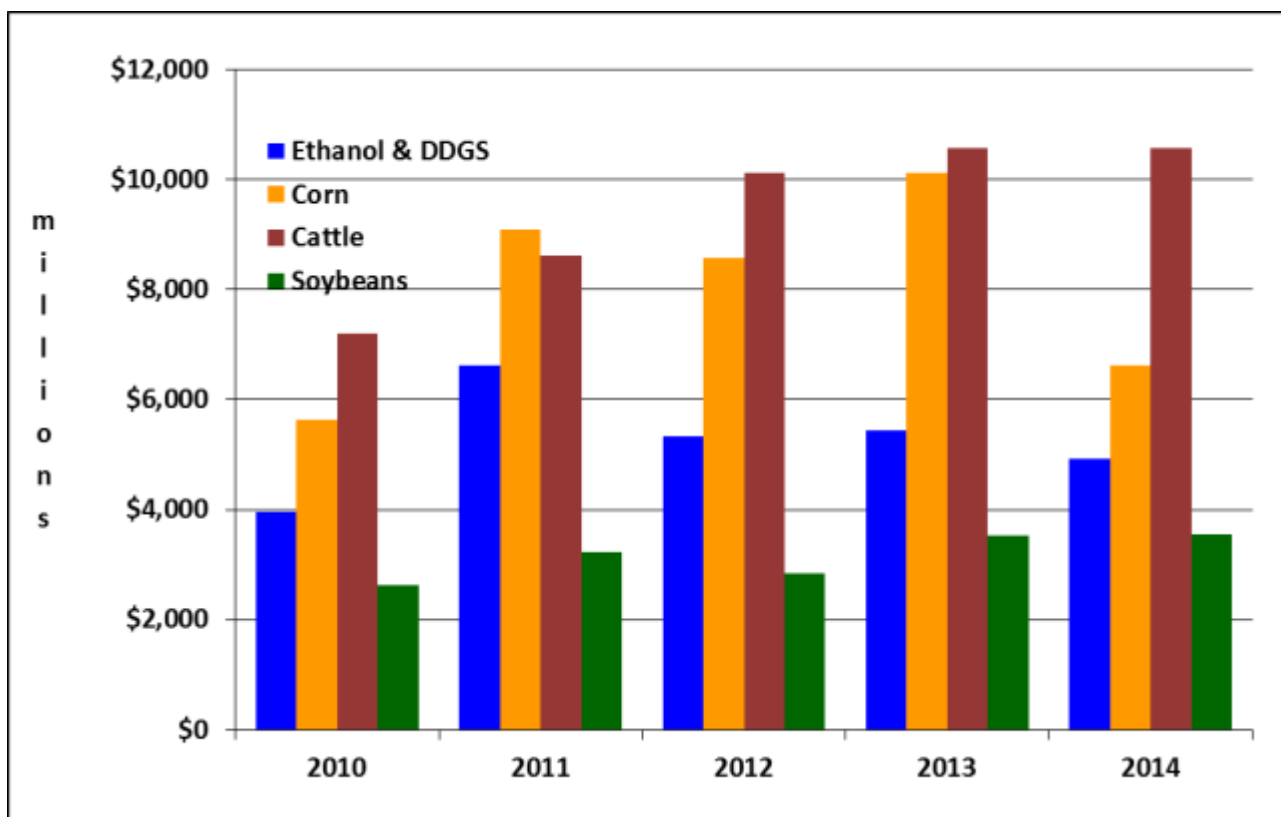
	<u>2010</u>	<u>2011</u>	<u>2012</u>	<u>2013</u>	<u>2014</u>
<b><u>Ethanol:</u></b>					
Annual Production (mil gals)	1,863	2,062	1,763	1,773	1,882
Annual Average Price FOB Plant (\$/gal)	<u>\$1.76</u>	<u>\$2.55</u>	<u>\$2.21</u>	<u>\$2.32</u>	<u>\$2.11</u>
Value of Ethanol Production (mil \$)	\$3,271	\$5,251	\$3,904	\$4,118	\$3,971
<b><u>Dried Distillers' Grain (DDGS):</u></b>					
Annual Production (mil tons)	5.91	6.54	5.59	5.62	5.97
Annual Average Price (\$/ton)	<u>\$117.18</u>	<u>\$209.22</u>	<u>\$255.58</u>	<u>\$234.74</u>	<u>\$161.44</u>
Value of DDGS Production (mil \$)	\$692	\$1,367	\$1,428	\$1,319	\$963
<b><u>Corn Oil:</u></b>					
Annual Production as of 03/2015 (tons)	-	-	-	-	22,314
Annual Average Price (\$/ton)					<u>\$739.48</u>
Value of Corn Oil Production (mil \$)					\$17
<b><u>Total Value:</u></b> (mil \$)	\$3,963	\$6,619	\$5,332	\$5,437	\$4,951

## Comparative Size

***67% of the value of  
corn production and  
57% of cattle sales***

Figure 3 and Table 2 show comparisons of the production value for ethanol and distillers' grain to the values for corn produced, cattle sales, and soybean production in Nebraska. The ethanol industry produces a value that averages 67 percent of the value of all corn produced and 57 percent when compared to cattle sales. Over the past five years ethanol and distillers' grain production exceeded the value of soybean production.

<sup>3</sup> Ethanol plants continue to assimilate technology that increases efficiency and diversifies the production portfolio including corn oil and carbon dioxide. The production and sale of these products increases revenue and adds additional value to the grain processed at ethanol plants. With the exception of the corn oil revenue impact in 2014, the impact of these and other secondary co-products of ethanol production are not included in the economic impacts reported.



**Figure 3. Comparative Values of Production**

**Table 2. Comparative Values of Ethanol & DDGS to Corn, Cattle and Soybeans**

	<u>2010</u>	<u>2011</u>	<u>2012</u>	<u>2013</u>	<u>2014</u>
<b><u>Ethanol, DDGS &amp; Corn Oil</u></b> (mil \$)	\$3,963	\$6,619	\$5,332	\$5,437	\$4,957
<b><u>Corn</u></b>					
Corn Production (mil bu)	1,469	1,536	1,292	1,624	1,602
Annual Average Price (\$/bu)	<u>\$3.83</u>	<u>\$5.92</u>	<u>\$6.63</u>	<u>\$6.23</u>	<u>\$4.13</u>
Value of Corn Production (mil \$)	\$5,630	\$9,088	\$8,568	\$10,114	\$6,616
<b><u>Cattle</u></b>					
Sales of Cattle (mil \$)	\$7,194	\$8,615	\$10,114	\$10,562	\$10,562
<b><u>Soybeans</u></b>					
Soybean Production (mil bu)	268	261	207	255	289
Annual Average Price (\$/bu)	<u>\$9.82</u>	<u>\$12.33</u>	<u>\$13.73</u>	<u>\$13.82</u>	<u>\$12.28</u>
Value of Soybean Production (mil \$)	\$2,630	\$3,221	\$2,844	\$3,526	\$3,548

## Productive Capacity and Employment

**2,077 mgpy  
capacity and  
1,301 jobs**

Table 3 lists the 24 plants that are producing ethanol and their permitted capacity which is on record with the Nebraska Department of Environmental Quality. Nebraska's capacity as of June 2014 stands at 2,077 million gallons per year. The total state employment, measured in full-time equivalents at each facility, is 1,301.

**Table 3. Permitted Capacity for Ethanol Production and Facility Employment, June 2014**

<b>Company</b>	<b>Nebraska location</b>	<b>Permitted Capacity (mgpy)</b>	<b>Facility Employment (FTE)</b>
Abengoa Bioenergy Corp.	Ravenna	80	62
Abengoa Bioenergy Corp.	York	55	58
ADM Corn Processing	Columbus	400	285
Aventine (Nebraska Energy)	Aurora	50	43
Aventine Aurora West, LLC	Aurora	113	50
Bridgeport Ethanol, LLC	Bridgeport	54	22
Cargill, Inc.	Blair	198	68
Chief Ethanol Fuels	Hastings	69	60
Cornhusker Energy	Lexington	50	50
E Energy Adams, LLC	Adams	55	43
Flint Hills Resources	Fairmont	115	45
Green Plains, LLC	Atkinson	44	30
Green Plains, LLC	Central City	100	47
Green Plains, LLC	Ord	50	35
Green Plains, LLC	Wood River	115	50
Husker Ag, LLC	Plainview	78	47
KAAPA Ethanol, LLC	Minden	59	34
Louis Dreyfus Commodities	Norfolk	53	40
Midwest Renewable Energy, LLC	Sutherland	25	30
Nebraska Corn Processing, Inc.	Cambridge	44	38
Siouxland Ethanol, LLC	Jackson	60	34
Standard Ethanol, LLC	Madrid	55	36
Trenton Agri Products, LLC	Trenton	45	34
Valero Renewable Fuels	Albion	110	60
<b>Total</b>		<b>2,077</b>	<b>1,301</b>

Does not include the development project of E-3 Biofuels at Mead, NE with a permitted capacity of 24 million gallons per year.

## Net Returns

### *Commodity type of business with variable returns*

The estimated net returns for a representative ethanol plant are shown in *Figure 4* for the years 2010 – 2014. The net returns include the revenue from the sale of ethanol and dried distillers' grain less the cost of corn along with the variable and fixed costs. As seen in the figure the net returns were briefly over \$1 per gallon in 2014, but for most of 2012 were in the negative range of around 10 to 15 cents per gallon. The variability in net returns reflects that the ethanol industry is a commodity type of business with returns highly dependent on input costs and output prices over which the industry has little or no control.

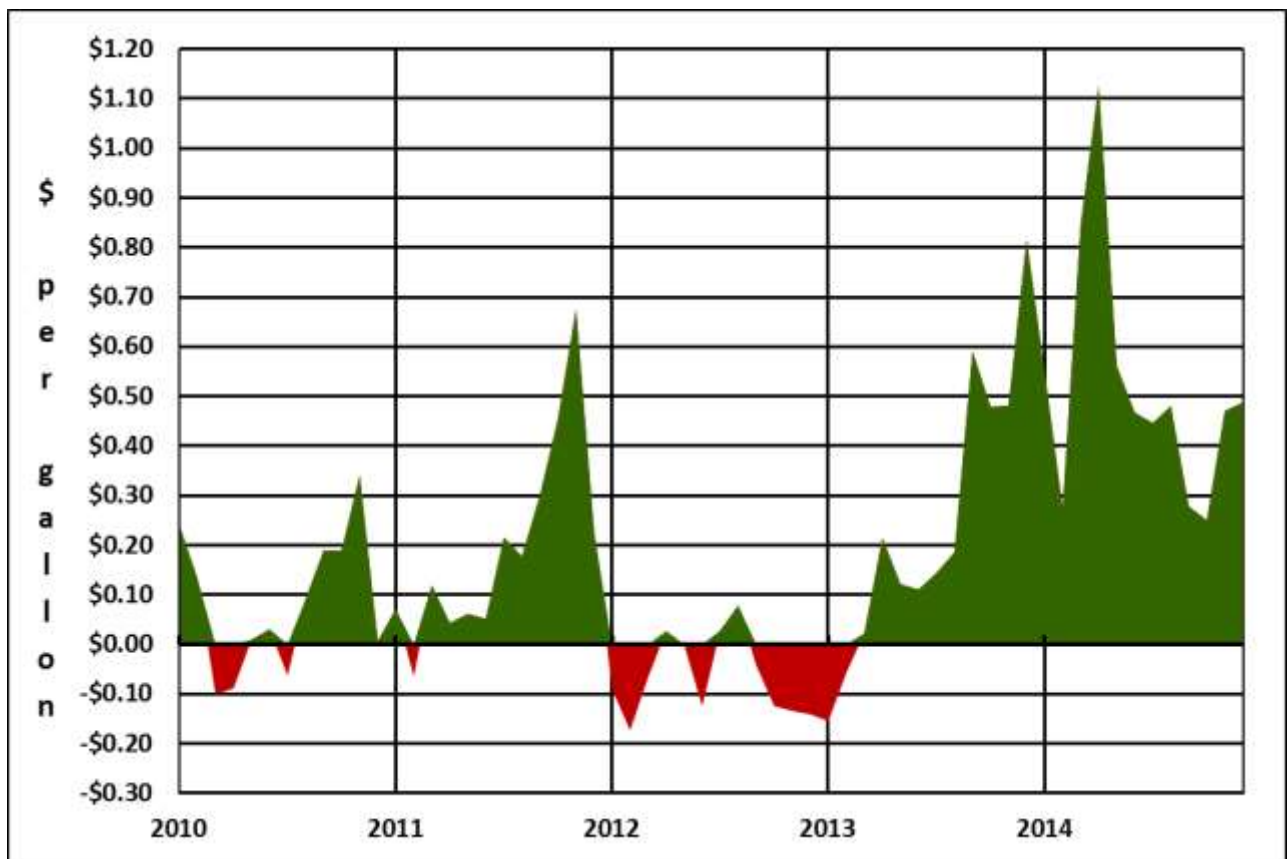


Figure 4. Net Returns for Ethanol and DDGS

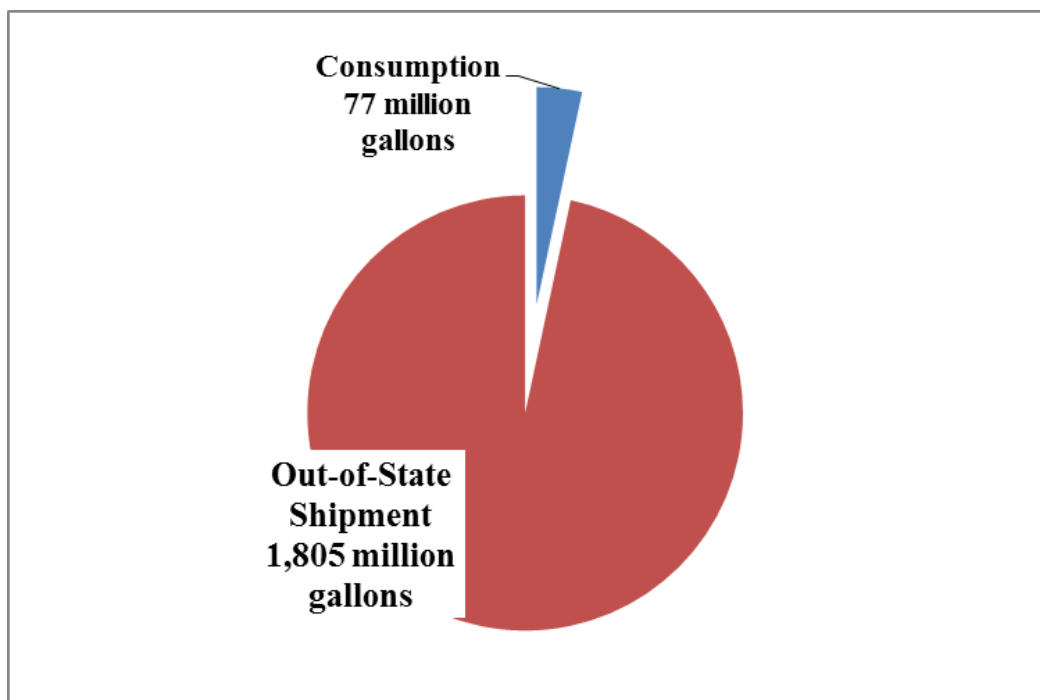
## Utilization of Ethanol

***Nebraska [is] one of the largest exporters of bioenergy***

As shown in *Table 4* and *Figure 5*, only 77 million gallons of ethanol were consumed within the state and 1,805 million gallons were shipped out in 2014. The large amount of ethanol production in Nebraska results in 96 percent being shipped out of state and makes Nebraska one of the largest exporters of bioenergy. The value of production within Nebraska in 2014 was estimated at \$3,971 million of which \$3,815 million came from out-of-state sales.

**Table 4. Ethanol Production and Utilization**

	<u>2010</u>	<u>2011</u>	<u>2012</u>	<u>2013</u>	<u>2014</u>
Annual Production (mil gals)	1,863	2,062	1,763	1,773	1,882
Consumption of Ethanol in Nebraska (mil gals)	<u>65</u>	<u>67</u>	<u>66</u>	<u>64</u>	<u>77</u>
Ethanol Surplus for out-of-state shipment (mil gals)	1,798	1,995	1,697	1,709	1,805
Percent of Ethanol production shipped out-of-state	97%	97%	96%	96%	96%
Value of Ethanol for out-of-state shipment (mil \$)	\$3,157	\$5,081	\$3,757	\$3,969	\$3,815



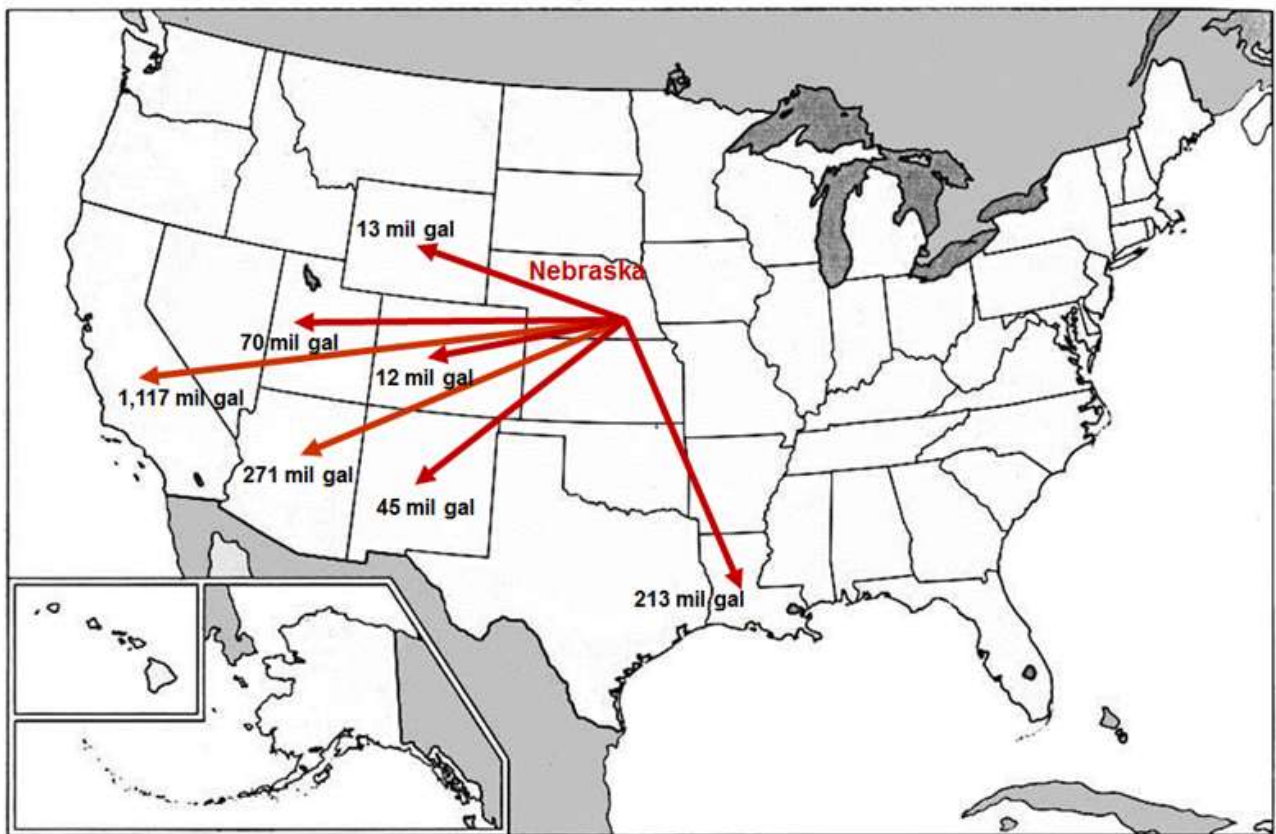
**Figure 5. Ethanol Consumption and Out-of-State Shipment, 2014**





A mathematical programming model was built to estimate the movement of ethanol from surplus states to deficit states, and to the ports of export, with the goal of minimizing transportation costs. The model put Nebraska's ethanol surplus in competition with other surplus producing states, like Iowa and South Dakota, in meeting the needs of the deficit states and the export market.

Shown in *Figures 7 and 8* are the projected movements from Nebraska and the respective gallons that would be shipped. It is estimated that Nebraska would primarily serve western and southwestern states. California would receive the largest shipment of 1,117 million gallons followed by Arizona at 271 million and Louisiana at 213 million. Nebraska would also export ethanol with the largest amount estimated to go through the Houston-Galveston port at 40.3 million gallons.



**Figure 7. Estimated Ethanol Movements from Nebraska to Deficit States**



**Figure 8. Estimated Ethanol Movements from Nebraska to Ports of Export**

The projected movements shown in *Figures 7 and 8* would occur under a set of ideal conditions – instant availability of supply, immediate consumption that is known for certain, and ample availability of carriers. Actual movement and amounts would vary somewhat from these projections due to seasonality of demand, variability of plant production, availability of carriers, and export market conditions, etc. Yet, the projections help visualize Nebraska’s geographical competitiveness relative to other surplus states.

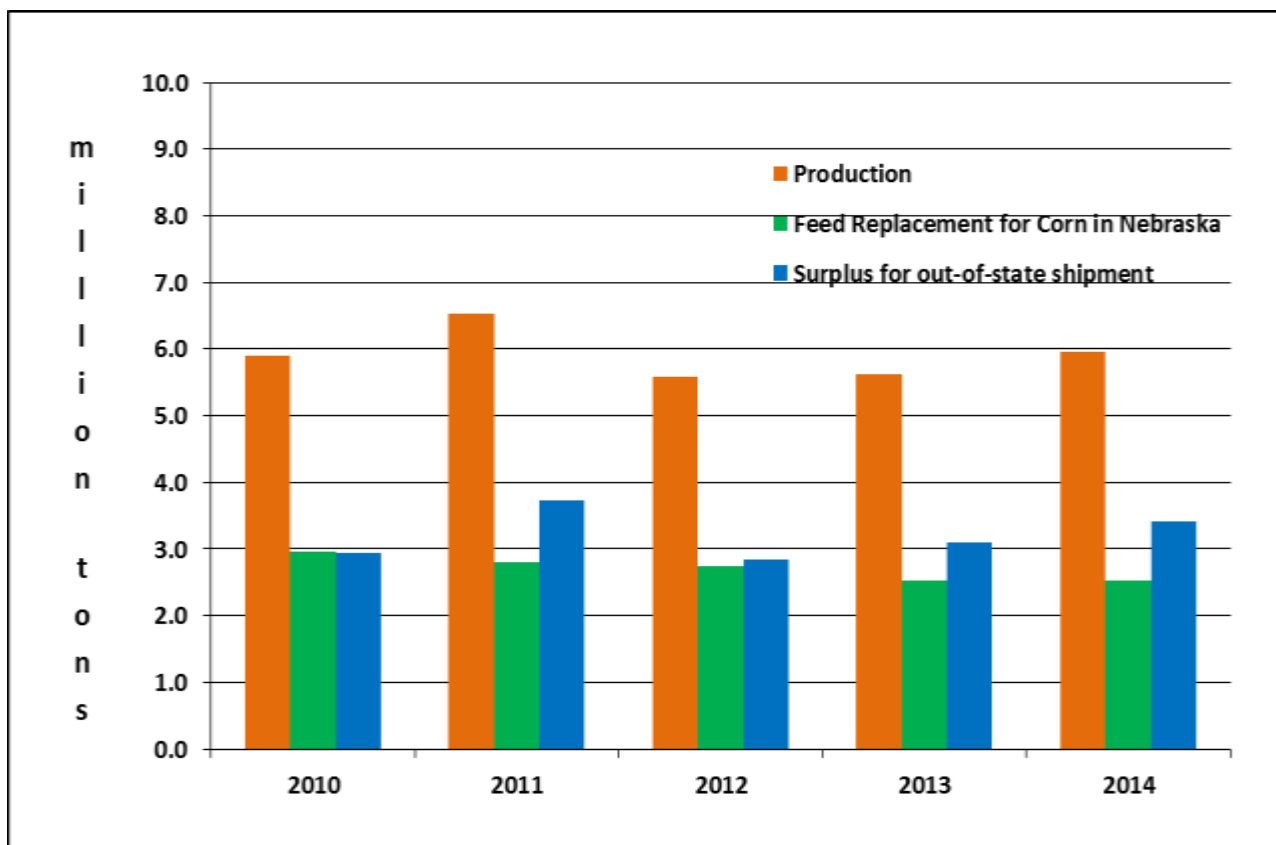
## Utilization of Dried Distillers’ Grain

***Nebraska is a surplus state for distillers’ grains***

Nebraska is also a surplus state for distillers’ grain. Based on a feed grain ration using the respective maximum inclusion rates for cattle, hogs, dairy and poultry in Nebraska, the amount of DDGS needed to replace corn was estimated at 2.53 million tons for 2014. See *Table 5* and *Figure 9*. With Nebraska’s production of 5.97 million tons and full adoption by livestock feeders, this left a surplus for out-of-state shipment of 3.44 million tons in 2014, and the value of those out-of-state shipments was estimated to be \$555 million.

**Table 5. Dried Distillers' Grain Production and Utilization**

	<u>2010</u>	<u>2011</u>	<u>2012</u>	<u>2013</u>	<u>2014</u>
Annual Production (mil tons)	5.91	6.54	5.59	5.62	5.97
DDGS Needed to Replace Corn for Livestock Feed in Nebraska (mil tons)	<u>2.97</u>	<u>2.81</u>	<u>2.74</u>	<u>2.53</u>	<u>2.53</u>
DDGS Surplus for out-of-state shipment (mil tons)	2.94	3.73	2.85	3.09	3.44
Percent of DDGS production shipped out of state	50%	57%	51%	55%	58%
Value of DDGS for out-of-state shipments (mil \$)	\$344	\$780	\$727	\$725	\$555



**Figure 9. DDGS Production and Utilization**

## Aggregate Economic Characteristics

*Table 6* describes key aggregate economic characteristics of the Nebraska ethanol industry including physical production and associated value, employment, labor income, and business tax revenue. These aggregate characteristics are the foundation for determining the direct economic impact of the industry.

One component of the direct economic impact is the Total Value of ethanol and distillers' grain production. In 2014 that value was \$4,951 million and included corn oil.

***\$71 million  
[directly]  
associated with  
1,301 jobs***

Two other components are employment and the associated labor income. Ethanol production is a capital and input-intensive process, implying that billions of dollars of production can be achieved with a limited number of employees. In 2014 there were 1,301 full time equivalent employees for the 24 plants. Under labor income given in *Table 6*, the prevailing wages, salary and benefit information indicates there was \$71 million associated with those jobs. The estimated proprietor's income for the facilities was \$34 million for a combined total of \$106 million.

Indirect business taxes are another component and they were estimated at \$13 million based on data from the Nebraska Department of Revenue from property taxes paid by each facility.

**Table 6. Annual Output, Employment, Labor Income and Indirect Business Taxes**

<b>Annual Output</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>
<b>Ethanol:</b>					
Annual Production (mil gals)	1,863	2,062	1,763	1,773	1,882
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Value of DDGs Production (mil \$)	\$692	\$1,367	\$1,428	\$1,319	\$963
<b>Corn Oil:</b>					
Annual Production as of 03/2015 (tons)	-	-	-	-	22,314
Annual Average Price (\$/ton)					<u>\$739.48</u>
Value of Corn Oil Production (mil \$)					\$17
<b>Total Value:</b> (mil \$)	\$3,963	\$6,619	\$5,332	\$5,437	\$4,951
<b>Employees</b>	1,291	1,429	1,222	1,229	1,301
<b>Labor Income</b> (mil \$)	\$105	\$116	\$99	\$100	\$106
Wages & Salaries including Benefits (mil \$)	\$71	\$78	\$67	\$67	\$71
Proprietors' Income (mil \$)	\$34	\$38	\$32	\$33	\$34
<b>Indirect Business Taxes, IBT, Effects</b> (mil \$)	\$15	\$15	\$15	\$14	\$13

***96% of ethanol  
and 58% of DDGS  
...were exported  
out of state***

Most production at Nebraska ethanol facilities results in a net positive economic impact for the state. This is because 96 percent of the ethanol produced and 58 percent of the dried distillers' grain produced in 2014 were exported out of state. Sales outside of the state represent a direct economic impact by bringing new money into the state economy.

## **Economic Impact Analysis and IMPLAN**

The aggregate economic characteristics described above are the first part in estimating the total economic impact on Nebraska. An additional "multiplier" impact occurs as money brought into the economy circulates further within the state, yielding additional business sales, labor income and employment. These multiplier impacts are in two forms: indirect impacts and induced impacts<sup>4</sup>.

Indirect economic impacts reflect additional economic activity due to business purchases, for example, the spending by ethanol plants on supplies and services. Indirect economic impacts can be estimated using the IMPLAN model. It is a model that can be used to provide estimates of the indirect economic impacts for businesses in over 400 industries.

Induced economic impacts reflect additional economic activity due to household purchases. For example, workers at ethanol plants spend their wages and salaries at businesses throughout the economy. The IMPLAN model can also be used to estimate the induced economic impacts.

The sum of the direct, indirect and induced economic impacts gives the total economic impact. A more complete discussion of the economic impact methodology is provided in Appendix 1.

## **Input-Output Multipliers**

*Table 7* shows the relative size of direct, indirect and induced impacts for each \$1 million in sales of the key economic concepts: output (sales), employment, labor income (wages, salaries, benefits and proprietor income) and indirect business taxes (primarily property taxes)<sup>5</sup>.

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<sup>4</sup> The current study utilizes a method for analyzing economic impact which is broadly consistent with the approaches taken in recent national studies or in studies of nearby states such as Iowa, South Dakota, Minnesota and Illinois (Hart, Otto and Michael Hudak, 2008; Taylor and Elliot, 2012; Ye, 2008; Low and Isserman, 2009), as well as in Nebraska (Lemke, 2014). In particular, the surveyed studies also used the IMPLAN model to analyze the impact of the ethanol industry on the local or national economy, in terms of employment, income and output. Most surveyed studies also estimated and reported direct, indirect and induced impacts. Other topics considered in one or more of the studies include the history of ethanol industry in a particular state, and the relationship between the ethanol industry and corn values, land values and farm income.

<sup>5</sup> The table design follows from Lemke, Kenneth, 2014.

**Table 7. Input-Output Multipliers Derived for Nebraska Ethanol Plants**

<b>Multipliers<sup>a</sup></b>	<b>Direct</b>	<b>Indirect</b>	<b>Induced</b>	<b>Total</b>
Output (mil \$)	1.0000	0.1051	0.0359	1.1410
Employment	0.2200	0.3400	0.2900	0.8500
Labor Income (mil \$)	0.0186	0.0331	0.0118	0.0635
Indirect Business Taxes (mil \$)	0.0026	0.0049	0.0017	0.0091

The multipliers are calculated using the data from the Nebraska IMPLAN model.

<sup>a</sup> Direct, Indirect, Induced and Total effects are per million dollars of output.

The indirect economic impact from industry output is approximately 10.5 percent as large as the direct economic impact from output (see the Output row and the Indirect column entry of 0.1051 for 10.5 percent). The induced economic impact is approximately 3.6 percent of the direct economic impact. These relatively small indirect and induced impacts reflect the fact that corn is the primary input in producing ethanol. Ethanol plant purchases of corn have very little economic impact on the state given that most land utilized to grow corn would have grown corn or other crops even in the absence of demand from ethanol plants. The indirect impact estimates, therefore, primarily reflect purchases of other inputs such as water or chemicals.

As was noted for *Table 6*, ethanol production is a capital and input-intensive industry so there is relatively little employment and wages for each \$1 million of production. There is \$18,600 in labor income (*Table 7*, Labor Income row and Direct column multiplier of 0.0186 times \$1million) associated with each \$1 million in ethanol plant sales. The indirect labor income impact is \$33,100 in labor income for each \$1 million in ethanol plant sales. The induced impact is \$11,800. Therefore, there is a total labor income impact of \$63,500 associated with each \$1 million in ethanol plant sales.

***Nearly 1 job for each \$1 million in ethanol plant sales***

Adding together direct, indirect, and induced employment impacts, there is nearly one job (0.85 jobs) in the Nebraska economy for each \$1 million in ethanol plant sales.

## Direct Effects

*Table 8* shows estimated economic impacts for the years 2010 through 2014 based on the aggregate economic characteristics in *Table 6* and the input-output multipliers in *Table 7*. In *Table 8* under the row of Output Effects, the Direct Output values represent out-of-state sales of ethanol and dried distillers' grain. For example, the Direct Output value of \$4,377 million in 2014 is 88 percent of the Total Value of \$4,951 million reported in *Table 6*. This is because 96 percent of the ethanol produced and 58 percent of the distillers' grain were out-of-state sales. In a similar manner, the values in the rows for Direct Employment, Direct Labor Income and Direct Indirect Business Taxes show their portion of respective effects supported by out-of-state sales. The entries for these line items are quite close to the corresponding industry activity totals reported in *Table 6*.

**Table 8. Estimated Economic Impacts Associated with Nebraska's Ethanol Industry**

	<u>2010</u>	<u>2011</u>	<u>2012</u>	<u>2013</u>	<u>2014</u>
<b>Employment Effects</b>					
Direct Employment (FTE)	1,147	1,268	1,026	1,058	1,150
Indirect Employment	1,772	1,960	1,585	1,634	1,777
Induced Employment	<u>1,511</u>	<u>1,672</u>	<u>1,352</u>	<u>1,394</u>	<u>1,516</u>
<b>Total Employment (FTE)</b>	<b>4,430</b>	<b>4,900</b>	<b>3,963</b>	<b>4,086</b>	<b>4,443</b>
<b>Labor Income Effects (mil \$)</b>					
Direct Labor Income	\$93	\$103	\$83	\$86	\$93
Indirect Labor Income	\$166	\$184	\$149	\$153	\$167
Induced Labor Income	<u>\$59</u>	<u>\$65</u>	<u>\$53</u>	<u>\$55</u>	<u>\$59</u>
<b>Total Labor Income Effects</b>	<b>\$319</b>	<b>\$352</b>	<b>\$285</b>	<b>\$294</b>	<b>\$319</b>
<b>Output Effects (mil \$)</b>					
Direct Output	\$3,519	\$5,873	\$4,476	\$4,679	\$4,377
Indirect, Output	\$370	\$617	\$470	\$492	\$460
Induced, Output	<u>\$126</u>	<u>\$211</u>	<u>\$161</u>	<u>\$168</u>	<u>\$157</u>
<b>Total Output</b>	<b>\$4,015</b>	<b>\$6,701</b>	<b>\$5,107</b>	<b>\$5,338</b>	<b>\$4,994</b>
<b>Indirect Business Taxes Effects (mil \$)</b>					
Direct Indirect Business Taxes	\$13	\$13	\$13	\$12	\$12
Indirect, Indirect Business Taxes	\$25	\$25	\$24	\$23	\$22
Induced, Indirect Business Taxes	<u>\$9</u>	<u>\$9</u>	<u>\$8</u>	<u>\$8</u>	<u>\$7</u>
<b>Total Indirect Business Taxes</b>	<b>\$47</b>	<b>\$47</b>	<b>\$45</b>	<b>\$43</b>	<b>\$41</b>

**Source:** Computed from the data presented in Tables 6 and 7, and from the Nebraska IMPLAN input-output model.

## Total Output

***Total Output  
effect of \$4,994  
million in 2014***

In addition to the direct effects described above for Direct Output, the indirect and induced effects were estimated by applying the respective multipliers from *Table 7* to the Direct Output values in *Table 8*. For example, the Indirect, Output effect in 2014 was \$460 million and the Induced, Output effect was \$157 million. Combining the direct, indirect and induced effects results in a Total Output effect of \$4,994 million in 2014. During the 2010 to 2014 period, the Total Output effect ranged from \$4,015 to \$6,701 million due to the underlying variability in prices for ethanol and distillers' grain.

## Indirect Business Taxes, Labor Income and Employment

In 2014 the ethanol industry contributed \$41 million in indirect business taxes to Nebraska, and in the prior years the impacts were fairly consistent.

***Labor income  
impact was \$319  
million earned by  
4,443 jobs...with  
average annual  
earnings of \$72,000***

In 2014, the total labor income impact was \$319 million. This income was earned by an estimated 4,443 jobs shown as total employment (FTE). The ethanol industry creates a substantial annual impact on the Nebraska labor market by supporting approximately 4,500 jobs with average annual earnings (wages, salaries and benefits) of \$72,000<sup>6</sup>. The average earnings includes direct jobs in the ethanol industry as well as jobs throughout the state. Most of these jobs are created in non-metropolitan Nebraska. Over the entire 2010 to 2014 time period, the annual labor income impact varied between \$287 and \$352 million per year.

## Summary for 2010-2014

One can see from *Table 8* that the total employment effects varied between 3,900 and 4,900 jobs over the five year period. The effects for labor income, output and indirect business taxes demonstrate the significant economic impact of the ethanol industry in Nebraska. The overall impact was \$4,994 million in 2014. The cumulative impact over the five years was \$26,155 million. The results confirm that the ethanol industry provides ongoing employment and a sustained economic impact for the state of Nebraska.

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<sup>6</sup> Ethanol industry wages are higher than those paid on average in the manufacturing industry. Data on average wages per worker in the ethanol industry and manufacturing overall are available in the *County Business Patterns* publication of the U.S. Bureau of Census. In 2012, the most recent year for which data is available, the average worker in the ethanol industry in Nebraska earned 21 percent more than the average manufacturing worker.



## Future Watch

The ethanol industry in Nebraska will be affected by emerging trends and at least four are worth watching starting in 2015 and going beyond. Two concurrent trends are the recovery of carbon dioxide, CO<sub>2</sub>, and the extraction of corn oil.

### ***Carbon dioxide is ... recovered and sold***

One-third of the weight of a bushel of corn is converted into carbon dioxide. CO<sub>2</sub> is used for a variety of food processing and beverage production applications. The neutral flavor and odor characteristics of fermentation CO<sub>2</sub> make it the most desirable source of the gas. CO<sub>2</sub> is also widely used as an industrial gas and to aid in the tertiary recovery process of oil and gas in well fields. CO<sub>2</sub> is sometimes recovered and sold by ethanol plants depending on the proximity of local customers.

### ***Corn oil extraction has gained interest***

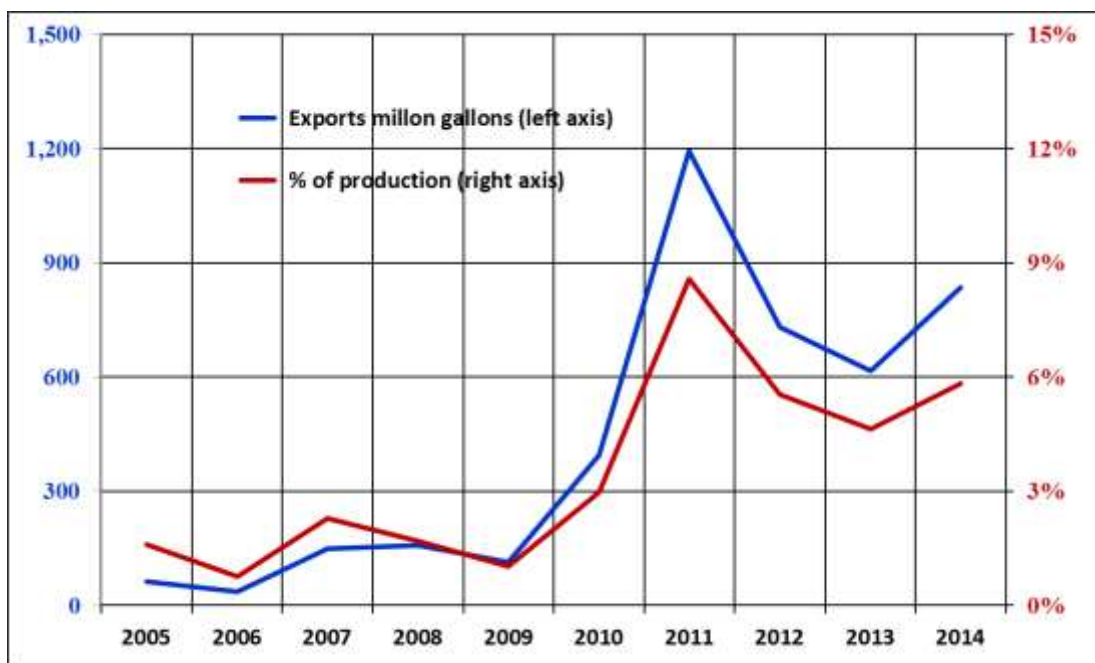
Historically, only corn wet milling plants extracted corn oil while producing ethanol. In approximately 2010, process technology firms began offering a relatively low capital cost integration of corn oil extraction for dry mill ethanol plants. By 2012 corn oil extraction gained considerable interest as legal and technical issues associated with the extraction processes were resolved. The relatively low capital cost of the extraction process addition coupled with a robust return on investment led to rapid assimilation at most ethanol plants. By 2015 virtually all plants in Nebraska had the capability to extract corn oil during the ethanol production process. Corn oil demand continues to be strong in the food, feed and biofuel sectors.

### ***836 million gallons of ethanol exported***

A third emerging trend is the export market for ethanol. In 2005 U.S. exports were 62 million gallons, peaking in 2011 at 1,193 million, and in 2014 were 836 million – more than ten times larger than ten years before (*Figure 10, left axis*).

### ***ethanol exports are 5.8% of production***

As a percentage of production, U.S. ethanol exports have more than doubled in the past ten years (*Figure 10, right axis*). In 2014 that share was 5.8 percent of the 14,340 million gallons produced.



**Figure 10. U.S. Ethanol Exports and as a Percentage of Production**

***Canada takes 40% of ethanol exports***

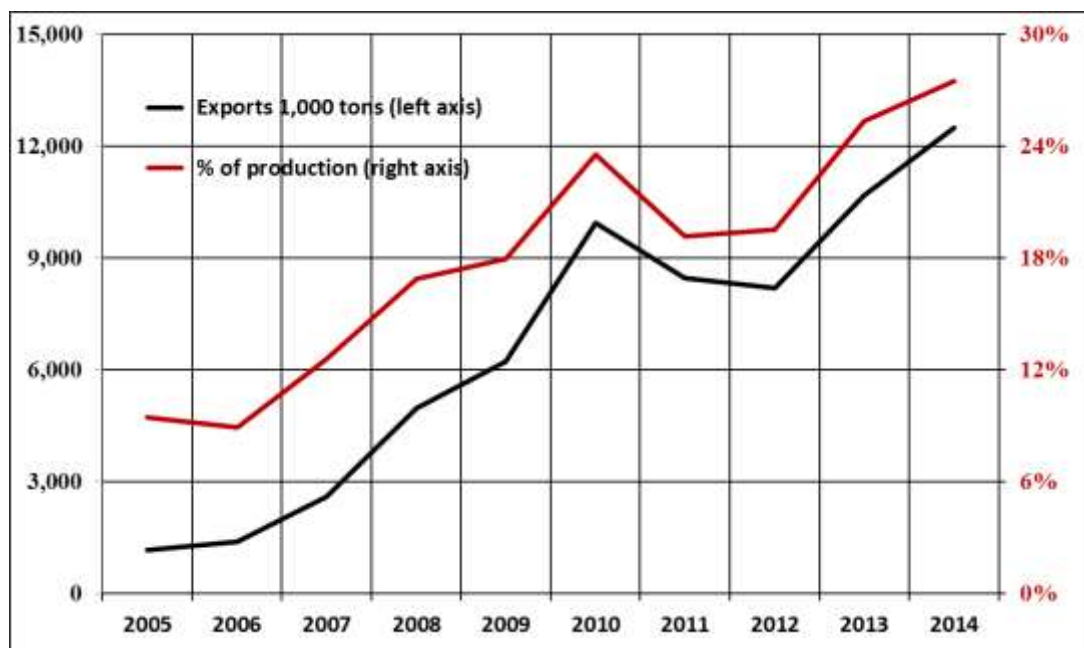
Table 9 shows Canada as the leading importing country taking 40 percent of all exports, or 336 million gallons out of the 836 million that were exported in 2014. The next nine countries took an additional 50 percent for a cumulative total of 90 percent by the top ten countries. The remaining 68 countries took the rest.

**Table 9. U.S. Ethanol Exports to Major Countries, 2014**

<b><u>Country:</u></b>	<b><u>U.S. Exports (mil gal)</u></b>	<b><u>Export Share</u></b>
Canada	336	40%
Brazil	112	13%
United Arab Emirates	68	8%
Philippines	68	8%
India	42	5%
Korea, South	36	4%
Mexico	30	4%
Netherlands	24	3%
Tunisia	21	3%
Spain	19	2%
<b>Top 10 importing countries</b>	<b>756</b>	<b>90%</b>
Remaining 68 countries	80	10%
<b>Total</b>	<b>836</b>	<b>100%</b>

***DDGS exports exceed 25% of production***

A related emerging trend comes from the more than ten times growth in DDGS exports (*Figure 11, left axis*) over the ten year period. Exports, as a percentage of production, tripled to over 25 percent (*Figure 11, right axis*) and they continue to show a strong uptrend.



**Figure 11. U.S. DDGS Exports and as a Percentage of Production**

***China takes 39% of DDGS exports***

*Table 10* shows China as the leading importing country in 2014 with 39 percent of all DDGS exports followed by Mexico with 14 percent. The top ten countries took 85 percent and the remaining 38 countries took the rest.

**Table 10. U.S. DDGS Exports to Major Countries, 2014**

<b>Country:</b>	<b>U.S. Exports (1,000 tons)</b>	<b>Export Share</b>
China	4,814	39%
Mexico	1,737	14%
Korea, South	763	6%
Vietnam	722	6%
Turkey	539	4%
Japan	532	4%
Canada	501	4%
Thailand	406	3%
Indonesia	318	3%
Ireland	287	2%
<b>Top 10 importing countries</b>	<b>10,620</b>	<b>85%</b>
Remaining 38 countries	<u>1,866</u>	<u>15%</u>
<b>Total</b>	<b>12,486</b>	<b>100%</b>

## Appendix 1: References

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Kenneth M. Lemke, 2014. "Estimated Economic Impacts of Nebraska's Ethanol Facilities 2013". Economic Development Department.

## Appendix 2: Sources of Data and Information for Tables and Figures

### Figure 1. Ethanol Production in Nebraska

[http://www.eia.gov/state/seds/sep\\_prod/pdf/PT1\\_NE.pdf](http://www.eia.gov/state/seds/sep_prod/pdf/PT1_NE.pdf)

[http://www.eia.gov/state/seds/sep\\_fuel/html/pdf/fuel\\_use\\_en.pdf](http://www.eia.gov/state/seds/sep_fuel/html/pdf/fuel_use_en.pdf)

### Figure 2 and Table 1. Value of Production for Ethanol and Dried Distillers' Grain

Ethanol Production

Nebraska Department of Revenue

Nebraska Ethanol Board

Distillers' Grain Production

Estimated by the authors using 17.75 pounds of distillers' grain per bushel and 2.8 gallons of ethanol per bushel

Corn Oil Production

Nebraska Ethanol Plant Survey (03/2015), Nebraska Ethanol Board

Prices of Ethanol

USDA, AMS, Nebraska Ethanol Corn and Co-Products Processing Values NW\_GR213

[http://www.ams.usda.gov/mnreports/nw\\_gr213.txt](http://www.ams.usda.gov/mnreports/nw_gr213.txt)

Livestock Marketing Information Center

Prices of Dried Distillers' Grain

USDA, AMS, Corn Belt Feedstuffs Report SJ\_GR225

[http://www.ams.usda.gov/mnreports/sj\\_gr225.txt](http://www.ams.usda.gov/mnreports/sj_gr225.txt)

Livestock Marketing Information Center

Prices of Corn Oil

Wall Street Journal, selected issues

### Figure 3 and Table 2. Comparative Values of Ethanol & DDGS to Corn, Cattle and Soybeans

Corn Production and Prices (calendar year months)

USDA, NASS, Quick Stats

<http://quickstats.nass.usda.gov/results/A6052EA9-E04B-3E1C-AB45-D49E3BCA771E>

<http://quickstats.nass.usda.gov/results/0783B5C6-8803-30B1-B9B3-A3B045B5E1A9>

Sales of Cattle

USDA, NASS, Quick Stats

<http://quickstats.nass.usda.gov/results/B4B16939-6AC9-3548-88F0-D3E68E3FA245>

Soybean Production and Prices (calendar year months)

USDA, NASS, Quick Stats

<http://quickstats.nass.usda.gov/results/EF096117-643B-31DC-87EE-9466A074A195>

<http://quickstats.nass.usda.gov/results/7360CD38-8D98-346C-9913-4038C5C56FB3>

**Table 3. Permitted Capacity for Ethanol Production and Facility Employment, June 2014**

Nebraska Department of Environmental Quality

<http://www.deq.state.ne.us/>

Nebraska Ethanol Board

**Figure 4. Net Returns for Ethanol and DDGS**

Estimated by the authors based on Nebraska prices for ethanol and distillers' grain and using the Iowa State University plant model for tracking ethanol profitability.

<http://www.extension.iastate.edu/agdm/energy/html/d1-10.html>

**Table 4. Ethanol Production and Utilization**

**Figure 5. Ethanol Consumption and Out-of-State Shipments, 2014**

Consumption of ethanol in Nebraska

Motor Fuels Division, Nebraska Department of Revenue

[http://www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep\\_use/total/use\\_tot\\_NEa.html&sid=NE](http://www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_use/total/use_tot_NEa.html&sid=NE)

[http://www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep\\_fuel/html/fuel\\_use\\_en.html&sid=NE](http://www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_fuel/html/fuel_use_en.html&sid=NE)

**Figure 6. Ethanol Surplus and Deficit States**

Estimated by the authors based on state level production and consumption of ethanol.

<http://www.eia.gov/state/seds/seds-data-complete.cfm?sid=US#Production>

<http://www.eia.gov/state/seds/seds-data-complete.cfm?sid=US#Consumption>

**Figures 7 and 8. Estimated Ethanol Movements from Nebraska**

Estimated by the author as described in the text.

**Table 5 and Figure 9. Dried Distillers' Grain Production and Utilization**

Estimated by the author for livestock feed as a replacement for corn.

**Table 6. Annual Output, Employment, Labor Income and Indirect Business Taxes**

Labor Income Effects estimated by the authors based on the output of ethanol and distillers' grain and number of employees.

Indirect Business Taxes, IBT, Effects estimated using data from a report by the Nebraska Department of Revenue Property Assessment Division, "*Nebraska Ethanol and Bio-Fuels Plant Valuations Compiled from Assessment Records for Tax Years 2010 – 2011.*"

**Table 7. Input-Output Multipliers Derived for Nebraska Ethanol Plants**

Calculated using data from the Nebraska IMPLAN model.

**Table 8. Estimated Economic Impacts Associated with Nebraska's Ethanol Industry**

Computed from the data in Tables 6 and 7, and from the Nebraska IMPLAN input-output model.

**Figures 10 and 11. U.S. Ethanol and DDGS Exports and as a Percent of Production**

Estimated by converting 1 barrel to 42 gallons of ethanol production, and 17.75 lbs of DDGS per gallon of ethanol produced. Exports are given in Tables 9 and 10.

[http://www.eia.gov/dnav/pet/pet\\_pnp\\_oxy\\_dc\\_nus\\_mbb1\\_m.htm](http://www.eia.gov/dnav/pet/pet_pnp_oxy_dc_nus_mbb1_m.htm)

**Table 9. U.S. Ethanol Exports by Major Country, 2014**

<http://apps.fas.usda.gov/gats/ExpressQuery1.aspx> , product code 0280AT for ethanol

**Table 10. U.S. DDGS Exports by Major Country, 2014**

<http://apps.fas.usda.gov/gats/ExpressQuery1.aspx>, product code 0110AT for DDGS

## Appendix 3: Economic Impact Methodology

The basic framework for analysis was the IMPLAN model of the Nebraska Economy. IMPLAN is a widely used input-output analysis software package and database which can provide a detailed picture of the economy for any state and sub-state region in the nation. For this analysis, IMPLAN data for the year 2013 was used, as this is the most recently available year of data. IMPLAN also has the capacity to model the economic impact of over 400 industry sectors. While there is no specific sector for the ethanol industry, sector data for the milling industry was modified to reflect the specific input mix which was relevant for ethanol facilities. In particular, as a capital-intensive industry, the IMPLAN sector was modified to reflect that a significant portion of revenue from an ethanol plant goes to compensate the cost of capital from building the facility, rather than current economic activity.

Economic impact analysis is composed of the direct economic impact, the indirect economic impact, and the induced economic impact. The direct economic impact refers to the out-of-state sales of the ethanol facility. Such out-of-state sales bring new revenue into the Nebraska economy to support jobs, wages, and business activity. Most sales of a Nebraska ethanol plant occur out of state (96 percent of ethanol and 58 percent of dried distillers' grain in 2014). Therefore, the direct economic impact from Nebraska ethanol plants is nearly as large as total industry sales.

The indirect and induced economic impact reflect additional economic activity in Nebraska as money attracted to the state (through the direct impact) circulates further within the state economy. The indirect economic impact is the additional economic activity driven by the purchases of the business sector. Ethanol plants, in particular, will purchase inputs and services from within the Nebraska economy such as water, energy, chemicals, accounting services and other inputs. These purchases provide revenue to other Nebraska businesses, generating indirect impacts on the Nebraska economy. There are even additional rounds of indirect economic impact as these supplier businesses in the water, energy, chemicals and accounting, industries for example, purchase their own goods and services from other Nebraska businesses. The summation of these additional rounds of indirect impact is estimated using the IMPLAN model. The IMPLAN model, utilizing its detailed accounting of the industries and businesses within the Nebraska economy, can model the cumulative impact of indirect purchases.

Note that the discussion of the indirect impact above did not discuss purchases of corn from Nebraska. Corn purchases are not included given that much Nebraska corn production predated its use by the state's ethanol industry. Further, much of the land converted for corn growing due to the ethanol industry was used to grow other crops of value. Therefore the economic impact of crop production should not, and is not, allocated to the ethanol industry as part of this study. This is part of the reason that the indirect and induced impact of the ethanol industry is relatively modest, as shown in *Tables 7 and 8*.

The induced economic impact reflects the additional economic activity in the household sector. Ethanol facilities are a capital-intensive business but each facility does provide dozens of high-paying jobs. Additional economic activity is created in the state as well-paid ethanol plant employees spend their wages and salaries throughout the economy. Spent wages and salaries become revenue for businesses which provide household goods and services, such as grocery stores, auto dealers, gasoline service stations, retail outlets, health care providers, insurance agencies, restaurants, and other recreation and entertainment businesses. This spending in turn supports part



of the wages of employees at these businesses yielding additional rounds of the induced impact. The cumulative impact of these rounds of induced household spending also is captured in the IMPLAN model, and referred to as the induced impact.

The total economic impact is the sum of the direct, indirect and induced economic impacts. The indirect and induced impacts are collectively known as the multiplier impact.

Economic impact is presented for four economic concepts in this report: output, labor income, employment, and indirect business taxes. Output is the increase in sales (business receipts) of businesses in the Nebraska economy, whether ethanol plants or businesses which have sales as the result of the indirect or induced impacts. The labor income impact refers to the wages, salaries and benefits earned by employees or the proprietors' income of business owners. The employment numbers (both direct and multiplier) reflect full-year jobs in a multitude of industries. Like jobs in the economy overall, most of the jobs generated due to the economic impact are full-time jobs, though there is some part-time employment. A portion of the jobs generated in industries such as retail or entertainment and recreation are part-time in nature. Indirect business taxes primarily refer to the property taxes paid by ethanol plants or by businesses with additional sales due to the indirect and induced impacts.