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Economic Impact of North Dakota's Ethanol Industry in Fiscal Year 2015

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Executive Summary

Ethanol was first produced in North Dakota in 1985. Starting in the mid-2000's large scale commercial ethanol production was driven by a combination of the phasing out of MTBE as a fuel additive and the passage of the Renewable Energy Policy Act of 2005 which mandated specific volumes of renewable fuels replace petroleum based fuel. Five ethanol plants have been built in North Dakota since 2007 with a combined annual production capacity of 498 million gallons. This study examines the economic impact of the operational activities of those plants on North Dakota's economy.

Contact information for each of the state ethanol production facilities were provided by the North Dakota Ethanol Council. A questionnaire was developed to solicit information on in-state operations expenditures, such as wages and salaries, benefits, inputs to production, transportation, utilities, and business and professional services. Each of the state's ethanol producers responded to the request for information resulting in a robust data set based on actual industry expenditures. Those expenditures were applied to the North Dakota Input-Output Model to estimate the total economic impact. The model used interdependence coefficients to estimate the secondary economic impacts arising from spending and respending of those initial outlays. Direct and secondary impacts are combined to estimate the total economic impact. Impacts are expressed using indicators such as personal income, retail trade activity, and employment.

Total economic impact (direct plus secondary) for the industry was $623.4 million in FY2015. Direct impacts constituting in-state industry expenditures totaled $212.3 million. Secondary impacts from the spending and respending of initial industry expenditures totaled $411.1million. The industry generated $187.7 million of economy-wide personal income and $121.5 million in retail trade activity. The industry also had direct employment of 234 FTE jobs and supported another 873 FTE secondary jobs throughout the economy as the result of the industry's business activity in FY2015. State and local tax revenues attributable to the industry were over $11 million in FY2015.

The ethanol industry has substantial economic effects as this study illustrates. While the ethanol industry is relatively new in the state compared to other value-added agriculture enterprises and other components of the state's energy industry, North Dakota continues to be well positioned to continue to produce ethanol. The state's agriculture industry produces corn for feed stock. Infrastructure capable of delivery of corn feedstock for conversion to ethanol as well rail and truck transportation systems for delivery of ethanol and dried distillers grain used as feed for livestock are well developed.

The ethanol industry also offers corn producers another potential market and adds value to agriculture commodities. Production facilities help to diversify the state's energy industry and economies of the rural communities where ethanol conversion facilities are located. The ethanol industry also creates employment opportunities with stable well-paying jobs in communities where employment opportunities can be limited. The ethanol industry clearly makes an important contribution to the state's economy.

Economic Impact of North Dakota's Ethanol Industry in Fiscal Year 2015

Randal C. Coon, Nancy M. Hodur, and Dean A. Bangsund*

Introduction

Ethanol was first produced in North Dakota in 1985. Two small plants were constructed in 1985 with a combined production capacity of 38.5 million gallons per year. The plant in Grafton was originally designed to use potatoes as feedstock but within a few years converted to corn feedstock. The plant produced 10 million gallons per year and was dismantled for scrap and parts in 2013. The Walhalla plant also ultimately closed in 2012 because the scale of the plant and access to feedstock.

Starting in the mid-2000's large scale commercial ethanol production was driven by a combination of the phasing out of MTBE as a fuel additive and the passage of the Renewable Energy Policy Act of 2005 which mandated specific volumes of renewable fuels replace petroleum based fuel. The Renewable Fuel Standard (RFS) which drove the development and expansion of the ethanol industry was intended to reduce greenhouse gas emissions, expand the nation's fuel supply, and reduce reliance on imported oil.

Growth in ethanol production nationwide occurred several years prior to expanded production in North Dakota. United States' ethanol production started increasing rapidly circa 2002. Production declined slightly in 2011 and 2012 before stabilizing with modest growth in recent years (Figure 1). Nationally 15 billion gallons of ethanol were produced in 2015. The first commercial ethanol production facility, Blue Flint Ethanol located in Underwood, North Dakota began producing ethanol in 2007. Three additional plants were constructed from 2007 to 2009 with the fifth plant that came online in 2015. North Dakota continues to be well positioned to produce ethanol. The state's agriculture industry produces ample corn for feed stock. Infrastructure capable of delivery of corn feedstock for conversion to ethanol as well rail and truck transportation systems for delivery of ethanol and dried distillers grain used as feed for livestock are well developed.

The ethanol industry also offers corn producers another potential market and adds value to agriculture commodities. Production facilities help to diversify the economies of the rural communities where ethanol conversion facilities are located. The ethanol industry also creates employment opportunities with stable well-paying jobs in communities where employment opportunities at time can be limited. Clearly the ethanol industry has economic effects. Study objectives are to estimate the economic contribution the ethanol industry makes to the North Dakota economy through operations.

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A previous assessment of the state's renewable energy industry was completed in 2012. The ethanol industry was included in that assessment. Because the industry has grown as a result of the addition of a new plant and operating efficiencies this study will update the previous assessment of the ethanol industry's economic impact. The study will also report the industry's capital investment as a result of plant construction activities. The industry's contribution will be measured in terms of key economic variables including personal income, retail trade, employment and tax revenues.

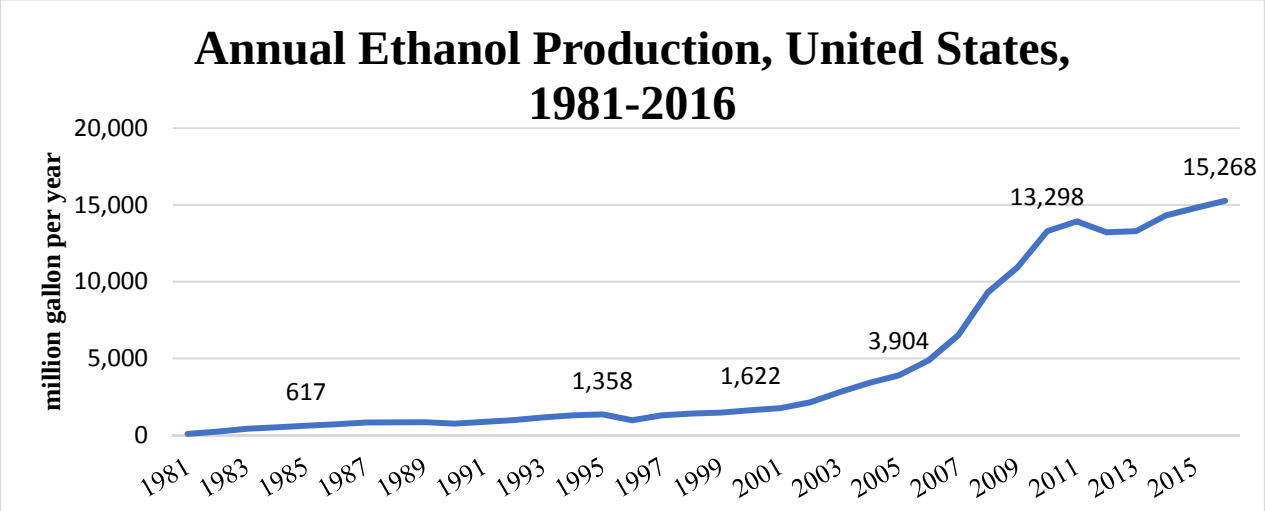

Figure 1. Annual Ethanol Production, United States, 1981-2016
Source: U.S. Energy Information Association (2017).

Methods

An economic contribution assessment measures the changes in economic variables that result from in-state expenditures by a given industry. This approach is frequently used to estimate the impact of the construction and operations of a new business or industry, the impact of an entertainment event, or predicting the implications of a change in public policy (Bangsund and Leistritz 2004, Hodur et al. 2006a, Leistritz and Coon 2008, Baade and Matheson 2001, Chhabra et al. 2003, Hodur and Leistritz 2006). The specific occurrence being measured in this study is the change in economic activity in North Dakota as a result of the ethanol industry. This assessment quantifies the economic contribution to the state's economy from the annual operations of the ethanol industry and reports capital investment for plant construction.

Economic effects for both construction and operations are categorized into direct and secondary effects. Direct effects are defined as the original expenditures made by the industry to in-state entities. Direct effects are often referred to as first-round effects. Direct effects for this analysis were available for both the construction and operations of the renewable energy industry in North Dakota. Secondary impacts, often referred to as the multiplier effect, are a result of subsequent rounds of spending and re-spending in the economy from the initial or first round dollars. The multiplier effect is based on linkages between basic and non-basic sectors of an economy (Schaffer et al. 2004). An increase in basic sector activities requires an

increase in inputs in non-basic sector activities. An increase in both basic and non-basic sectors activities translates into increased aggregate wages and salaries for local households which are used to purchase goods and services.

Input-output analysis is a common tool used to measure economic linkages. This methodology measures the number of times an original dollar (direct expenditure) turns over (multiplies) before it leaves that economy. The North Dakota Input-Output Model was used to estimate the secondary impacts that result from the spending and re-spending of the original dollars injected into the economy. The North Dakota Input-Output Model consists of interdependence coefficients, or multipliers, that measure the level of business activity in a given sector that arises from a change in demand for goods and services in other economic sectors. The spending and re-spending of the original dollar is called the multiplier process, which produces estimates of the total level of business activity generated as the original dollars "turn over" in the economy (Coon et al. 1989; Coon et al. 2012). Expenditure data provided by North Dakota ethanol producers was allocated to the appropriate sectors of the North Dakota input output model (Appendix B). For a complete discussion of economic base theory see Schaffer et al. (2004).

The levels of business activity estimated by the model provide key economic measures such as retail trade and personal income, and are used to estimate secondary employment and tax revenues based upon historic relationships. Empirical testing has confirmed the model's accuracy in estimating changes in statewide economic activity. Comparing the personal income estimate produced by the model with published values provides an indication of how well the model simulates the state's economy. For the period 1958-2014, the North Dakota Input-Output Model estimates of personal income averaged within 8 percent of those reported by the U.S. Department of Commerce (Coon and Bangsund 2017; Bureau of Economic Analysis 2016).

Contact information for each of the state ethanol production facilities were provided by the North Dakota Ethanol Council. A questionnaire was developed to solicit information on in-state operations expenditures, such as wages and salaries, benefits, inputs to production, transportation, utilities, and business and professional services (Appendix B). Each of the state's ethanol producers responded to the request for information resulting in a robust data set based on actual industry expenditures. In in previous assessment not all the state's ethanol producers responded to the request for expenditure data. In the previous study, expenditures for non-responding firms were based on average expenditure from responding firms and extrapolated on a per gallon of production.

Expenditures for corn were estimated from survey data. However, not all expenditures for corn represent an economic contribution attributable to the ethanol industry. Other markets for corn exist and in the absence of the ethanol industry corn would be marketed for other uses, primarily animal feed (Swenson and Eathington 2006, Peters 2007, Hodur, et al. 2006b). Including all the industry's in-state corn purchases would substantially overstate the economic effects of ethanol production since much of the corn needed for those plants was already being grown and marketed for other uses. Accordingly, total expenditures for corn were not included in the estimate of direct effects. However, the difference in the price paid for ethanol production over what would have been paid in alternate markets was included in the estimate of economic impacts. The price premium paid by ethanol producers is the amount that the plant pays for corn above the local market price and is referred to as improved basis. The improved basis multiplied

by the bushels of corn purchased from North Dakota sources represents an economic impact directly attributable to the ethanol industry and was included in the impact analysis.

While expenditures for corn are largely excluded from the calculation of the ethanol industry's economic impact, reporting the quantity of corn purchased does provide a useful descriptor of the size of the industry. In 2015, ethanol producers purchased 159 million bushels of corn from North Dakota producers.

Based on a review of the historic difference between the price of corn delivered to an ethanol plant and alternate local markets, it was estimated, there was an average $0.05 per bushel premium for corn purchased at local ethanol plants (Maple River Grain 2012, The Arthur Companies 2012).

Information presented in this assessment was organized such that proprietary data would remain confidential. To keep sensitive financial data from being attributable to any particular producer, all survey data was aggregated at the industry or economic sector level. While the overall size of the industry, and its role in the North Dakota economy, are of particular interest to industry representatives, policy makers, business leaders, and other stakeholders, effects at the plant-level are also of interest to local stakeholders. To make this analysis of the state's ethanol industry more useful to local officials for evaluating plant-scale impacts, an economic impact for a hypothetical 60 million gallon per year ethanol plant was generated based on average values for in-state expenditures obtained from all ethanol producers in the state. Key values for the assessment were obtained by dividing industry total expenditures, by economic sector, by the state's total ethanol production to determine average in-state expenditures per million gallons of ethanol output. A plant capacity of 60 million gallons per year was used to most closely approximate the output of several plants in North Dakota. Appendix A contains additional details of that analysis.

The level of capital investment related to construction of ethanol production facilities was based on information obtained from the industry questionnaire. Each firm provided total construction costs. The percentage of total construction costs that accrued to North Dakota entities were based on personal conversations with industry representatives. In-state construction costs were allocated to the various industry sectors using the same methodology as the study conducted in 2012. All construction expenditures were reported in current year dollar values, that is the dollars are expressed in terms of the purchasing power in each respective year.

North Dakota Ethanol Production

The state has 5 commercial ethanol production facilities. Four of the five plants are in eastern North Dakota with one in western North Dakota (Figure 2). Nameplate capacity of the state's plants ranges from 50 to 168 million gallons per year. Red Trail Energy, LLC plant capacity is 50 million gallons per year, while Dakota Spirit and Blue Flint Ethanol produce 65 and 70 million gallons per year, respectively. Hankinson Renewable Energy, LLC and Tharaldson Ethanol are the state's largest plants with plant capacity of 145 and 168 million gallons, respectively. Based on nameplate capacity the state's ethanol plants have the capacity to produce 498 million gallons of ethanol per year. Actual production is less than nameplate as plants generally do not actually produce at 100 percent capacity. In addition to ethanol, the plants produced 1.4 million tons of dried distillers grain in 2016, which is marketed as livestock feed.

The plants employee 225 employees statewide, 40 to 55 employees per plant in 2016. The average wage for workers at the state's ethanol plants is $64,000 per year (ND Ethanol Council, 2017). Nameplate capacity, employment and other production information for the state's ethanol production facilities are detailed in Table 2.

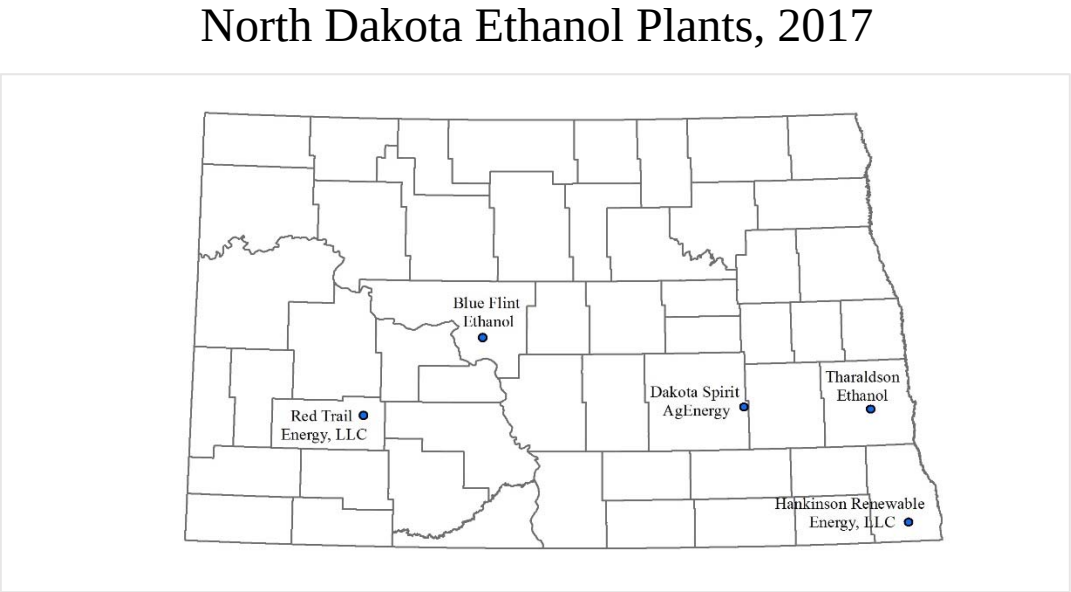

Figure 2. North Dakota Ethanol Plants, 2017
Source: North Dakota Ethanol Council

Table 2. Plant Nameplate Capacity, Production Statistics and Employment, North Dakota Ethanol Plants, 2016

Plant Name	Nameplate Production Capacity	Corn Used	Dried Distillers Grain	Employees
	million gallons/year (2016)	million bushels (2016)	tons (2016)	number (2016)
Blue Flint Ethanol	70	25	200,000	42
Dakota Spirit AgEnergy	65	23	190,000	40
Hankinson Renewable Energy, LLC	145	51	440,000	47
Red Trail Energy, LLC	50	18	125,000	42
Tharaldson Ethanol	168	61	480,000	55
Total	498	177	1,455,000	225
Source: North Dakota Ethanol Council				

While all plants have nameplate capacities, actual production of ethanol in North Dakota is reported quarterly to the North Dakota Department of Commerce and North Dakota Ethanol Council. The Nebraska Energy Office (2017) estimates production for all ethanol plants in the United States and sums the individual plant output to estimate state totals. Data from the Nebraska Energy Office was used to estimate production from 1985 to 2010. Actual production

data from the North Dakota Ethanol Council was reported from 2011-2016. Prior to 2011 actual production data was not reported to the North Dakota Department of Commerce or the North Dakota Ethanol Council.

Estimates and actual product align closely with each plant's name plate capacity. Current name-plate capacity of the state's ethanol plants is 498 million gallons per year (Table 1). Actual production as reported to the North Dakota Ethanol Council was 486 million gallons in 2016 (Table 2). In 2016, the industry converted 177 million bushels of corn into ethanol (Table 2).

North Dakota increased its estimated production from 38.5 million gallons in 1985 to 377.0 million gallons in 2008 (Table 1). Three plants were constructed from 2007 to 2009. Production remained relatively stable from 2008 to 2014, ranging from 368 to 377 million gallons per year. Like national production trends there was a slight decrease is production in 2011 and 2012 when high corn prices forced a market correction. In 2015, a new plant came on line, increasing production to 424 million gallons per year. In the absence of new plant construction or expansion of existing plants, increased production can be attributed to production efficiencies (Figure 2). Growth in the ethanol industry has leveled off in recent years and has transitioned from an emerging industry to a stable presence in rural North Dakota.

Table 3. Estimated and Actual Ethanol Production, North Dakota, Selected Years 1985-2016

Year	Estimated Ethanol Production[1]
	---- million gallons/year ----
1985	38.5
2006	88.0
2007	128.0
2008	377.5
2009	377.5
2010	377.5
2011	383.6
2012	365.1
2013	368.0
2014	370.9
2015	424.1
2016	486.0

[1]Production figures from 2011-2016 are actual production figure reported to the North Dakota Ethanol Council. Production figures from 1985-2010 are estimates made by the Nebraska Energy Office.

Source: 1985-2013, Nebraska Energy Office (2017); 2011-2016, North Dakota Ethanol Council

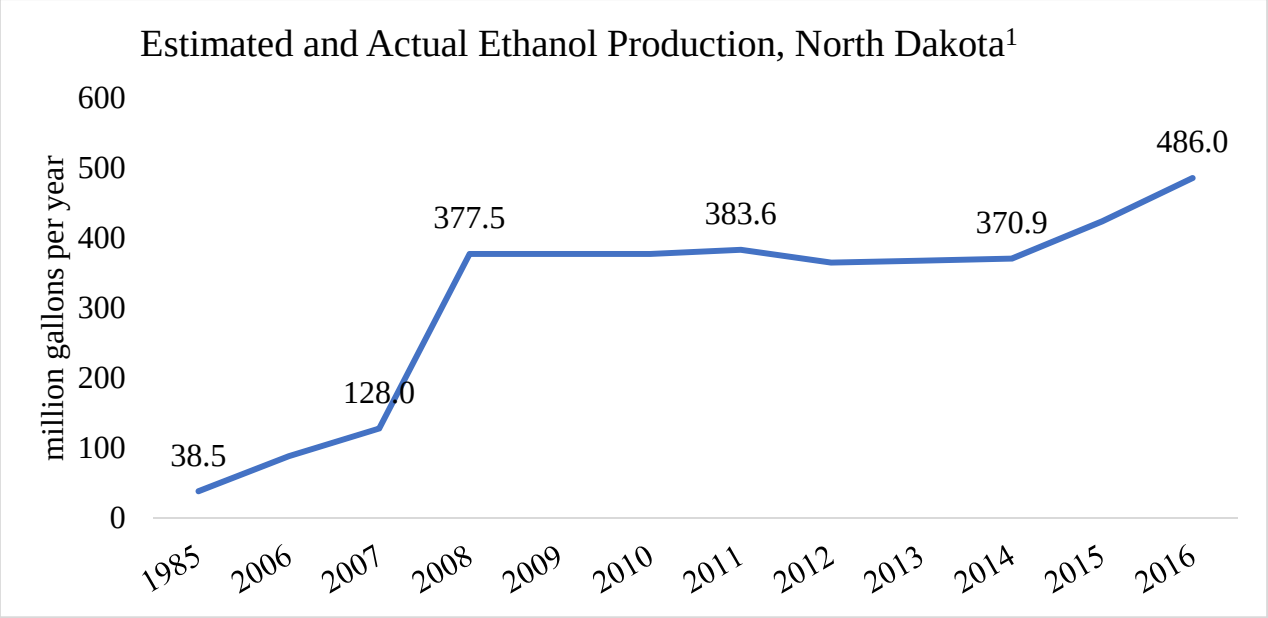

Figure 2. Estimated Ethanol Production, North Dakota, 1985-2016
[1]Production figures from 2011-2016 are actual production figure reported to the North Dakota Ethanol Council. Production figures from 1985-2010 are estimates made by the Nebraska Energy Office.
Source: 1985-2010: Nebraska Energy Office (2017), 2011-2016: North Dakota Ethanol Council

Results

Results are divided into annual impacts from operations and one-time construction impacts.

Economic Impact, Operations

Total in-state expenditures by the ethanol industry are presented by economic sector in Table 2. In FY2015, the industry spent $212.3 million in North Dakota for operational activities. The expenditures were highlighted by $80.2 million to the *Transportation* sector, $62.2 million to *the Communications and Public Utilities* sector, and $26.2 million to the *Households* sector. Additional revenue to farmers for the increased value of their corn was included in the *Households* sector. These expenditures represent the direct economic impacts of the ethanol industry in North Dakota.

Table 3. Estimated Direct Economic Impact, Operations, North Dakota's Ethanol Producers, by Input-Output Model Sector, FY2015	
Sector	Estimated Expenditure
	-------- $000 -------
Construction	11,900
Transportation	80,200
Communications and Public Utilities	62,200
Agricultural Procession and Miscellaneous Manufacturing	100
Retail Trade	10,000
Finance, Insurance and Real Estate	13,500
Business and Personal Services	5,100
Professional and Social Services	3,100
Households	26,200
TOTAL	212,300

Applying the expenditures to the North Dakota Input-Output Model's multipliers provided an estimate of the total business activity generated as the result of the operations of the ethanol plants, or total economic impact. The total business activity (direct plus secondary impacts) generated in North Dakota by the ethanol plants was estimated to be $623.4 million in FY2015 (Table 3). This level of business activity would result in $187.7 million of economic activity (direct plus secondary) in the *Households* sector. *Households* sector impacts represent economy-wide personal income. Total impacts in the *Retail Trade* sector were estimated to $121.5 million for FY2015. Of the $623 million in total business activity, $411.1 million were secondary impacts.

Table 4. Estimated Annual Total Economic Impact, Operations, North Dakota's Ethanol Industry, FY2015			
Sector	Direct	Secondary	Total
	---------- $000 ----------		
Construction	11,900	12,900	24,800
Transportation	80,200	2,200	82,400
Communications and Public Utilities	62,200	19,700	81,900
Agriculture Processing and Miscellaneous Manufacturing	100	6,800	6,900
Retail Trade	10,000	111,500	121,500
Finance, Insurance, and Real Estate	13,500	25,600	39,100
Business and Personal Services	5,100	9,400	14,500
Professional and Social Services	3,100	12,400	15,500
Households	26,200	161,500	187,700
Other[1]	--	49,100	49,100
TOTAL	212,300	411,100	623,400

[1]Other includes agriculture, mining, and government.

Because the industry has increased production capacity since the previous assessment of the industry in 2012, the direct impacts for the ethanol industry were larger than those reported in the renewable energy study in 2012 (Coon et al. 2012). However, the total impacts were slightly

less. Stated alternatively, the industry's expenditures in the state grew from 2012 to 2015, but the subsequent overall impact, which includes the secondary impacts, was slightly lower than the 2012 estimates. The change in secondary effects were driven by differences in the reported expenditure data. Some sectors have multipliers that are larger than others, which means the dollars spent in that sector "turn over" more times before they leave the economy. Each individual sector of the Input-Output Model has a different multiplier based on the expenditure patterns associated with that economic sector. Although total expenditures for this study were larger than those in the 2012 study, some of those expenditures were assigned to sectors with smaller multipliers. This resulted in smaller secondary impacts, and the reduction in secondary impacts were sufficient to more than offset the increase in direct spending. For example, expenditures in the *Finance, Insurance and Real Estate* sector were less in 2015 than in 2011. This would suggest that some plants were carrying less debt, perhaps having retired capital investment loans. Overall, the data collected for this assessment was more robust than the previous assessment. All five ethanol producers provided expenditure data while in the previous study, expenditures for those producers that did not participate were estimated. This allowed the expenditures to be allocated more precisely to the respective sectors of the North Dakota Input-Output Model.

The ethanol industry in North Dakota employed 234 full-time equivalent workers in FY2015 (Table 4). In addition to direct employment, the level of business activity generated by the industry supports secondary (indirect and induced) jobs. The level of business activity generated by the industry supports an estimated 873 secondary jobs. Tax collections attributable to the ethanol industry totaled $11.1 million for FY2015 (Table 4). Sales and use taxes attributable to the industry were $5.6 million and personal income taxes were $2.8 million.

Table 5. Direct and Secondary Employment and Tax Revenues, Operations, North Dakota's Ethanol Industry, FY2015

Item	
Employment:	-----number----
Direct (Full Time Equivalent)	234
Secondary (Full Time Equivalent)	873
Tax Revenues:	----------$000s----------
Sales & Use	5,623
Personal Income	2,816
Corporate Income	1,203
Other[1]	1,505
TOTAL	11,147

[1]Other includes property tax, unemployment, and miscellaneous taxes.

One-time Construction Impacts

While the first ethanol plants were built in mid-1980's, full scale commercial operations did not start to come on-line until 2007, 2008 and 2009. A fifth plant was recently constructed and began operations in 2015. Because of the small number of plants constructed in North Dakota, it is not possible to report construction impacts by year without potentially revealing proprietary information. To avoid revealing any confidential information, construction impacts

of all five plants were combined to illustrate the level of capital investment the industry has made in the state since the first commercial scale plants were built in 2007.

Overall the industry has invested $840.5 million to construct commercial scale ethanol facilities. Often a substantial portion of large capital construction capital investment, like construction of an ethanol plants goes to specialized firms located outside the state. Manufactures of specialized equipment and specialized construction capacities often cannot be procured from North Dakota suppliers. While not all the capital investment represents an in-state expenditure a substantial portion of the total capital investment does accrue to North Dakota entities. Expenditures related to construction activities to in-state entities totaled $312.1 million. About half of all the in-state impacts accrue in the *Construction* sector, $164 million. Nine to twelve percent of in-state expenditure accrue in the *Business and Personal Service* sector, *Retail* sector *and Finance, Insurance and Real Estate* sectors.

Table 6. Total and In-state (North Dakota) Capital Expenditures, Plant Construction, North Dakota Ethanol Industry, 2007, 2008, 2009 and 2015

	2007, 2008, 2009, 2015	
Sector	Total Expenditures	In-state (North Dakota) Expenditures
	----------$000s----------	
Construction	429,495.5	164,095
Retail	104,222.0	39,819
Finance, Insurance, and Real Estate	131,118.0	50,096
Business and Personal Services	79,007.0	30,186
Professional and Social Services	33620.0	12,845
Households	63,037.5	24,084
TOTAL	840,500.0	312,125

Conclusions

The ethanol industry has substantial economic effects as this study illustrates. While the ethanol industry is relatively new in the state compared to other value-added agriculture enterprises and other components of the state's energy sector, North Dakota continues to be well positioned to continue to produce ethanol.The state's agriculture industry produces ample corn for feed stock. Infrastructure capable of delivery of corn feedstock for conversion to ethanol as well rail and truck transportation systems for delivery of ethanol and dried distillers grain used as feed for livestock are well developed.

The ethanol industry also offers corn producers another potential market and adds value to agriculture commodities. Production facilities help to diversify the state's energy sector and the economies of the rural communities where ethanol conversion facilities are located. The ethanol industry also creates employment opportunities with stable well-paying jobs in communities where employment opportunities can be limited. The ethanol industry clearly makes an important contribution to the state's economy with total economic impacts of over $600 million annually. The industry has also made a substantial capital investment to build an ethanol industry in North Dakota. The industry has invested over $800 million in capital

investments to build the state's five commercial facilities. Over $300 million of that capital investment accrued to North Dakota entities. Clearly the industry has made a substantial investment in the state to build a commercial ethanol industry.

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Appendix A

Economic Impact of a Hypothetical 60 Million Gallon per year Ethanol Plant in North Dakota

Community leaders, policymakers, and local stakeholders often are interested in a more localized understanding of a specific facility on their local community, county, or region. However, confidentiality negates providing an analysis specific to any individual ethanol plant that provided financial data for the industry study.

To guide and frame those discussions without disclosing confidential financial information, the impacts associated with a hypothetical 60 million gallon per year facility were estimated. Total in-state expenditures, obtained from survey data from all five plants, were aggregated into economic sectors. In-state expenditures, by economic sector, were then divided by total ethanol production in FY2015 to provide generic estimates of in-state spending per million gallons of ethanol output. Multiplying the expenditures (per million gallons) by the hypothetical 60 million gallons per year plant provided an estimate of total in-state expenditures or direct economic impacts (Table 1).

The hypothetical ethanol plant would have $28.6 million of in-state expenditures (direct impacts). The economic sectors with the largest direct impacts would be the *Transportation* sector with $10.8 million and the *Communications and Public Utilities* sector with $8.4 million. The third largest amount of in-state expenditures would be for wages and salaries with $3.5 million in direct expenditures to the *Households* sector.

Expenditures for corn were estimated from survey data. However, not all expenditures for corn represent an economic contribution attributable to the ethanol industry. Other markets for corn exist and in the absence of the ethanol industry corn would be marketed for other uses, primarily animal feed (Swenson and Eathington 2006, Peters 2007, Hodur, et al. 2006b). Including all the industry's in-state corn purchases would substantially overstate the economic effects of ethanol production since much of the corn needed for those plants was already being grown and marketed for other uses. Accordingly, total expenditures for corn were not included in the estimate of direct effects. However, the difference in the price paid for ethanol production over what would have been paid in alternate markets was included in the estimate of economic impacts. The price premium paid by ethanol producers is the amount that the plant pays for corn above the local market price and is referred to as improved basis. The improved basis multiplied by the bushels of corn purchased from North Dakota sources represents an economic impact directly attributable to the ethanol industry and was included in the impact analysis. If local or regional corn production is insufficient to meet a local plant's needs, the presence of new local demand for corn could result in acreage shifts from existing crops into corn. In those situations, the marginal change in the value of crop production from those acreage shifts could be considered an economic effect attributable to the ethanol plant. However, for this hypothetical example, it was assumed sufficient local or regional corn production was sufficient to meet a plant's requirements.

Bushels of corn purchased from North Dakota producers could vary substantially depending on location. For example, if a plant were constructed near the state boundaries it is possible substantial quantities of corn could be purchased from producers in other states, such as

South Dakota or Minnesota. Average corn purchased from the state's similarly sized plants was 25.8 million bushels per year.

Expenditure data were applied to the North Dakota Input-Output Model to estimate the total (direct and secondary) economic impact. The total economic impact (statewide) for the hypothetical ethanol plant would be $84.0 million, assuming FY2015 expenditure patterns (Table 1). The direct impacts of $28.6 million would generate additional secondary impacts of $55.4 million, and total impact (direct plus secondary) of $84.0 million. Total impacts (direct plus secondary) were greatest in the *Households* sector (economy-wide personal income) and the *Retail Trade* sector, *25.3 million and* $16.4 million, respectively.

An average number of full-time equivalent (FTE) jobs for a 60 million gallon per year ethanol plant would be 44 FTE workers (Appendix Table 2). Average full-time equivalent wages were estimated to be $62,047. Economy-wide business activity would be expected to support 117 secondary (indirect and induced) FTE jobs (Table 2). The business activity generated by operations of the ethanol plant would create tax revenues for the state, including $758,000 in sales and use taxes, $379,000 in personal income taxes, and $162,000 in corporate income taxes, based upon historic relationships ((Table 2).

While actual localized impacts would vary based on various local socio-economic conditions, this assessment provides a reasonable approximation of the impacts of a single 60-million-gallon ethanol plant in North Dakota.

Appendix Table A1. Estimated Total Annual Economic Impact, Operations, Hypothetical 60 Million Gallons Per Year Ethanol Plant, North Dakota, FY2015 Financial Characteristics

Sector	Direct	Secondary	Total
	---------- $000 ----------		
Construction	1,601	1,734	3,335
Transportation	10,812	296	11,108
Communication and Public Utilities	8,384	2,657	11,041
Agricultural Processing and Miscellaneous Manufacturing	12	909	921
Retail Trade	1,352	15,014	16,366
Finance, Insurance and Real Estate	1,819	3,445	5,264
Business and Personal Services	691	1,269	1,960
Profession and Social Services	411	1,675	2,086
Households	3,524	21,768	25,292
Other[1]	--	6,613	6,613
TOTAL	28,606	55,380	83,986

[1]Other includes agriculture, mining, and government.

Appendix Table A2. Direct and Secondary Employment and Tax Revenues, Operations, North Dakota's Ethanol Industry, FY2015	
Item	
Employment:	-----number----
Direct (Full Time Equivalent)	44
Secondary (Full Time Equivalent)	117
Tax Revenues:	----------$000s--------
Sales & Use	758
Personal Income	379
Corporate Income	162
Other[1]	_____
TOTAL	

APPENDIX B

DEFINITIONS FOR EXPENDITURE CATEGORIES

The following definitions are derived from Standard Industrial Classification Manual (SIC codes) and have been provided to assist in allocating expenses into common categories. If needed, please refer to the following web site for additional examples of the expenses included in each category: http://www.osha.gov/pls/imis/sic_manual.html Each category has several Major Group numbers, which contain additional detail on the type of activities in each category.

Construction: Includes expenses for construction projects, such as construction (including new work, additions, alterations, remodeling, and repairs) of residential, industrial, public, office, warehouse, and other buildings and structures. (Major Groups 15, 16, and 17)

Transportation: Includes expenses for railroad, motor freight, water transportation, air transportation, and other transportation to include packing and crating services, and rental of transportation equipment. (Major Groups 40, 41, 42, 43, 44, 45, 46, and 47)

Communications: Includes expenditures for telephone, telegraph, radio, television, satellite services, Internet transactions, and other communication services. (Major Group 48)

Public Utilities: Includes expenses for natural gas, electricity, water supply, and sanitary (sewer & garbage) services. (Major Group 49)

Manufacturing: Includes expenses for on-site fabrication of processing components, contract manufacturing for items used in processing operations, and the rebuilding of machinery and equipment at the plant. (Major Groups 20 through 39, with emphasis on 35-39)

Wholesale Trade: Expenses paid to establishments primarily engaged in selling merchandise to retailers; to industrial, commercial, institutional, or professional users; or to other wholesalers, or acting as agents in buying merchandise for or selling merchandise to such persons or companies. (Major Groups 50 and 51)

Retail Trade: Includes expenses for building materials, hardware, food, general merchandise, office supplies, automobile fuel, computers, eating and drinking establishments, work uniforms, and most other business and office-related supplies. (Major Groups 52, 53, 54, 55, 56, 57, 58, and 59)

Finance, Insurance, and Real Estate: Includes expenses for loan service, interest on loans, investment counseling, insurance, real estate transactions, brokerage fees, and any other financial service expenditures. (Major Groups 60, 61, 62, 63, 64, 65, 66, and 67)

Business and Personal Services: Examples of business and personal services include expenses for advertising, collection services, photocopying/duplication/printing services, equipment rental, computer services, computer software, security services, tax preparation, automotive/equipment/miscellaneous repairs, entertainment, janitorial services, and overnight lodging. (Major Groups 70, 72, 73, 75, 76, 78, 79, and 87)

Professional and Social Services: Includes expenses for health/pharmaceutical, medical, legal, educational, research and development, child care, vocational training, and other professional services. (Major Groups 80, 81, 82, 83, 84, 86, 88, and 89)

ETHANOL PRODUCER OPERATIONAL EXPENDITURES QUESTIONNAIRE

Company: _____

Location: _____

Contact Person: _____

Listing of expenditures made in FY 2015 (or most recent fiscal year)

Expenditure Categories	Estimated Annual Expenditure In North Dakota
	----------$----------
Corn from North Dakota	
Wages and salaries	
Benefits	
Construction	
Plant maintenance and overhaul	
Transportation	
Communications	
Coal	
Public utilities: Electricity	
Natural gas	
Water	
Garbage/waste disposal	
Miscellaneous manufacturing	
Wholesale trade	
Retail trade	
Finance	
Insurance	
Real estate	
Business and personal services	
Professional and social services	
Other Expenses	

Expenditures for Taxes	Estimated Annual Expenditure In North Dakota
	----------$----------
Government (taxes paid in ND)	
Property taxes	
Sales and use taxes	
Unemployment	
Other taxes (please specify)	

II. **Total annual revenue:** $_____

III. **Number of employees in full-time equivalents:** _____ FTEs

IV. **Corn Purchased from North Dakota entities:** _____Bushels

V. **Annual Ethanol Production:** _____Gallons

VI. **DDGs** _____ Tons Produced

Total sales DDGs $_____

What percentage of DDG sales were to local entities and what percentage were shipped out of state?

Out of state _____ %
Locals (in ND) _____ %
Totals _____ %

VI. **Plant Construction:** Beginning date _____

Completion date _____

VII. **Cost of Plant Construction:** $_____