# MEASURING THE ECONOMIC IMPACTS OF SWITCHGRASS AND CELLULOSIC ETHANOL PRODUCTION IN OKLAHOMA

By

JAMES DAKOTA MOSS

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Thesis Approved:

Dr. Rodney Holcomb

Thesis Adviser

Dr. Phil Kenkel

Dr. Dave Shideler

Dr. Sheryl A. Tucker

Dean of the Graduate College

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# CHAPTER I

## INTRODUCTION

Due in part to an increasing reliance on foreign fuel supply, consumers in the United States are seeing an increase in fuel prices. Higher fuel prices makes it more expensive for consumers to conduct day to day activities such as driving to work, purchasing goods, and even heating their homes. With this dependence on foreign energy the U.S. could be vulnerable to an energy crisis similar to those in 1973 and 1979. Because of the increase in energy prices, dependence on foreign oil, and government policies, the demand for biofuels has increased greatly. The production of biofuels could hypothetically let consumers see a decrease in their energy costs and communities could see possible economic opportunities through biofuel production. Government policy such as the Energy Independence and Security Act of 2007 was created to help the country become more energy independent and less dependent on foreign energy sources. In Title II, Subtitle A, Section 202, the Renewable Fuel Standard set forth a mandate for 36 billion gallons renewable fuels to be produced in the United States by 2022 (U.S. Congress, 2007). To help meet this rising demand, renewable fuel plants are being built throughout the grain belt in the United States. With renewable fuel plants being highly

dependent on agricultural inputs, they are usually located in rural communities with easy access to feed stock supplies.

With Oklahoma being a major agriculture based state, it could potentially have the opportunity to become a large contributor to the production of alternative energy sources. Currently ethanol plants in the U.S. use mainly corn as their feedstock, but the state of Oklahoma in not a major corn producer. Corn-ethanol production not being present, Oklahoma has a potential advantage in producing an alternative viable renewable energy crop such as switchgrass for a cellulosic feedstock. As the production of cellulosic ethanol from switchgrass in Oklahoma is being considered the direct and indirect economic impacts must be projected and analyzed for the regions they are located.

Switchgrass (Panicum virgatum) is a perennial grass native to North America. It is resistant to many pests and plant diseases, and it is capable of producing high yields with very low applications of fertilizer. This means that the need for agricultural chemicals to grow switchgrass is low; however, fertilization may be necessary to maintain harvestable stands. Switchgrass also is very tolerant of poor soils, flooding and drought (Burden 2011). Switchgrass yields in some areas can exceed 10 tons per acre with relatively low amounts of inputs (Ugarte, English, and Jensen, 2007). Epplin (2009) also showed that switchgrass lands are not expected to require many farming activities, which could benefit farmers through collective land use shifts to switch grass production with lower establishment and operating costs compared to other crops. Given these benefits of switchgrass it is being considered as a leading feedstock for cellulosic ethanol production.

Ethanol production from switchgrass has been projected to have a positive economic impact on the county where the biofuel facility is located and surrounding areas where switchgrass would be sourced. Schlosser et al. (2008) showed through multiple scenarios with changes in sales, increasing employment, detailed budget information, and changes in grain procurement how cellulosic ethanol production positively impacted labor markets for the Great Plains region. Swenson (2006) modeled ethanol plant configuration in a three county region in Iowa based on configuration of input and output accounts for the industry with price, cost, and other regional production factors used to modify IMPLAN® sector accounts. Fulton (2010) determined that the impacts of switchgrass farming and cellulosic ethanol conversion in eastern and western Tennessee would have positive economic impacts through the region's output, employment, and total value added.

With the possible installation of a cellulosic biofuel conversion facility and the need for local supplies of biomass, farmers will have the opportunity to expand operations to meet this need or convert crop land over to an energy crop. Research has also examined potential advantages of cellulosic conversion technology using varying feed stocks, including agricultural residues, native grasses, introduced perennials, and dedicated energy crops at the same facility (Thorsel et al. 2004**)**. Because of varying harvest windows across species, specialized harvest and collection equipment could be used throughout many months and reduce the fixed costs of harvest machinery per unit of feedstock. With the need for specialized harvest equipment, agricultural cooperatives may be a viable alternative for producers wanting to produce, harvest, store, and market the energy crops. Incentives such as the Biomass Crop Assistance Program (BCAP) in

the 2008 Farm Bill were designed specifically to spur regional land use transition into switch grass and other biomass feedstock crops, yet the impacts on regional equipment demand were not considered when BCAP was introduced.

Biorefinery locations must have or be near optimal storage facilities that can handle the needed amount of biomass to keep the facilities operational year round. A facility's location must also be close enough to where biomass is being produced so that harvest, production, and logistics costs are economically feasible. The location must also have the utilities and infrastructure to bring in biomass and take out cellulosic ethanol and byproducts. Communities identified as viable locations for a cellulosic biofuel facility have the possibility to see benefits in the form of new jobs, increased economic activity, and advances in local agriculture through crop expansion and use of specialized technology.

The overall objective of this research is to determine the economic impacts of potential bioenergy production on communities and counties in Oklahoma. Specific objectives include:

A. Measure the direct economic impacts of cellulosic ethanol production.

B. Measure the indirect economic impacts of cellulosic ethanol production.

C. Measure the induced economic impacts of cellulosic ethanol production.

D. Analyze the main industries impacted by cellulosic ethanol production in the region the plant is located.

# CHAPTER II

## RELATED LITERATURE

In Oklahoma, little research has been conducted on the possible economic impact of cellulosic ethanol conversion facilities that include the needed infrastructure and needed acres for biomass production. In fact, the literature is inconsistent on the optimal locations for biorefineries in Oklahoma. Tembo et al. (2003) identified Canadian, Comanche, Custer, Garfield, Jackson, Okmulgee, Payne, Pontotoc, Texas, Washington, and Woodward counties as the most viable designated cellulosic conversion facility locations. According to the EPA's Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis, the most viable counties in Oklahoma for biomass production are Craig, Grady, Hughes, Kingfisher, Lincoln, Muskogee, and Osage counties. (U.S. EPA, 2010)

### *Location Feasibility*

With varying viable locations, economical and physical factors will influence the success of a plant. Agricultural supply constraints limit the number of plants an immediate region can support (Low and Isserman, 2008). Low and Isserman (2008) also state that factors that will influence location are access to railways, adequate highways for truck transport, and access to abundant water and power. In the central northern region of the U.S., the

largest plants are adjacent to major grain distribution terminals. For cellulosic ethanol plants to become operational and the industry to reach full potential in Oklahoma a significant investment will be required in infrastructure.

According to Ragan and Kenkel (2007) the full development of a cellulosic based industry could require $10 billion or more for infrastructure investment in Oklahoma and across the southern plains. Granja et al. (2010) determined that economic success associated with a cellulosic ethanol conversion facility can be analyzed through economic risk associated with development and operation. Economic factors for establishment and operation will be essential in the determination for specific viable locations. Duffy (2008) showed that costs for production, storage, and transportation may vary depending on the practices employed, and optimal practices will most likely vary by plant location in Oklahoma.

*Biofuel Demand*

Ugarte et al. (2007) discusses the mandates and policies that have brought on the need for research and development of the ethanol industry. In 2005 The Energy Policy Act mandated that 7.5 billion gallons of renewable fuels be produced by 2012. The Biofuels Security Act of 2007 set a series of mandates that required 10 billion gallons of renewable fuels by 2010, 30 billion by 2020, and sixty billion by 2030. Ugarte et al. (2007) concluded that if these mandates are met for the entire period through 2030 the cumulative displacement could be as high as 10.48 billion barrels of oil and a possible reduction in imports of $629 billion dollars.

With the growing demands and deadlines being set forth for alternative energy sources, cellulosic feedstock such as switchgrass will need to play a major role (Walsh et

al., 2007). Because switchgrass is not a conventionally grown crop, it must compete with conventional crops for land use, and it is assumed that switchgrass can be grown on any land suitable for corn or wheat production (Beckman et al., 2011). Beckman et al. (2011) also determined that the mandates for cellulosic ethanol will have effects strongest in the wheat market, as switchgrass will primarily compete with land used for wheat production. If mandates are met by 2030 estimated cellulosic feedstock production in Oklahoma could be as much as 38 million dry tons annually (Ugarte et al., 2007). Ragan and Kenkel (2007) determined that use of CRP lands to produce biorefinery feedstock would have minimal impacts on other crop and livestock industries due to the current lack of production on those acres. If switchgrass is to become competitive with wheat or corn for land, farmers will need to have incentives to convert crop production and improved pasture acres to a long-term feedstock crop. This could be in the form of subsidies or a premium from the ethanol plant they are to supply.

*Cellulosic Ethanol Feasibility*

In switchgrass production estimated costs are higher for bales and pellets than for modulated and chopped material based on yield, hauling distance, and truck capacity for estimated delivery cost (Bransby et al., 2005). Popp and Hogan (2007) also concluded that an advantage of the module system is the ability to provide chopped material to the plant where it can be easily metered for the production process, but difficulties associated with module building are uncertainties about whether and how well switchgrass modules will last in the field as well as the high labor and equipment intensity compared to the more easily adoptable round baling or large square baling.

Harvest costs may vary greatly due to differences in harvesting practices and the associated equipment used for these activities. Thorsel et al. (2004) under economies of size for supplying biomass to a biorefinery estimated the optimal harvester unit to be ten laborers, nine tractors, three mowers, three rakes, three balers, and one bale transporter; also it was determined that balers that form large rectangular solid (approximately 1:2 m×1:2 m×2:4 m) bales would be the least-cost method of baling. In general, it is easier to stack and store rectangular solid bales than cylindrical bales. Besides baling or module building switchgrass, another method to consider is loafing of switchgrass, grinding and transportation the biomass by truck to a biorefinery. The cheapest harvest method, depending on location and biorefinery, may be baling, loafing or ensiling (Kumar and Shahab, 2007). Determining possible harvest costs helps to provide the economically efficient scale for a biomass conversion facility.

In the determination of size for a cellulosic ethanol facility, it is important to consider the number of available acres of production that surround the facility's possible location. Size of a cellulosic biomass facility is determined by millions of gallons produced per year at full capacity, such as 20, 50, or 100 million gallons per year. For cellulosic ethanol facilities research has shown that higher the conversion rates (gallons per ton), lower construction costs and lower delivered lignocellulosic biomass costs are necessary to sustain financial viability (Busby et al. 2008).

Biomass conversion facilities must achieve economies of size in order to make ethanol a feasible alternative fuel (Busby et al. 2008). Gill et al. (2003) studied the feasibility of 15, 30, and 80 million gallon-per-year ethanol production facilities, and based on their estimates, each facility required a certain subsidy level to remain

economically feasible. Under a zero subsidy level, the 15 million gallon-per-year facility has no chance of success, but with a .455/gal subsidy the plant has a 100% chance of success. The 30 million gallon-per-year facility was 100% successful with a subsidy value of $0.375/gal, and the 80 million gallon-per-year facility was 100% successful with a $0.225/gal subsidy. This study shows that a facility must utilize economies of size in order to be economically efficient. In certain viable locations, economies of size are needed in relation to available biomass resources and infrastructure.

*Economic Impact Assessments*

Once a facility's location is determined there will be many different economic impacts measured. Using input-output analysis, direct, indirect, and induced impacts can be measured to show how a specific activity such as the operation of an ethanol facility will affect the region's economy in the region. Measuring these impacts at different locations is more beneficial and efficient for the results of the study, and suggests how a plant will affect communities with different levels of urbanization and size. Low and Isserman (2008) conducted a study similar to this for three communities in Illinois and classified the communities as being rural, urban, or mixed rural. This classification in their study helped to show how the establishment and operation of an ethanol plant would affect differing communities.

Measuring the impact of biofuel production has also been conducted through input-output analysis. Swenson (2006) utilized input-output analysis to estimate impacts for ethanol plants for a three county region in Iowa. Focusing his models on accounts for the industries that are sensitive to price, cost and other regional production factors, Swenson (2006) modified industry accounts to show ethanol production. Through this

type of analysis, impacts for output, value added, and jobs were measured. Further, Swenson (2006) assumed that with the production of ethanol corn production would not increase to meet the demand, but did show an increase of 135 jobs. In utilizing input-output analysis software such as IMPLAN® more in depth industry details can also be measured to show how industry change can affect additional industries.

Schlosser et al. (2008) evaluated input-output impact projections by taking actual labor impacts from a Kansas ethanol plant opening and comparing them to the projected impacts before the plant was established. In multiple scenarios with projections based on employment or projected sales, Schlosser et al. (2008) showed pre-opening jobs and income estimates exceeded the actual impacts. In other scenarios with more information on actual production technology estimates were more approximate to what actually took place.

Flanders and McKissick (2007) analyzed a proposed operation of a cellulosic ethanol production from wood cellulose in Georgia. Using input-output analysis on Treutlen County for the plant location, impacts for plant construction and ethanol production were measured. With the construction and operation of the plant, 194 jobs would be created on the county level, 432 jobs for an 18 county region, and, on the state level, and 444 jobs. With no viable operating plant to compare projections, these estimations may be off, as in the case of Schlosser et al. (2008).

Petersan (2002) used input-output analysis to estimate employment and economic impacts for the operation of Nordic Biofuels Ethanol Plant in Ravenna, Nebraska. A nine-county model was developed using industry data from 1999. Variables impacting the analysis included labor income, property income, employment, and industry output.

Input-output analysis measured employment effects, labor effects, output effects, indirect business tax effects, and retail sale effects.

Fulton (2010) used input-output analysis to measure the impact of cellulosic ethanol production in the western and eastern regions of Tennessee and compare the two. In analyzing the two regions, factors included production, storage, transport, and conversion of switchgrass to ethanol. Using the costs from those factors, the study projected the economic impacts of a cellulosic ethanol facility in the two study regions. Fulton concluded that the implementation of a cellulosic facility in either region would have a positive economic impact for the study area.

# CHAPTER III

## METHODOLOGY

The economic impacts from the operation of cellulosic ethanol facilities in Oklahoma were determined using the input-output analysis software IMPLAN®. IMPLAN® is software that uses a combination of regional social accounts, industry accounts, and multiplier models to provide adaptable models. The IMPLAN® data utilizes county, state, and federal economic statistics by region and uses this data to measure the effect on a region or local economy for a new activity or event such as the operation of a cellulosic ethanol facility.

The first step of the study was to establish the location and number of plants in the state. Secondly, switchgrass production was added to IMPLAN® since it is not currently represented in the industry accounts. Industry accounts and study area data will be modified to show that switchgrass will be in production in the target area. Third, each scenario assumed the ethanol plants were already constructed and the operation activity was modeled through operating and depreciation expenditures. In this study construction cost impacts for an ethanol plant and establishment costs for switchgrass stands were not measured. Construction costs for a plant only occur once, thus are temporary do not sustain long-term employment. Establishment cost for switchgrass stands exist but are

sunk costs and not accounted for in this study. Operating costs for a plant and maintenance costs for switchgrass take place over many years and were measured. Finally, after switchgrass production and cellulosic ethanol plant operation were modeled, economic impacts from the two activities were projected by IMPLAN® for each different scenario.

Input-Output Analysis and IMPLAN®

Input-output analysis is a type of applied economic analysis that tracks the interdependence among various producing and consuming sectors of an economy. More particularly, it measures the relationship between a given set of demands for final goods and services and the inputs required to satisfy those demands (MIG, 2012). When models are run in IMPLAN®, estimates of multipliers are provided to determine the direct economic effects, indirect economic effects, and induced economic effects.

In IMPLAN® multipliers are estimations for the changes in the final demand for a given industry on all other industries in the study region's economy. Type I multipliers are used to measure the direct and indirect economic impacts while Type II multipliers are used to measure direct, indirect, and induced economic impacts. For example an employment multiplier of 1.5 is used for employees of a cellulosic ethanol facility. For every one direct employee at the ethanol plant an additional 1.5 indirect jobs will be created in the local economy. The same is for an income multiplier; with an income multiplier of 1.4 is being used, for every dollar being generated by the ethanol plant an additional $1.40 will be generated in the local economy.

The direct economic effects that are modeled are expenditures or production changes that consumers make as a result of an activity. Indirect economic effects are the

impacts of local industries from which goods or services are bought due to the new activity in the area (MIG, 2012). Induced economic effects are responses by an economy to the new activity's (direct impacts) payroll and owners spending income locally (MIG, 2012).

The combination of the direct, indirect, and induced effects represent the transfer of money between industries due to the new activity in the modeled region. The three effects represent changes in the region's employment, labor income, total value added, and output. Employment is the number of new jobs created in the region due to the new activity. Labor income represents employee compensation and proprietor income. Total value added represents the cost of production in excess of goods and services purchased from the industry. This category captures labor costs as well as expenses associated with management experience, investor returns, and retained earnings by the firm. Output represents the total revenues, sales, or the total value of the output from the activity.

*Switchgrass Production Area and Plant Location Data*

In determining the optimal plant locations and switchgrass production areas this study expanded on the dissertation work of Mohua Haque (2010). A comprehensive mathematical programming model was used to determine optimal locations and production areas. The model is designed and solved to determine the area and quantity of switchgrass harvested by county, the number of harvest machines, and the cost to procure, harvest, store, and transport a flow of switchgrass biomass to an optimally located and optimally sized biorefinery (Haque, 2010).

In Haque's model it is assumed that the life of an ethanol plant is twenty years. All plant investment costs will occur in year zero. Biomass harvest and delivery, plant

operation, and ethanol production begins in year one and continues through year twenty. All operation activities in year one through year twenty are assumed to be identical. Biorefinery investment costs for a 50 million gallon capacity facility are assumed to be $275 million. The biorefinery is assumed to operate 350 days per year, and depends entirely on switchgrass as a single feedstock. A conversion rate of 100 gallons of ethanol per dry ton of switchgrass is assumed. Feedstock delivery takes place in all twelve months of the year. In the model six candidate biorefinery locations are considered in Canadian, Garfield, Okmulgee, Payne, Pontotoc, and Washington counties.

For switchgrass stands total harvested acres in each county may not exceed the number of acres available for harvest in the county. Biomass harvested is equal to the available biomass in the field. Haque's original model was limited to the eastern 57 counties of Oklahoma's 77 counties as production regions. The harvest season begins in July and extends through March. Fields harvested in July are expected to require 80 pounds per acre of nitrogen to achieve highest yields while fields harvested in October through March are expected to require only 63 pounds per acre. Switchgrass production is restricted to cropland and improved pasture land and is limited to no more than ten percent of the each production county's cropland and no more than ten percent of the county's improved pasture land. Storage losses at the biorefinery and in the field are assumed to be one percent per month. Also switchgrass dry matter will be of equivalent value to the biorefinery independent of harvest month and time in storage.

Haque's (2010) model was expanded by Haque in post doctoral research to account for switchgrass production in all 77 counties in Oklahoma. The model identified nine possible optimal locations for ethanol plants in an iterative manner, up to the point

where 10% of all crop and pasture acres in each county was converted to switchgrass production.

Table 3.1. Scenarios 1-9 with ethanol plant locations and needed acres and biomass tonnage to supply the ethanol plants.

| Scenario | Assumptions | Biorefinery locations | Total Biomass harvested (tons) For total Cropland and Improve pasture | Acres harvested For total Cropland and Improve pasture |
|---|---|---|---|---|
| 1 | Restricted to one biorefinery | Grady | 605,320 | 133,139 |
| 2 | Restricted to two biorefineries | Grady & Garfield | 1,211,188 | 271,961 |
| 3 | Restricted to three biorefineries | Grady, Garfield, & Okmulgee | 1,818,083 | 400,967 |
| 4 | Restricted to four biorefineries | Grady, Garfield, Okmulgee,& Pontotoc | 2,423,282 | 554,783 |
| 5 | Restricted to five biorefineries | Grady, Garfield, Okmulgee, Pontotoc, & Woods | 3,029,439 | 707,302 |
| 6 | Restricted to six biorefineries | Grady, Garfield, Okmulgee, Pontotoc, Woods, & Washington | 3,634,462 | 853,002 |
| 7 | Restricted to seven biorefineries | Canadian, Comanche, Garfield, Okmulgee, Pontotoc, Washington, Woodward | 4,239,542 | 1,023,216 |
| 8 | Restricted to eight biorefineries | Blaine, Garfield, Grady, Jackson, Okmulgee, Pontotoc, Washington, Woodward | 4,846,144 | 1,223,953 |
| 9 | Restricted to nine biorefineries | Blaine, Grady, Garfield, Jackson, Okmulgee, Pontotoc, Texas, Woods, Washington | 5,454,980 | 1,450,558 |

The economic impacts reported in this thesis were measured by modeling the iterative scenarios with one plant one location, two plants two locations, up to nine plant locations. The updated Haque study results of the nine different scenarios are provided.

Biorefinery locations by scenario are shown in Table 3.1. as well as total acres harvested and biomass harvested to supply the biorefineries for each scenario.

In the current study it is assumed that all ethanol plants are 50 million gallon annual capacity. Plants will operate 350 days a year. Payroll for all plant employees is assumed to be $2.7 million for each plant. Biomass is supplied throughout the year. Also it is assumed that switchgrass stands and ethanol plants are already established. Because both are already established the investment costs for switchgrass stands and ethanol plants are not included in the input-output analysis. Only the switchgrass maintenance costs and ethanol plant operation and depreciation costs are included in the study. Operation and depreciation costs for each plant are assumed to be identical, and maintenance costs for switchgrass are assumed to be identical for both cropland and improved pasture land. Land use is restricted to no more than 10% of cropland acres or pasture land acres by county as in Haque's (2010) earlier model. Land use is restricted to only 10% to keep land prices from rising as ethanol plants are bidding to lease land for switchgrass production.

*Switchgrass Production*

To account for switchgrass production in the targeted study areas for each differing scenario, the first step was to create a different model for each scenario containing the counties where switchgrass production would be in production for that specific scenario in IMPLAN®. Each scenario's switchgrass production region can be viewed in Appendix A. After the new model is opened and each county with switchgrass production is added to the model, industry accounts where constructed. To show switchgrass production is currently in operation in the targeted region, study area data

and industry production accounts were edited in all other crop farming (IMPLAN® sector 10).

In determining specific industry accounts to edit to account for switchgrass production in the study region, a switchgrass maintenance budget developed by Griffith et al. (2010) was utilized to calculate new coefficients for the costs of DAP, Urea, fertilizer application, swathing, bailing, hauling, and operating capital. The cost of DAP was divided by the total value of production for switchgrass to give the new coefficient for IMPLAN® sector 319 (Wholesale trade businesses). Next urea cost was divided by the total value of production for switchgrass to give the new coefficient for IMPLAN® sector 130 (Fertilizer manufacturing). The three costs for the activities of fertilizer application, swathing, and bailing are combined and then divided by the total value of production to give the new coefficient under sector 19 (Support activities for agriculture and forestry). The cost of hauling from field to plant is divided by total value of production to give the new coefficient under sector 335 (Transport by truck). Operating capital is divided by total value of production to give the final needed coefficient under sector 354 (Monetary authorities and depository credit intermediation activities). These new coefficients are entered into industry production account sector 10 (all other crop farming) to show that switchgrass production is in the study region. To complete the model to account for switchgrass production in the region study area data under sector 10 is also changed. Totals for employment, output, employee compensation proprietor income, other property type income and indirect business tax were altered to reflect switchgrass production in the region. Scenario 1 values used to edit the study area data

and production function under sector 10 can be viewed in Appendix B. After these changes were made, the model was reconstructed through multipliers.

In each scenario for switchgrass production the number of switchgrass supplying counties changed as we add another plant location. As the production region expanded the average yield per acre for switchgrass production also changed. This differing yield per acre in each scenario influences all cost activities in the model and causes differing coefficients used in each scenario.

When the model was reconstructed a new industry change activity was added for the switchgrass supply counties, and an event under this activity was created under sector 10, all other crop farming. The event year was changed to 2009 and under industry sales the total value for production for switchgrass in that scenario was entered. Total value of production was the sum of cash cost, labor cost, and proprietor income for switchgrass. After the switchgrass activity was put into the model, the direct, indirect, and induced economic effects that take place in the targeted production region due to switchgrass production for each scenario were estimated. This process was repeated for all scenarios as the switchgrass production region increased to supply the increasing number of plants.

*Modeling Ethanol Production*

In cellulosic ethanol production we assumed that the plants were already established in the state of Oklahoma. Because of this assumption, establishment and construction costs were not used in measuring the economic impacts for ethanol production. Expenditures for ethanol plant operation were taken from a Tennessee cellulosic ethanol plant budget created by Ugarte et al. (2006) to measure the impacts of a 69.3 million gal/year cellulosic ethanol plant. All expenditures were converted to be used

for a 50 million gal/year plant for this study by multiplying the original expenditure by a (50/69.3) ratio. Because the budget was from 2006 the IMPLAN® sectors where the expenditures fell had to be edited, as the industry sectors changed from having 509 sectors to 440 sectors. Below is the converted operating budget for ethanol plants in the current study with corresponding IMPLAN® in Table 3.2.

Table. 3.2. IMPLAN® expenditures for ethanol production from switchgrass.

| Type | IMPLAN Sector | Description | Expenditures |
|---|---|---|---|
| Operating | 10 | All Other Crop Farming | $16,915,300.87 |
| Operating | 33 | Water, sewage and other treatment and delivery systems | $299,333.33 |
| Operating | 123 | Alkalies and chlorine manufacturing | $175,063.74 |
| Operating | 124 | Carbon black manufacturing | $65,651.29 |
| Operating | 125 | All other basic inorganic chemical manufacturing | $997,511.53 |
| Operating | 126 | Other basic organic chemical manufacturing | $6,621,177.49 |
| Operating | 130 | Fertilizer manufacturing | $154,855.70 |
| Operating | 164 | Lime and gypsum product manufacturing | $1,132,948.77 |
| Operating | 357 | Insurance carriers | $485,111.83 |
| Operating | 368 | Accounting, tax preparation, bookkeeping, and payroll services | $484,497.84 |
| Operating | 390 | Waste management and remediation services | $1,500,216.45 |
| Operating | 417 | Commercial and industrial machinery and equipment repair and maintenance | $1,714,124.82 |
| Depreciation | 35 | Construction of new nonresidential manufacturing structures | $36,602.45 |
| Depreciation | 123 | Alkalies and chlorine manufacturing | $572.26 |
| Depreciation | 124 | Carbon black manufacturing | $214.61 |
| Depreciation | 125 | All other basic inorganic chemical manufacturing | $3,260.75 |
| Depreciation | 141 | All other chemical product and preparation manufacturing | $1,114.72 |
| Depreciation | 188 | Power boiler and heat exchanger manufacturing | $764,256.85 |
| Depreciation | 189 | Metal tank (heavy gauge) manufacturing | $650,420.63 |
| Depreciation | 190 | Metal can, box, and other metal container (light gauge) manufacturing | $42,170.27 |
| Depreciation | 202 | Other fabricated metal manufacturing | $36,533.91 |
| Depreciation | 203 | Farm machinery and equipment manufacturing | $122,575.76 |
| Depreciation | 207 | Other industrial machinery manufacturing | $640,788.60 |
| Depreciation | 213 | Other commercial and service industry machinery manufacturing | $107,266.96 |
| Depreciation | 214 | Air purification and ventilation equipment manufacturing | $1,019,031.02 |
| Depreciation | 214 | Air purification and ventilation equipment manufacturing | $17,801.59 |
| Depreciation | 215 | Heating equipment (except warm air furnaces) manufacturing | $73,306.64 |
| Depreciation | 216 | Air conditioning, refrigeration, and warm air heating equipment manufacturing | $220,336.22 |
| Depreciation | 222 | Turbine and turbine generator set units manufacturing | $829,566.38 |

| | | | |
|---|---|---|---|
| Depreciation | 226 | Pump and pumping equipment manufacturing | $490,205.63 |
| Depreciation | 227 | Air and gas compressor manufacturing | $80,202.02 |
| Depreciation | 228 | Material handling equipment manufacturing | $1,481,998.56 |
| Depreciation | 228 | Material handling equipment manufacturing | $11,934.34 |
| Depreciation | 230 | Other general purpose machinery manufacturing | $21,563.49 |
| Depreciation | 251 | Industrial process variable instruments manufacturing | $42,852.09 |
| Byproduct | 31 | Electric power generation, transmission, and distribution | $4,721,594.52 |

For each scenario the values for the above IMPLAN® sectors were quantified based on the number of ethanol plants in the model. For the first scenario, values were only for one plant and multiplied by one, multiplied by two for two plants in scenario 2, and this continued through all nine scenarios.

For the ethanol plant in IMPLAN® a new model was constructed with the target location for the first scenario. Once the model was constructed a new industry change activity was opened to show ethanol plant operation. Under this activity, the operating and depreciation expenditures were entered under events to show an ethanol plant in operation. The inputs available locally for each scenario, their scenario values, and the total direct impact they had can be seen in Appendix B.

Once the events were entered for ethanol plant operation under the industry exchange activity another activity was created to account for plant employee income in the region. This activity was represented as a labor income change in the region with a new event under it for payroll. A value of $2.7 million was used as the total salary for plant employees. This value was taken from Hodur and Leistritz (2009) when they analyzed the impacts of a 50 million gal/year cellulosic plant in North Dakota. This salary value was used for each scenario and quantified depending on the number of plants in the given scenario. Once these activities were entered with their corresponding events,

the model showed the direct, indirect, and induced impacts that cellulosic ethanol production was expected to have in the region for the given scenario.

The steps discussed above were followed for each scenario with the values for each activity and event being multiplied corresponding to the number of ethanol plants in the scenario. Among the scenarios the only difference between scenarios took place for the first. For the first scenario model different management scenarios are modeled to compare how a 50% cooperative owned ethanol plant will impact the region compared to a 100% privately owned ethanol plant.

In each scenario, a 100% private ownership was assumed, but in the first we compared private and cooperative ownership impacts. A cooperative business does not retain profits but redistributes them to members through annual cash patronage or qualified stocks. Accounting for private ownership, we just followed the original steps discussed above. To account for cooperative ownership, we took 50% of the plant's profits and kept them in the region. To do this, under the labor income change activity, we added an additional event for proprietor income. Under proprietor income, 50% of the plants profits were entered. Profits were calculated by taking the current market price of $2.29 gallon (Nebraska Energy Statistics, 2012) and adding a dollar tax credit (DOE, 2011) to give a new ethanol price of $3.29. The breakeven price from scenario one of $2.81 (Haque, 2010) was subtracted from the new ethanol price of $3.29 to give a profit of $0.48 per gallon of ethanol. The $0.48 profit per gallon was multiplied by the plant capacity of 50 million gal/year to give plant profits of $24 million, and 50% of the plant profits ($12 million) were entered in to the proprietor income event. With this, we were able to model cooperative ownership in IMPLAN® through cash returns to producers in

the region. Once the cooperative and private ownership models were run separately, results were compared from the two to analyze how the different management will affect Grady County.

# CHAPTER IV

## RESULTS

It is important to remember that investment costs for both switchgrass production and cellulosic ethanol production were treated as temporary costs and not included in the model. Also, switchgrass production and ethanol production were modeled separately as two different models, so results are presented separately for each individual scenario. Results for the two activities were also summed to show the total impact in the given scenario for the study region. For the results we focus on the total impacts from the two activities, as well as go into detail on how they affect industry employment and output. It should also be noted that the methods used for each scenario were the same, except for the first scenario where different ownership/management practices (private ownership versus cooperative ownership) were considered.

### *Scenario one*

For the first scenario, we modeled both a cooperative ownership and private ownership structure. For this we measured the impacts of 0% cooperative ownership (100% private ownership), 50% cooperative ownership (50% private ownership), and 100% cooperative ownership (0% private ownership). Also, switchgrass production to

supply the single ethanol plant was modeled. The impacts from switchgrass production, from private ownership, from the 50% cooperative ownership model, and finally impacts for the 100% model are presented below.

For switchgrass production there were eight counties in the production region for the single plant located in Grady County (scenario one). Industry output for switchgrass production was $32.2 million in direct effects, $11.2 million in indirect effects, and $16.9 million in induced effects. The total industry impacts for the switchgrass production region including direct, induced, and indirect were $60.3 million. Employment for switchgrass production was 169 direct employees, 123 indirect employees, and 165 induced employees. This gave an impact of 457 total employees for switchgrass production. All impacts are shown below in table 4.1.

Table. 4.1. Switchgrass Production Scenario One. Eight County production region.

| | Switchgrass Production | | | |
|---|---|---|---|---|
| | Direct Effects | Indirect Effects | Induced Effects | Total Effects |
| Employment | 169 | 123 | 165 | 457 |
| Labor Income | $9,541,416.85 | $4,553,850.07 | $6,356,543.20 | $20,451,810.11 |
| Total Value Added | $9,541,416.85 | $6,439,878.17 | $10,746,172.92 | $26,727,467.94 |
| Output | $32,180,907.10 | $11,239,092.17 | $16,887,026.37 | $60,307,025.64 |

Employment results showed that the industries affected the most fall under IMPLAN sector 10 (All other crop farming), sector 19 (Support activities for agriculture and forestry), sector 335 (Transport by truck), and sector 319 (Wholesale trade businesses). Industries affected by output from switchgrass production are under sectors 10 (All other crop farming), 319 (Wholesale trade businesses), 335 (Transport by truck), and 361 (Imputed rental activity for owner-occupied dwellings). The top ten industries

affected by switchgrass production for employment, output, labor income, and value added can be seen in Appendix C.

Under private ownership for the ethanol plant in Grady county we see output impacts projected at $5.3 million direct, $.68 million indirect, and $3.7 induced, for total output impacts of $9.7 million. Under employment for the private ownership ethanol plant there are 52 direct employees, 7 indirect employees, and 40 induced employees, for a total of 99 employees. For employment under operation of the privately owned ethanol plant the industry's most affected areas are IMPLAN® sectors 417 (Commercial and industrial machinery and equipment repair and maintenance), 390 (Waste management and remediation services), 368 (Accounting, tax preparation, bookkeeping, and payroll services), and 413 (Food services and drinking places). Under output the most affected industries are IMPLAN® sectors 417(Commercial and industrial machinery and equipment repair and maintenance), 31 (Electric power generation, transmission, and distribution), 390 (Waste management and remediation services), and 361 (Imputed rental activity for owner-occupied dwellings).

For the first cooperative-owned cellulosic ethanol plant scenario we assume 50% producer ownership and so 50% of the profits will stay in the region and distributed as annual cash patronage. Under the 50% cooperative ownership industry output is $5.3 million direct, $.68 million indirect, and $11.7 million induced, for a total industry output of $17.7 million. Employment for the cooperative ethanol plant is 52 direct employees, 7 indirect employees, and 125 induced employees, totaling 184 employees. The top ten industries affected for employment, labor income, output, and value added can be seen in Appendix C.

The top industries impacted by employment for the cooperative plant are IMPLAN® sectors 417 (Commercial and industrial machinery and equipment repair and maintenance), 413 (Food services and drinking places), 437 (* Employment and payroll only (state & local govt, non-education)), and 368 (Accounting, tax preparation, bookkeeping, and payroll services). For industry output the top sectors affect by ethanol plant operation are 361 (Imputed rental activity for owner-occupied dwellings), 417 (Commercial and industrial machinery and equipment repair and maintenance), 31 (Electric power generation, transmission, and distribution), and 390 (Electric power generation, transmission, and distribution).

The second cooperative owned cellulosic ethanol plant scenario assumes 100% producer ownership with 100% of the profits staying in the region and distributed as annual cash patronage. Under this cooperative ownership model industry output is $5.3 million direct, $.68 million indirect, and $19.7 million induced, for a total of $25.7 million. Employment for the cooperative ethanol plant is 52 direct employees, 7 indirect employees, and 210 induced employees, for a total of 269 employees. The top ten industries affected for employment, labor income, output, and value added can be seen in Appendix C.

The top industries impacted by employment for the cooperative plant are IMPLAN® sectors 417 (Commercial and industrial machinery and equipment repair and maintenance), 413 (Food services and drinking places), 437 (* Employment and payroll only (state & local govt, non-education)), and 394 (Offices of physicians, dentists, and other health practitioners). For industry output the top sectors affect by ethanol plant operation are 361 (Imputed rental activity for owner-occupied dwellings), 417

(Commercial and industrial machinery and equipment repair and maintenance), 31 (Electric power generation, transmission, and distribution), and 413 (Food services and drinking places).

Comparing the three differing ownership structures for the cellulosic ethanol plant we see a decrease in direct output from the 100% private ownership to 50% cooperative ownership of $112,823. Indirect industry output decreases by $45,707. However, induced industry output increases by $7.4 million. Total industry impacts for output increase by $7.2 million as the plant changes from 100% private ownership to 50% cooperative ownership. There are no direct or indirect changes in employment as the ownership structures change, but induced employment impacts for the region increase from 40 induced employees for the 100% private management to 124 induced employees for the cooperative management. This gives a total of 84 jobs created through the 50% cooperative ownership scenario.

As the model changes from an assumed 50% cooperative ownership to 100% cooperative ownership we see a no changes in the direct or indirect impacts, but a large increase is shown through the induced impacts. Under induced impacts employment jobs increase from 125 to 210, labor income increases from $4.2 million to $6.9 million, total value added increases from $7.5 million to $12.7 million, and industry output increases from $11.7 million to $19.7 million. In Table 4.2 the direct, indirect, induced, and total impacts for each differing management model can be seen and compared. With the increase in cooperative ownership it is shown that there is a large increase in induced impacts from the additional cash returns kept in the study region.

Table 4.2. Scenario 1. Private Ownership, 50% Cooperative Ownership, and 100% Cooperative Ownership Management Impacts.

| | Direct Effects | Indirect Effects | Induced Effects | Total Effects |
|---|---|---|---|---|
| | Private Ownership (0% coop ownership) | | | |
| Employment | 52 | 7 | 40 | 99 |
| Labor Income | $1,933,639.04 | $228,823.40 | $1,373,056.63 | $3,535,519.08 |
| Total Value Added | $3,434,784.34 | $355,600.20 | $2,383,011.72 | $6,173,396.25 |
| Output | $5,336,510.92 | $682,556.55 | $3,687,517.76 | $9,706,585.24 |
| | 50% Cooperative Ownership | | | |
| Employment | 52 | 7 | 125 | 184 |
| Labor Income | $1,933,639.04 | $228,823.40 | $4,158,492.66 | $6,320,955.10 |
| Total Value Added | $3,434,784.34 | $355,600.20 | $7,527,034.26 | $11,317,418.79 |
| Output | $5,336,510.92 | $682,556.55 | $11,710,683.67 | $17,729,751.14 |
| | 100% Cooperative Ownership | | | |
| Employment | 52 | 7 | 210 | 269 |
| Labor Income | $1,933,639.04 | $228,823.40 | $6,943,928.51 | $9,106,390.95 |
| Total Value Added | $3,434,784.34 | $355,600.20 | $12,671,056.49 | $16,461,441.02 |
| Output | $5,336,510.92 | $682,556.55 | $19,733,849.11 | $25,752,916.59 |

*Scenarios two-six*

In scenario one the only ethanol plant located in Oklahoma is in Grady County. In scenario two ethanol plants are located in Grady and Garfield County. In scenario three ethanol plants are located in Grady, Garfield, and Okmulgee County. A plant is added per scenario on top of these first three plant locations up to scenario six. For scenario four a plant is added in Pontotoc county, scenario five a plant is added in Woods County, and in scenario six a plant is added to Washington County. For scenarios seven through nine, plant locations change due to optimal infrastructure and switchgrass supply density, but that will be discussed later.

For scenarios two through six the switchgrass production county area increases with the addition of each plant. In scenario two switchgrass production takes place in 13

counties, scenario three 25 counties, scenario four 37 counties, scenario five 45 counties, and in scenario six 56 counties. Table 4.3 shows the total combined direct, indirect, and induced economic impacts for switchgrass production and ethanol production for scenarios two through six.

Table 4.3. Total impacts for switchgrass and ethanol production in scenarios two-six.

| | Scenario 2 | Scenario 3 | Scenario 4 | Scenario 5 | Scenario 6 |
|---|---|---|---|---|---|
| Switchgrass Production | | | | | |
| Employment | 925 | 1,637 | 2,189 | 2,672 | 3,229 |
| Labor Income | $42,569,270.17 | $67,034,656.26 | $89,755,008.79 | $110,584,794.39 | $132,078,642.37 |
| Total Value Added | $54,473,637.35 | $87,246,540.41 | $116,273,142.45 | $142,286,205.25 | $169,277,760.58 |
| Output | $116,931,346.80 | $195,848,404.06 | $262,863,129.26 | $323,230,003.80 | $386,535,038.14 |
| Ethanol Production | | | | | |
| Employment | 204 | 306 | 410 | 524 | 601 |
| Labor Income | $8,266,028.95 | $12,251,465.29 | $16,516,918.62 | $20,654,685.40 | $24,261,618.53 |
| Total Value Added | $14,772,697.91 | $22,265,496.10 | $30,753,718.18 | $38,406,041.35 | $45,916,985.24 |
| Output | $23,435,791.54 | $35,448,042.76 | $48,934,088.92 | $61,274,166.91 | $73,274,947.66 |

In scenario two an employment impact of 925 jobs is generated from the production of switchgrass. In scenario three employment increases to 1,637, scenario four 2,189, scenario five 2,672, and in scenario six 3,229. From scenario two through six switchgrass production area increases from 13 counties to 56 counties, adding on average 576 jobs per scenario. In scenarios two through six labor income increases from $42.6 million to $132 million with an average increase of $22.3 million for each scenario. Total value added in scenario two is $54.5 million and increase to $169.3 million in scenario six, increasing on average $28.7 million per scenario. Total industry output for scenarios two through six ranges from $116.9 million to $368.5 million with an average increase of $67.4 million from scenario to scenario.

In this study the main focus for the economic impacts are employment and total industry output. In scenarios two through six top industries impacted from switchgrass production for employment are IMPLAN® sectors 10 (All other crop farming) which in this study is switchgrass farming, sector 19 (Support activities for agriculture and forestry), sector 335 (Transportation by truck), and sector 413 (Food services and drinking places). Scenarios two through six industries impacted by total industry output fall under IMPLAN® sector 10 (All other crop farming), sector 335 (Transportation by truck), sector 319 (Wholesale trade businesses), sector 19 (Support activities for agriculture and forestry), and sector 361 (Imputed rental activity for owner-occupied dwellings).

Ethanol production in scenario two has an employment impact of 204 jobs. In scenario three projected employment increases to 306, scenario four to 410, scenario five to 524, and in scenario six 601 jobs. From scenario two through six the projected employment impacts average for ethanol production ninety-nine jobs from the addition of each plant from scenario to scenario. Labor income for scenarios two through six increases from $8.3 million in scenario two to $24.3 million in scenario six with an average increase of $3.9 million for each scenario. Total value added in scenario two is $14.8 million and increase to $45.9 million in scenario six, increasing on average $7.8 million per scenario. Total industry output for scenarios two through six ranges from $23.4 million to $73.3 million with an average increase of $12.5 million from scenario to scenario.

With the main focus of the economic impacts being employment and total industry output for this study in scenarios two through six top industries impacted from

ethanol production under employment fall under IMPLAN® sectors 417 (Commercial and industrial machinery and equipment repair and maintenance), sector 390 (Waste management and remediation services), sector 413 (Food services and drinking places), sector 31 (Electric power generation transmission and distribution), and sector 368 (Accounting, tax preparation, bookkeeping, and payroll services). Scenarios two through six industries impacted by total industry output fall under IMPLAN® sectors 31 (Electric power generation transmission and distribution), 417 (Commercial and industrial machinery and equipment repair and maintenance), sector 390 (Waste management and remediation services), and sector 361 (Imputed rental activity for owner-occupied dwellings).

*Scenarios Seven-Nine*

As the number of plants increase the optimal locations also change in relation to switchgrass supply density and available infrastructure to supply the switchgrass to the plants. In the previous six scenarios plant locations were added onto the previous scenarios without optimal locations needing to change, but in scenarios seven through nine ethanol plant locations do change in relation to infrastructure and switchgrass production density. Plants for scenario seven are located in Canadian, Comanche, Garfield, Okmulgee, Pontotoc, Washington, and Woodward Counties. The switchgrass production area increases to 64 counties to meet the production demand for the seven ethanol plants. For scenario eight optimal ethanol plant locations change to Blain, Garfield, Grady, Jackson, Okmulgee, Pontotoc, Washington, and Woodward County. The switchgrass production area increases to 71 counties to meet the production demand for eight ethanol plants. For the ninth and final scenario ethanol plant locations are Blain,

Garfield, Grady, Jackson, Okmulgee, Pontotoc, Texas, Woods, and Washington County. The switchgrass production area increases to all 77 counties in Oklahoma to meet the production demand for the nine ethanol plants. In the table below we see the total combined direct, indirect, and induced economic impacts for switchgrass production and ethanol production for scenarios seven through nine.

Table 4.4. Total impacts for switchgrass and ethanol production in scenarios seven-nine.

| | Scenario 7 | Scenario 8 | Scenario 9 |
|---|---|---|---|
| Switchgrass Production | | | |
| Employment | 3,794 | 4,590 | 5,160 |
| Labor Income | $156,365,852.03 | $188,998,798.53 | $215,860,071.22 |
| Total Value Added | $200,176,761.31 | $240,858,132.41 | $274,675,043.01 |
| Output | $453,040,482.56 | $540,033,080.10 | $614,732,675.81 |
| Ethanol Production | | | |
| Employment | 594 | 795 | 971 |
| Labor Income | $25,742,709.62 | $32,700,784.46 | $37,211,089.95 |
| Total Value Added | $48,856,387.43 | $62,421,963.65 | $70,932,854.86 |
| Output | $77,374,881.21 | $99,671,514.28 | $114,140,566.82 |

In scenario seven to nine switchgrass production area increases from sixty-four counties to seventy-seven counties with an employment impacts ranging from 3,794 to 5,160 jobs with an average increase of 683 jobs from scenario to scenario. In scenarios seven through nine labor income increases from $156.4 million to $215.8 million with an average increase of $29.7 million for each scenario. Total value added in scenario seven is $200 million and increase to $247.7 million in scenario nine, increasing on average $37.2 million per scenario. Total industry output for scenario seven through nine ranges from $453 million to $614.7 million with an average increase of $80.8 million from scenario to scenario.

Focusing on the economic impacts from employment and total industry output in scenarios seven through nine top industries impacted from switchgrass production under employment are IMPLAN® sectors 10 (All other crop farming) which in this study is switchgrass farming, sector 19 (Support activities for agriculture and forestry), sector 335 (Transportation by truck), and sector 413 (Food services and drinking places). Scenarios seven through nine industries impacted by total industry output fall under IMPLAN® sector 10 (All other crop farming), sector 335 (Transportation by truck), sector 19 (Support activities for agriculture and forestry), and sector 361 (Imputed rental activity for owner-occupied dwellings).

Ethanol production in scenario seven has an employment impact of 3,794 jobs. In scenario eight projected employment increases to 4,590, and in scenario nine to 5,160. Scenario's seven through nine the projected employment impacts average for ethanol production 189 jobs from the addition of each plant from scenario to scenario. Labor income for scenarios seven through nine increases from $25.7 million in scenario seven to $37.2 million in scenario nine with an average increase of $5.7 million for each scenario. Total value added in scenario seven is $48.9 million and increase to $70.9 million in scenario nine, increasing on average $11 million per scenario. Total industry output for scenarios seven through nine ranges from $77.4 million to $114 million with an average increase of $18.4 million from scenario to scenario.

With the main focus from the economic impacts being employment and total industry output for this study in scenarios seven through nine top industries impacted from ethanol production under employment are IMPLAN® sectors 417 (Commercial and industrial machinery and equipment repair and maintenance), sector 390 (Waste

management and remediation services), sector 413 (Food services and drinking places), and sector 31 (Electric power generation transmission and distribution). Scenarios seven through nine industries impacted by total industry output fall under IMPLAN® sectors 31 (Electric power generation transmission and distribution), 417 (Commercial and industrial machinery and equipment repair and maintenance), sector 390 (Waste management and remediation services), and sector 361 (Imputed rental activity for owner-occupied dwellings).

# CHAPTER V

## SUMMARY, CONCLUSION, AND RECOMINDATIONS FOR FURTHER RESERCH

In the state of Oklahoma switchgrass production for biomass and cellulosic ethanol production could have a possible positive economic impact for differing communities in the state. Currently in the state switchgrass is not commercially grown so the exact economic effects it would have are unknown. The same is true for cellulosic ethanol production, since no one conversion technology has been proven most effective for switchgrass or similar feedstocks. As a result, there is not currently a plant located in neither the state nor a representative example to show how it would impact the site location community or surrounding communities. These facts notwithstanding, the objective of this study was to project how proposed switchgrass production proposed cellulosic ethanol plants would impact Oklahoma communities.

Through the use of a comprehensive linear mathematical programming model, optimal switchgrass production regions and cellulosic ethanol plant locations were determined for Oklahoma. Using data for switchgrass maintenance and data for cellulosic ethanol conversion, expenditures were entered into IMPLAN® to estimate the direct, indirect, and induced impacts on industries in the study region. This was done for nine scenarios, with an additional biorefinery site being iteratively added with each scenario

and the ninth scenario represents a scenario where all 77 counties in the state are producing switchgrass on 10% of their cropland and pasture land acres. In each scenario ethanol plants are assumed to be 50 million gal/year capacity and already in operation, and switchgrass is assumed to be in existing stands so investment costs are not considered in the economic impacts of either activity.

In scenario one, where a single plant was optimally located in Oklahoma, additional impact assessments were made for varying levels of cooperative and private ownership of the facility. By retaining plant profits in the region through cash patronage to producer owners cooperative ownership was measured for 50% cooperative ownership and 100% cooperative ownership. For the 100% privately owned no profits are retained in the region. For the 100% privately owned scenario there is a combined industry output for switchgrass production and ethanol production of $70 million, and a combined employment impact of 556 employees for the region. In the 100% cooperative owned scenario there is a combined industry output for switchgrass production and ethanol production of $86.1 million, and a combined employment impact of 726 employees in the region. Because of the induced impacts that result from the cooperative membership model industry output is $16.1 million higher than the privately owned and employment has 170 more jobs.

In all other scenarios private equity ownership is assumed. From the establishment of a single plant in the state and the switchgrass production area of only eight counties to supply it a combined economic impact for industry output of $70 million and an employment impact of 556 jobs from the two activities. In the ninth scenario switchgrass production and ethanol production have a combined industry output

impact of $728.9 million and the total employee impact is 6,132. From the range of industry output and employment from scenarios one through nine the results show that the production of switchgrass for cellulosic ethanol production will have a large economic impact on the state of Oklahoma.

With the implementation of more plants the economic impact increases but an important factor is the ownership structure for the ethanol plants. In scenario one modeling different management scenarios under cooperative ownership and private ownership a large difference was measured through the induced economic impacts for varying levels of cooperative ownership. Induced economic effects are responses by an economy due to the new activity's (direct impacts) payroll and owners-spending income locally (MIG, 2012). With the induction of cash patronage into the local economy through the cooperative ownership induced impacts were much higher because the cash returns to producers went back into the local economy. In future studies cooperative ownership needs to be measured and compared to private ownership for multiple plant locations to see how these greater induced returns will impact differing local economies and the state as a whole.

Also aspects that are beyond the scope of this study are attitudes toward ethanol production from switchgrass in Oklahoma communities. Currently switchgrass production and cellulosic ethanol production are not present in Oklahoma. For these activities to be feasible attitudes of producers need to be addressed as well as the willingness to adopt switchgrass for cellulosic ethanol production. Currently the impacts for jobs and income from switchgrass production compared to jobs and income from other crops in Oklahoma are being assessed in an alternate study. The needed incentives

to get producers to engage in long term contracts to supply ethanol facilities with biomass would have to be considered.

Further the impacts of ethanol production for multi-year periods are not addressed in the current study. The long term economic effects on the communities where optimal plant locations were found need to be measured. With switchgrass being grown on improved pasture and cropland the Oklahoma livestock market would also see impacts. Studies beyond the present one would need to show if these impacts would be positive or negative on livestock producers and on what scale. Lastly the environmental impacts for both switchgrass production and cellulosic ethanol production need to be analyzed and how they'll affect the involved industries and regions in which they are located.

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# APPENDICES

**APPENDIX A:** TOTAL BIOMASS AND ACERAGE HARVESTED BY COUNTY

Table A.1 Total Acres and Biomass utilized by County for Scenario 1

| | **Total acres by county by cropland and improve pasture land for 1 plant** | | **Total biomass harvested by county by cropland and improve pasture land for 1 plant** | |
|---|---|---|---|---|
| County | Cropland | Pastureland | Cropland | Pastureland |
| Caddo | 26092.9 | 12448.6 | 135719.993 | 49732.325 |
| Canadian | 21412.7 | | 92560.19 | |
| Cleveland | 4074.5 | 3699.2 | 24094.537 | 13233.888 |
| Garvin | 7653.929 | | 32750.697 | |
| Grady | 16645.8 | 3294.82 | 90308.865 | 10200.762 |
| McClain | 7062.5 | 6264.6 | 35409.963 | 21299.64 |
| Oklahoma | 5525.4 | 2941.3 | 33261.803 | 12375.52 |
| Stephens | 6031.1 | 9991.3 | 23388.606 | 30983.021 |
| Total | | 133,139 | | 605,320 |

Table A.2 Total Acres and Biomass utilized by County for Scenario 2

| | **Total acres by county by cropland and improve pasture land for 2 plant** | | **Total biomass harvested by county by cropland and improve pasture land for 2 plants** | |
|---|---|---|---|---|
| County | Cropland | Pastureland | Cropland | Pastureland |
| Alfalfa | 27,196 | | 112,514 | |
| Caddo | 26,093 | 12,449 | 126,928 | 38,080 |
| Canadian | 21,413 | | 95,253 | |
| Cleveland | 4,075 | 3,699 | 23,015 | 12,352 |
| Garfield | 37,041 | 7,731 | 213,300 | 30,769 |
| Garvin | 9,018 | | 38,130 | |
| Grady | 16,646 | | 81,741 | |
| Grant | 37,120 | | 137,708 | |
| Jeffers | | 5,744 | | 20,668 |
| Kingfish | 25,921 | | 113,145 | |
| McClain | 7,063 | 6,265 | 32,528 | 21,300 |
| Oklahoma | 5,525 | 2,941 | 33,262 | 11,550 |
| Stephens | 6,031 | 9,991 | 30,071 | 38,875 |
| Total | | 271,961 | | 1,211,188 |

Table A.3 Total Acres and Biomass utilized by County for Scenario 3

| | **Total acres by county by cropland and improve pasture land for 3 plants** | | **Total biomass harvested by county by cropland and improve pasture land for 3 plants** | |
|---|---|---|---|---|
| County | Cropland | Pastureland | Cropland | Pastureland |
| Alfalfa | 27195.5 | | 110737.263 | |
| Caddo | 26092.9 | 12448.6 | 138719.364 | 46240.325 |
| Canadian | 21412.7 | | 95478.63 | |
| Cherokee | 4341.6 | | 19419.977 | |
| Cleveland | 4074.5 | 3699.2 | 23014.813 | 13251.393 |
| Creek | 6343.9 | | 28674.428 | |
| Garfield | 37040.6 | 7731 | 224254.43 | 30769.38 |
| Garvin | 9018.4 | | 38129.795 | |
| Grady | 16645.8 | 6406.322 | 77273.373 | 19833.973 |
| Grant | 34320.542 | | 131647.082 | |
| Haskell | 5309.2 | 1552.834 | 22670.284 | 5152.303 |
| Hughes | 5410.2 | 7090 | 28721.67 | 25261.67 |
| Kingfish | 25920.5 | | 110685.981 | |
| McClain | 7062.5 | 6264.6 | 32527.756 | 21299.64 |
| McIntosh | 5449.2 | 5165.4 | 29992.397 | 16704.904 |
| Muskogee | 11055.2 | 6067.1 | 58375.878 | 19748.411 |
| Okfuskee | 3984 | 5632.5 | 21058.482 | 23656.5 |
| Oklahoma | 5525.4 | 2941.3 | 33261.803 | 12375.52 |
| Okmulgee | 6453 | 4917.1 | 38347.598 | 23300.17 |
| Pittsburg | 7263.1 | 8735.8 | 35141.653 | 26355.909 |
| Rogers | 7867.8 | 5368.8 | 45486.116 | 24870.966 |
| Seminole | 4812.8 | | 22560 | |
| Stephens | 6031.1 | 9991.3 | 23388.606 | 30983.021 |
| Tulsa | 5156 | 2920.9 | 24130.08 | 13669.812 |
| Wagoner | 10248 | | 50912.064 | |
| Total | | 400,967 | | 1,818,083 |

Table A.4 Total Acres and Biomass utilized by County for Scenario 4

| | **Total acres by county by cropland and improve pasture land for 4 plant** | | **Total biomass harvested by county by cropland and improve pasture land for 4 plants** | |
|---|---|---|---|---|
| County | Cropland | Pastureland | Cropland | Pastureland |
| Alfalfa | 27195.5 | | 110345.741 | |
| Caddo | 26092.9 | 12448.6 | 135957.055 | 47320.347 |
| Canadian | 21412.7 | 4725.425 | 95334.759 | 13268.994 |
| Carter | 4592.3 | 10386.9 | 18580.446 | 28356.237 |
| Cherokee | 4341.6 | | 19419.977 | |
| Cleveland | 4074.5 | 3699.2 | 23014.813 | 14116.147 |
| Coal | 3540.3 | 5358.1 | 20082.701 | 21073.407 |
| Creek | 6343.9 | 6763.8 | 28674.428 | 18613.978 |
| Garfield | 37040.6 | 7731 | 229281.314 | 30769.38 |
| Garvin | 9018.4 | 9006.6 | 54471.136 | 34369.186 |
| Grady | 16645.8 | 10013.6 | 84141.594 | 31002.106 |
| Grant | 37981.496 | | 127902.688 | |
| Haskell | 5309.2 | 5533.5 | 22670.284 | 18360.153 |
| Hughes | 5410.2 | 7090 | 31266.628 | 31035.766 |
| Jeffers | 4618.3 | 8102.5 | 17295.533 | 29152.795 |
| Johnston | 3682.6 | 5945.5 | 18394.587 | 21403.8 |
| Kingfish | 25920.5 | | 108094.512 | |
| Lincoln | 8854 | | 37053.99 | |
| Love | 3030.219 | 5162.5 | 11645.132 | 17129.175 |
| Marshall | 2267.2 | | 7903.459 | |
| McClain | 7062.5 | 6264.6 | 32839.804 | 21299.64 |
| McIntosh | 5449.2 | 5165.4 | 29992.397 | 16704.904 |
| Murray | 2457.7 | 2932.8 | 12099.257 | 10426.104 |
| Muskogee | 11055.2 | 6067.1 | 58375.878 | 19748.411 |
| Okfuskee | 3984 | 5632.5 | 20237.525 | 23656.5 |
| Oklahoma | 5525.4 | 2941.3 | 33261.803 | 12536.501 |
| Okmulgee | 6453 | 4917.1 | 38347.598 | 23300.17 |
| Pittsburg | 7263.1 | 8735.8 | 38976.7 | 26355.909 |
| Pontotoc | 5604.6 | 8642.6 | 32674.818 | 30257.743 |
| Pottawatomi | 7707.7 | 6801.6 | 37125.569 | 20894.515 |
| Rogers | 7867.8 | 5368.8 | 42245.757 | 24681.419 |
| Seminole | 4812.8 | 6902.4 | 23763.2 | 21369.83 |
| Sequoyah | 5895.2 | 4399.4 | 25956.566 | 15582.675 |
| Stephens | 6031.1 | 9991.3 | 23968.762 | 37570.192 |
| Tulsa | 5156 | 2920.9 | 22837.145 | 12910.378 |

| | | | | |
|---|---|---|---|---|
| Wagoner | 10248 | | 48083.616 | |
| Washing | 5186.6 | | 27698.519 | |
| Total | | 554782.94 | | 2423282.053 |

Table A.5 Total Acres and Biomass utilized by County for Scenario 5

| | **Total acres by county by cropland and improve pasture land for 5 plant** | | **Total biomass harvested by county by cropland and improve pasture land for 5 plants** | |
|---|---|---|---|---|
| County | Cropland | Pastureland | Cropland | Pastureland |
| Alfalfa | 27195.5 | 4995.6 | 139033.448 | 15935.964 |
| Caddo | 26092.9 | 12448.6 | 135957.055 | 46240.325 |
| Canadian | 21412.7 | 1323.89 | 94794.098 | 3717.484 |
| Carter | 4592.3 | 10386.9 | 18580.446 | 28356.237 |
| Cherokee | 4341.6 | | 19419.977 | |
| Cleveland | 4074.5 | 3699.2 | 23014.813 | 14116.147 |
| Coal | 3540.3 | 5358.1 | 18846.433 | 20825.145 |
| Comanche | 10145.25 | | 32355.714 | |
| Creek | 6343.9 | 6763.8 | 28630.7 | 18613.978 |
| Dewey | 14441.6 | 6007.1 | 66532.451 | 18381.726 |
| Garfield | 37040.6 | 7731 | 213227.284 | 30769.38 |
| Garvin | 9018.4 | 9006.6 | 46845.177 | 30677.126 |
| Grady | 16645.8 | 10013.6 | 75087.539 | 31002.106 |
| Grant | 39051.9 | | 139236.032 | |
| Harper | 15227 | | 78419.05 | |
| Haskell | 5309.2 | 5533.5 | 22670.284 | 18360.153 |
| Hughes | 5410.2 | 7090 | 31266.628 | 31035.766 |
| Jeffers | 4618.3 | 8102.5 | 17295.533 | 29152.795 |
| Johnston | 3682.6 | 5945.5 | 14306.901 | 16647.4 |
| Kay | 28257.4 | | 103456.73 | |
| Kingfish | 25920.5 | | 109573.983 | |
| Lincoln | 8854 | | 39511.437 | |
| Love | 4241.3 | 5162.5 | 16299.316 | 17129.175 |
| Major | 18171.8 | | 61379.625 | |
| Marshall | 2267.2 | | 7903.459 | |
| McClain | 7062.5 | 6264.6 | 32939.5 | 21299.64 |
| McIntosh | 5449.2 | 5165.4 | 29012.258 | 16704.904 |
| Murray | 2457.7 | 2932.8 | 12099.257 | 10426.104 |
| Muskogee | 11055.2 | 6067.1 | 58375.878 | 22111.598 |
| Noble | 16213.2 | | 51436.377 | |
| Okfuskee | 3984 | 5632.5 | 20237.525 | 23656.5 |
| Oklahoma | 5525.4 | 2941.3 | 33261.803 | 13035.547 |
| Okmulgee | 6453 | 4917.1 | 38347.598 | 23300.17 |
| Pittsburg | 7263.1 | 8735.8 | 37650.425 | 26355.909 |
| Pontotoc | 5604.6 | 8642.6 | 29407.336 | 30257.743 |

| | | | | |
|---|---|---|---|---|
| Pottawatomi | 7707.7 | 6801.6 | 37038.343 | 20894.515 |
| Rogers | 7867.8 | 5368.8 | 45409.008 | 25571.614 |
| Seminole | 4812.8 | 6902.4 | 23763.2 | 21369.83 |
| Sequoyah | 5895.2 | 4399.4 | 25956.566 | 15582.675 |
| Stephens | 6031.1 | 9991.3 | 23388.606 | 35173.864 |
| Tulsa | 5156 | 2920.9 | 24130.08 | 13669.812 |
| Wagoner | 10248 | | 50912.064 | |
| Washing | 4737.074 | | 25352.871 | |
| Woods | 24699.8 | 6873.7 | 129868.709 | 27288.589 |
| Woodward | 9056.68 | | 29547.417 | |
| Total | | 707302.497 | | 3029438.86 |

Table A.6 Total Acres and Biomass utilized by County for Scenario 6

| | **Total acres by county by cropland and improve pasture land for 6 plants** | | **Total biomass harvested by county by cropland and improve pasture land for 6 plants** | |
|---|---|---|---|---|
| County | Cropland | Pastureland | Cropland | Pastureland |
| Adair | 4632.4 | | 20039.762 | |
| Alfalfa | 27195.5 | 4995.6 | 139033.448 | 15935.964 |
| Blaine | 10120.835 | | 32305.706 | |
| Caddo | 26092.9 | 12448.6 | 135957.055 | 46240.325 |
| Canadian | 21412.7 | 9342.5 | 94786.943 | 26233.74 |
| Carter | 4592.3 | 10386.9 | 18580.446 | 28356.237 |
| Cherokee | 4341.6 | | 19419.977 | |
| Cleveland | 4074.5 | 3699.2 | 23014.813 | 14116.147 |
| Coal | 3540.3 | 5358.1 | 17312.421 | 21073.407 |
| Comanche | 2526.175 | | 7939.769 | |
| Craig | 10088 | 5326.5 | 56638.399 | 23058.419 |
| Creek | 6343.9 | 6763.8 | 28674.428 | 18613.978 |
| Custer | 215.614 | | 709.37 | |
| Delaware | 6880.7 | 5524.6 | 36854.405 | 27925.308 |
| Dewey | 14441.6 | 6007.1 | 66532.451 | 18381.726 |
| Garfield | 37040.6 | 7731 | 214264.518 | 30769.38 |
| Garvin | 9018.4 | 9006.6 | 49205.228 | 30457.253 |
| Grady | 16645.8 | 10013.6 | 81740.865 | 31002.106 |
| Grant | 39051.9 | | 135483.47 | |
| Harper | 15227 | | 78419.05 | |
| Haskell | 5309.2 | 5533.5 | 22670.284 | 18360.153 |
| Hughes | 5410.2 | 7090 | 31266.628 | 31035.766 |
| Jeffers | 4618.3 | 8102.5 | 17295.533 | 29152.795 |
| Johnston | 3682.6 | 5945.5 | 14306.901 | 16647.4 |
| Kay | 28257.4 | | 103210.153 | |
| Kingfish | 25920.5 | 11270.1 | 109902.92 | 29953.174 |
| Latimer | 2669.4 | | 12273.367 | |
| Leflore | 9338.558 | 8455.9 | 51227.56 | 35396.397 |
| Lincoln | 8854 | | 39524.256 | |
| Love | 4241.3 | 5162.5 | 16299.316 | 17129.175 |
| Major | 18171.8 | | 61605.326 | |
| Marshall | 2267.2 | 2298.3 | 7903.459 | 5727.364 |
| Mayes | 9480.5 | 5655.2 | 40742.449 | 16286.976 |
| McClain | 7062.5 | 6264.6 | 32939.5 | 21299.64 |
| McIntosh | 5449.2 | 5165.4 | 29992.397 | 16704.904 |

| | | | | |
|---|---|---|---|---|
| Murray | 2457.7 | 2932.8 | 13443.619 | 10426.104 |
| Muskogee | 11055.2 | 6067.1 | 58375.878 | 24262.333 |
| Noble | 16213.2 | | 51436.377 | |
| Nowata | 5378.5 | 4153.9 | 27882.144 | 12972.63 |
| Okfuskee | 3984 | 5632.5 | 21565.342 | 23656.5 |
| Oklahoma | 5525.4 | 2941.3 | 33261.803 | 13035.547 |
| Okmulgee | 6453 | 4917.1 | 38347.598 | 23300.17 |
| Osage | 7930.4 | 9061.9 | 34973.064 | 23530.547 |
| Ottawa | 9452 | 3043.2 | 46071.884 | 14071.757 |
| Pittsburg | 7263.1 | 8735.8 | 35804.178 | 26355.909 |
| Pontotoc | 5604.6 | 8642.6 | 32674.818 | 30257.743 |
| Pottawatomi | 7707.7 | 6801.6 | 37354.127 | 20894.515 |
| Rogers | 7867.8 | 5368.8 | 44662.984 | 24870.966 |
| Seminole | 4812.8 | 6902.4 | 23763.2 | 22617.383 |
| Sequoyah | 5895.2 | 4399.4 | 25956.566 | 15582.675 |
| Stephens | 6031.1 | 9991.3 | 23388.606 | 33456.697 |
| Tulsa | 5156 | 2920.9 | 24130.08 | 13669.812 |
| Wagoner | 10248 | | 46133.024 | |
| Washing | 5186.6 | 2350.5 | 35061.416 | 10976.835 |
| Woods | 24699.8 | 6873.7 | 129759.11 | 27288.589 |
| Woodward | 12811.1 | 7769.5 | 41796.214 | 19462.597 |
| Total | | 853,002 | | 3,634,462 |

Table A.7 Total Acres and Biomass utilized by County for Scenario 7

| | **Total acres by county by cropland and improve pasture land for 6 plants** | | **Total biomass harvested by county by cropland and improve pasture land for 4 plants** | |
|---|---|---|---|---|
| County | Cropland | Pastureland | Cropland | Pastureland |
| Adair | 4632.4 | | 20039.762 | |
| Alfalfa | 27195.5 | | 112863.289 | |
| Blaine | 21936.3 | | 84453.373 | |
| Caddo | 26092.9 | 12448.6 | 120847.335 | 43350.405 |
| Canadian | 21412.7 | 9342.5 | 117327.072 | 26233.74 |
| Carter | 4592.3 | 10386.9 | 18580.446 | 28356.237 |
| Cherokee | 4341.6 | | 19419.977 | |
| Cleveland | 4074.5 | 3699.2 | 23014.813 | 14116.147 |
| Coal | 3540.3 | 5358.1 | 18006.237 | 19233.332 |
| Comanche | 10689.1 | 7124.7 | 41361.823 | 20455.014 |
| Cotton | 11866.2 | 7642.3 | 47002.018 | 22605.923 |
| Craig | 10088 | 5326.5 | 55593.725 | 23058.419 |
| Creek | 6343.9 | 6763.8 | 28674.428 | 18613.978 |
| Custer | 20602 | | 76202.308 | |
| Delaware | 6880.7 | 5524.6 | 36854.405 | 28019.666 |
| Dewey | 14441.6 | 6007.1 | 66532.451 | 18381.726 |
| Ellis | 12612.5 | 5666.4 | 49441 | 14902.632 |
| Garfield | 37040.6 | 7731 | 229031.05 | 30769.38 |
| Garvin | 9018.4 | 9006.6 | 46845.177 | 34369.186 |
| Grady | 16645.8 | 10013.6 | 79777.178 | 31002.106 |
| Grant | 39051.9 | | 140847.745 | |
| Harper | 15227 | | 78419.05 | |
| Haskell | 5309.2 | 5533.5 | 22670.284 | 18360.153 |
| Hughes | 5410.2 | 7090 | 31266.628 | 31035.766 |
| Jeffers | 4618.3 | 8102.5 | 21248.798 | 29152.795 |
| Johnston | 3682.6 | 5945.5 | 14306.901 | 16647.4 |
| Kay | 28257.4 | | 103210.153 | |
| Kingfish | 25920.5 | 11270.1 | 112653.498 | 28580.974 |
| Kiowa | 26136 | 7948.3 | 82694.304 | 19083.868 |
| Latimer | 2669.4 | 3342 | 12273.367 | 10527.3 |
| Leflore | 10010.5 | 8455.9 | 56307.06 | 35396.397 |
| Lincoln | 8854 | | 39066.303 | |
| Logan | 1325.755 | | 4518.172 | |
| Love | 4241.3 | 5162.5 | 16299.316 | 17129.175 |
| Major | 18171.8 | | 61329.825 | |

| | | | | |
|---|---|---|---|---|
| Marshall | 2267.2 | 2298.3 | 7903.459 | 5727.364 |
| Mayes | 9480.5 | 5655.2 | 40742.449 | 16286.976 |
| McClain | 7062.5 | 6264.6 | 32939.5 | 21299.64 |
| McIntosh | 5449.2 | 5165.4 | 29992.397 | 18457.362 |
| Murray | 2457.7 | 2932.8 | 12099.257 | 10426.104 |
| Muskogee | 11055.2 | 6067.1 | 58375.878 | 24262.333 |
| Noble | 16213.2 | | 51436.377 | |
| Nowata | 5378.5 | 4153.9 | 27882.144 | 12972.63 |
| Okfuskee | 3984 | 5632.5 | 20472.886 | 23656.5 |
| Oklahoma | 5525.4 | 2941.3 | 33261.803 | 14190.596 |
| Okmulgee | 6453 | 4917.1 | 38347.598 | 23300.17 |
| Osage | 7930.4 | 9061.9 | 34973.064 | 23162.216 |
| Ottawa | 9452 | 3043.2 | 46071.884 | 12416.256 |
| Pawnee | 4513.9 | | 14360.396 | |
| Pittsburg | 7263.1 | 8735.8 | 35804.178 | 26355.909 |
| Pontotoc | 5604.6 | 8642.6 | 32674.818 | 30257.743 |
| Pottawatomi | 7707.7 | 6801.6 | 37158.371 | 20894.515 |
| Pushmataha | 3452.6 | | 13848.379 | |
| RogerMills | 8750.5 | | 26400.259 | |
| Rogers | 7867.8 | 5368.8 | 42203.666 | 24870.966 |
| Seminole | 4812.8 | 6902.4 | 23763.2 | 21369.83 |
| Sequoyah | 5895.2 | 4399.4 | 25956.566 | 15582.675 |
| Stephens | 6031.1 | 9991.3 | 28734.573 | 42143.366 |
| Tillman | 26269.6 | 6951.2 | 103160.719 | 19911.712 |
| Tulsa | 5156 | 2920.9 | 24130.08 | 13669.812 |
| Wagoner | 10248 | 570.205 | 45244.669 | 1539.553 |
| Washing | 5186.6 | 2350.5 | 35061.416 | 10976.835 |
| Woods | 24699.8 | 6873.7 | 112305.438 | 20466.442 |
| Woodward | 12811.1 | 7769.5 | 55728.285 | 25950.13 |
| Total | | 1,023,216 | | 4,239,542 |

Table A.8 Total Acres and Biomass utilized by County for Scenario 8

| | **Total acres by county by cropland and improve pasture land for 8 plants** | | **Total biomass harvested by county by cropland and improve pasture land for 4 plants** | |
|---|---|---|---|---|
| County | Cropland | Pastureland | Cropland | Pastureland |
| Adair | 4632.4 | | 20039.762 | |
| Alfalfa | 27195.5 | 850.441 | 113233.781 | 2034.68 |
| Beaver | 31030.8 | 8493.9 | 107366.568 | 24547.371 |
| Beckham | 15772.3 | | 50712.676 | |
| Blaine | 21936.3 | 8404.7 | 85927.078 | 22163.194 |
| Caddo | 26092.9 | 12448.6 | 132561.951 | 46240.325 |
| Canadian | 21412.7 | 9342.5 | 95299.509 | 26233.74 |
| Carter | 4592.3 | 10386.9 | 18580.446 | 28356.237 |
| Cherokee | 4341.6 | 4855.6 | 19419.977 | 13017.864 |
| Cleveland | 4074.5 | 3699.2 | 23014.813 | 14116.147 |
| Coal | 3540.3 | 5358.1 | 18846.433 | 21073.407 |
| Comanche | 10689.1 | 7124.7 | 33595.841 | 15909.455 |
| Cotton | 11866.2 | 7642.3 | 38707.544 | 18616.643 |
| Craig | 10088 | 5326.5 | 53988.941 | 21777.395 |
| Creek | 6343.9 | 6763.8 | 28674.428 | 18613.978 |
| Custer | 20602 | 7810.9 | 77463.52 | 17183.98 |
| Delaware | 6880.7 | 5524.6 | 36854.405 | 26600.949 |
| Dewey | 14441.6 | 6007.1 | 64245.44 | 17300.448 |
| Ellis | 12612.5 | 5666.4 | 49441 | 14902.632 |
| Garfield | 37040.6 | 7731 | 228389.58 | 30769.38 |
| Garvin | 9018.4 | 9006.6 | 46845.177 | 28038.53 |
| Grady | 16645.8 | 10013.6 | 84619.371 | 31002.106 |
| Grant | 39051.9 | | 136239.794 | |
| Greer | 12702 | 4822.3 | 44590.371 | 11067.179 |
| Harmon | 10972.9 | 4796.9 | 39546.332 | 11335.075 |
| Harper | 15227 | 5235 | 78419.05 | 11045.85 |
| Haskell | 5309.2 | 5533.5 | 22670.284 | 18360.153 |
| Hughes | 5410.2 | 7090 | 31266.628 | 31035.766 |
| Jackson | 25734.5 | | 83478.568 | |
| Jeffers | 4618.3 | 8102.5 | 17295.533 | 29152.795 |
| Johnston | 3682.6 | 5945.5 | 14306.901 | 16647.4 |
| Kay | 28257.4 | | 113718.621 | |
| Kingfish | 25920.5 | 11270.1 | 115566.335 | 28580.974 |
| Kiowa | 26136 | 7948.3 | 100414.512 | 23173.269 |
| Latimer | 2669.4 | 3342 | 12273.367 | 10527.3 |

| | | | | |
|---|---|---|---|---|
| Leflore | 10010.5 | 8455.9 | 56307.06 | 35396.397 |
| Lincoln | 8854 | 6491.969 | 37053.99 | 17723.074 |
| Logan | 10271.6 | | 35005.613 | |
| Love | 4241.3 | 5162.5 | 16299.316 | 17129.175 |
| Major | 18171.8 | 7280.4 | 81773.1 | 18565.02 |
| Marshall | 2267.2 | 2298.3 | 7903.459 | 5727.364 |
| Mayes | 9480.5 | 5655.2 | 40742.449 | 16286.976 |
| McClain | 7062.5 | 6264.6 | 35076.151 | 21299.64 |
| McIntosh | 5449.2 | 5165.4 | 29992.397 | 16704.904 |
| Murray | 2457.7 | 2932.8 | 12099.257 | 10426.104 |
| Muskogee | 11055.2 | 6067.1 | 58375.878 | 22028.693 |
| Noble | 16213.2 | | 51436.377 | |
| Nowata | 5378.5 | 4153.9 | 27882.144 | 12972.63 |
| Okfuskee | 3984 | 5632.5 | 20237.525 | 23656.5 |
| Oklahoma | 5525.4 | 2941.3 | 33261.803 | 13200.554 |
| Okmulgee | 6453 | 4917.1 | 38347.598 | 23300.17 |
| Osage | 7930.4 | 9061.9 | 34973.064 | 23162.216 |
| Ottawa | 9452 | 3043.2 | 44596.965 | 12416.256 |
| Pawnee | 4513.9 | | 14151.077 | |
| Payne | 6612.7 | | 21821.91 | |
| Pittsburg | 7263.1 | 8735.8 | 38976.7 | 26355.909 |
| Pontotoc | 5604.6 | 8642.6 | 32674.818 | 30257.743 |
| Pottawatomi | 7707.7 | 6801.6 | 37221.651 | 20894.515 |
| Pushmataha | 3452.6 | | 15628.884 | |
| RogerMills | 8750.5 | 890.82 | 26400.259 | 1958.022 |
| Rogers | 7867.8 | 5368.8 | 42203.666 | 24870.966 |
| Seminole | 4812.8 | 6902.4 | 23763.2 | 21369.83 |
| Sequoyah | 5895.2 | 4399.4 | 25956.566 | 15582.675 |
| Stephens | 6031.1 | 9991.3 | 28734.573 | 34023.367 |
| Tillman | 26269.6 | 6951.2 | 92212.912 | 16397.881 |
| Tulsa | 5156 | 2920.9 | 24130.08 | 13669.812 |
| Wagoner | 10248 | 2911.9 | 43988.339 | 8910.414 |
| Washing | 5186.6 | 2350.5 | 33339.628 | 9879.152 |
| Washita | 26691.1 | | 87506.771 | |
| Woods | 24699.8 | 6873.7 | 112719.539 | 20466.442 |
| Woodward | 12811.1 | 7769.5 | 55728.285 | 25950.13 |
| Total | | 1,223,953 | | 4,846,144 |

Table A.9 Total Acres and Biomass utilized by County for Scenario 9

| | **Total biomass harvested by county by cropland and improve pasture land for 9 plants** | | **Total acres by county by cropland and improve pasture land for 9 plants** | |
|---|---|---|---|---|
| County | Cropland | Pastureland | Cropland | Pastureland |
| Adair | 24620.28 | 15052.006 | 4632.4 | 4476.3 |
| Alfalfa | 139033.45 | 11951.973 | 27195.5 | 4995.6 |
| Atoka | 10752.678 | 13418.805 | 5774.8 | 9881.3 |
| Beaver | 95623.667 | 24547.371 | 31030.8 | 8493.8 |
| Beckham | 50712.676 | 18547.478 | 15772.3 | 8095.8 |
| Blaine | 85715.983 | 22163.194 | 21936.3 | 8404.7 |
| Bryan | 16630.625 | 545.941 | 9736.9 | 435.707 |
| Caddo | 120739.03 | 46053.052 | 26092.9 | 12448.6 |
| Canadian | 94814.794 | 26233.74 | 21412.7 | 9342.5 |
| Carter | 18580.446 | 28356.237 | 4592.3 | 10386.9 |
| Cherokee | 23858.829 | 15993.375 | 4341.6 | 4855.6 |
| Choctaw | 2687.957 | | 1308.645 | |
| Cimarron | 128256.81 | 19614.916 | 38865.7 | 8038.9 |
| Cleveland | 23014.813 | 14116.147 | 4074.5 | 3699.2 |
| Coal | 18846.433 | 16390.428 | 3540.3 | 5358.1 |
| Comanche | 33595.841 | 15909.455 | 10689.1 | 7124.7 |
| Cotton | 38707.544 | 18616.643 | 11866.2 | 7642.3 |
| Craig | 47691.512 | 20924.013 | 10088 | 5326.5 |
| Creek | 28674.428 | 18613.978 | 6343.9 | 6763.8 |
| Custer | 74685.078 | 18257.979 | 20602 | 7810.9 |
| Delaware | 34988.36 | 26600.949 | 6880.7 | 5524.6 |
| Dewey | 66532.451 | 18381.726 | 14441.6 | 6007.1 |
| Ellis | 42024.85 | 14900.192 | 12612.5 | 5666.4 |
| Garfield | 222512.33 | 27770.267 | 37040.6 | 7731 |
| Garvin | 46845.177 | 28874.547 | 9018.4 | 9006.6 |
| Grady | 75243.418 | 31002.106 | 16645.8 | 10013.6 |
| Grant | 131507.27 | 9871.747 | 39051.9 | 4651 |
| Greer | 44590.371 | 11067.179 | 12702 | 4822.3 |
| Harmon | 32567.567 | 9334.767 | 10972 | 4796.9 |
| Harper | 66656.192 | 9388.972 | 15227 | 5235 |
| Haskell | 22670.284 | 18360.153 | 5309.2 | 5533.5 |
| Hughes | 31266.628 | 31035.766 | 5410.2 | 7090 |
| Jackson | 83478.568 | 8789.85 | 25734.5 | 5170.5 |
| Jeffers | 21248.798 | 35816.291 | 4618.3 | 8102.5 |
| Johnston | 14306.901 | 16647.4 | 3682.6 | 5945.5 |

| | | | | |
|---|---|---|---|---|
| Kay | 105096.23 | 7619.518 | 28257.4 | 4113.1 |
| Kingfish | 110685.9 | 28580.974 | 25920.5 | 11270.1 |
| Kiowa | 91954.079 | 19201.72 | 26136 | 7948.3 |
| Latimer | 12273.367 | 11880.81 | 2669.4 | 3342 |
| Leflore | 56307.06 | 39947.363 | 10010.5 | 8455.9 |
| Lincoln | 39524.256 | 30675.882 | 8854 | 10534.3 |
| Logan | 35005.613 | 17723.232 | 10271.6 | 7587 |
| Love | 16299.316 | 17129.175 | 4241.3 | 5162.5 |
| Major | 81773.1 | 18565.02 | 18171.8 | 7280.4 |
| Marshall | 7903.459 | 5727.364 | 2267.2 | 2298.3 |
| Mayes | 40742.449 | 16286.976 | 9480.5 | 5655.2 |
| McClain | 32527.756 | 21299.64 | 7062.5 | 6264.6 |
| McCurtain | 32719.893 | 25224.553 | 7228.2 | 7357.1 |
| McIntosh | 29992.397 | 16704.904 | 5449.2 | 5165.4 |
| Murray | 11561.512 | 10426.104 | 2457.7 | 2932.8 |
| Muskogee | 58375.878 | 23299.522 | 11055.2 | 6067.1 |
| Noble | 51436.377 | 7502.796 | 16213.2 | 4387.6 |
| Nowata | 27882.144 | 12972.63 | 5378.5 | 4153.9 |
| Okfuskee | 20493.696 | 23656.5 | 3984 | 5632.5 |
| Oklahoma | 33261.803 | 13200.554 | 5525.4 | 2941.3 |
| Okmulgee | 38347.598 | 23300.17 | 6453 | 4917.1 |
| Osage | 34973.064 | 23162.216 | 7930.4 | 9061.9 |
| Ottawa | 43739.13 | 12416.256 | 9452 | 3043.2 |
| Pawnee | 14513.003 | 6378.3 | 4513.9 | 3543.5 |
| Payne | 23276.704 | 14879.008 | 6612.7 | 7018.4 |
| Pittsburg | 38976.7 | 26355.909 | 7263.1 | 8735.8 |
| Pontotoc | 28100.343 | 30257.743 | 5604.6 | 8642.6 |
| Pottawatomi | 37366.93 | 20894.515 | 7707.7 | 6801.6 |
| Pushmataha | 15628.884 | 18417.934 | 3452.6 | 5298.6 |
| RogerMills | 29794.577 | 23337.733 | 8750.5 | 9408.1 |
| Rogers | 42203.666 | 21944.97 | 7867.8 | 5368.8 |
| Seminole | 24064 | 21604.2 | 4812.8 | 6902.4 |
| Sequoyah | 25956.566 | 15582.675 | 5895.2 | 4399.4 |
| Stephens | 28734.573 | 39835.313 | 6031.1 | 9991.3 |
| Texas | 195586.28 | 14827.7 | 52436 | 5113 |
| Tillman | 84955.886 | 16397.881 | 26269.6 | 6951.2 |
| Tulsa | 24130.08 | 13669.812 | 5156 | 2920.9 |
| Wagoner | 50199.117 | 9434.556 | 10248 | 2911.9 |
| Washing | 31555.274 | 9879.152 | 5186.6 | 2350.5 |
| Washita | 87506.771 | 19716.386 | 26691.1 | 9382.5 |
| Woods | 128312.73 | 27288.589 | 24699.8 | 6873.7 |
| Woodward | 51254.325 | 25950.13 | 12811.1 | 7769.5 |
| Total | | 5454980 | | 1450557 |

**APPENDIX B:** ETHANOL PLANT EXPINDITURES FOR OPERATION, LOCAL AVAILABLE INPUTS BY SCENARIO AND SWITCHGRASS PRODUCTION FUNCTION SCENARIO 1 EXAMPLE

Table B.1 IMPLAN Expenditures for Ethanol Production from Switchgrass for Scenario 1

| Type | IMPLAN Sector | Description | Expenditures |
|---|---|---|---|
| Operating | 2 | Grain farming | $16,915,300.87 |
| Operating | 33 | Water, sewage and other treatment and delivery systems | $299,333.33 |
| Operating | 123 | Alkalies and chlorine manufacturing | $175,063.74 |
| Operating | 124 | Carbon black manufacturing | $65,651.29 |
| Operating | 125 | All other basic inorganic chemical manufacturing | $997,511.53 |
| Operating | 126 | Other basic organic chemical manufacturing | $6,621,177.49 |
| Operating | 130 | Fertilizer manufacturing | $154,855.70 |
| Operating | 164 | Lime and gypsum product manufacturing | $1,132,948.77 |
| Operating | 357 | Insurance carriers | $485,111.83 |
| Operating | 368 | Accounting, tax preparation, bookkeeping, and payroll services | $484,497.84 |
| Operating | 390 | Waste management and remediation services | $1,500,216.45 |
| Operating | 417 | Commercial and industrial machinery and equipment repair and maintenance | $1,714,124.82 |
| Depreciation | 35 | Construction of new nonresidential manufacturing structures | $36,602.45 |
| Depreciation | 123 | Alkalies and chlorine manufacturing | $572.26 |
| Depreciation | 124 | Carbon black manufacturing | $214.61 |
| Depreciation | 125 | All other basic inorganic chemical manufacturing | $3,260.75 |
| Depreciation | 141 | All other chemical product and preparation manufacturing | $1,114.72 |
| Depreciation | 188 | Power boiler and heat exchanger manufacturing | $764,256.85 |
| Depreciation | 189 | Metal tank (heavy gauge) manufacturing | $650,420.63 |
| Depreciation | 190 | Metal can, box, and other metal container (light gauge) manufacturing | $42,170.27 |
| Depreciation | 202 | Other fabricated metal manufacturing | $36,533.91 |
| Depreciation | 203 | Farm machinery and equipment manufacturing | $122,575.76 |
| Depreciation | 207 | Other industrial machinery manufacturing | $640,788.60 |
| Depreciation | 213 | Other commercial and service industry machinery manufacturing | $107,266.96 |
| Depreciation | 214 | Air purification and ventilation equipment manufacturing | $1,019,031.02 |
| Depreciation | 214 | Air purification and ventilation equipment manufacturing | $17,801.59 |
| Depreciation | 215 | Heating equipment (except warm air furnaces) manufacturing | $73,306.64 |
| Depreciation | 216 | Air conditioning, refrigeration, and warm air heating equipment manufacturing | $220,336.22 |
| Depreciation | 222 | Turbine and turbine generator set units manufacturing | $829,566.38 |
| Depreciation | 226 | Pump and pumping equipment manufacturing | $490,205.63 |
| Depreciation | 227 | Air and gas compressor manufacturing | $80,202.02 |
| Depreciation | 228 | Material handling equipment manufacturing | $1,481,998.56 |
| Depreciation | 228 | Material handling equipment manufacturing | $11,934.34 |
| Depreciation | 230 | Other general purpose machinery manufacturing | $21,563.49 |
| Depreciation | 251 | Industrial process variable instruments manufacturing | $42,852.09 |
| Byproduct | 31 | Electric power generation, transmission, and distribution | $4,721,594.52 |

Table B.2. Local available inputs by IMPLAN® sector by scenario and total direct impact.

| Modified IMPLAN Sector | Description | Expenditures of ethanol plants INCLUDED in the scenarios | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | All other crop farming | $16,915,301 | $33,830,602 | $50,745,903 | $67,661,203 | $84,576,504 | $101,491,805 | $118,407,106 | $135,322,407 | $152,237,708 |
| 31 | Electric power generation, transmission, and distribution | $4,721,595 | $9,443,189 | $14,164,784 | $18,886,378 | $23,607,973 | $28,329,567 | $33,051,162 | $37,772,756 | $42,494,351 |
| 33 | Water, sewage and other treatment and delivery systems | $299,333 | $598,667 | $898,000 | $1,197,333 | $1,496,667 | $1,796,000 | $2,095,333 | $2,394,667 | $2,694,000 |
| 35 | Construction of new nonresidential manufacturing structures | $36,602 | $73,205 | $109,807 | $146,410 | $183,012 | $219,615 | $256,217 | $292,820 | $329,422 |
| 123 | Alkalies and chlorine manufacturing | | | | | | | | | $1,580,724 |
| 126 | Other basic organic chemical manufacturing | | | | | | $39,727,065 | $46,348,242 | $52,969,420 | $59,590,597 |
| 130 | Fertilizer manufacturing | $154,856 | $309,711 | $464,567 | $619,423 | $774,278 | $929,134 | $1,083,990 | $1,238,846 | $1,393,701 |
| 141 | All other chemical product and preparation manufacturing | $1,115 | $2,229 | $3,344 | $4,459 | $5,574 | $6,688 | $7,803 | $8,918 | $10,032 |
| 164 | Lime and gypsum product manufacturing | | | | | | | $7,930,641 | $9,063,590 | $10,196,539 |
| 188 | Power boiler and heat exchanger manufacturing | | | $2,292,771 | $3,057,027 | $3,821,284 | $4,585,541 | $5,349,798 | $6,114,055 | $6,878,312 |
| 189 | Metal tank (heavy gauge) manufacturing | | | $1,951,262 | $2,601,683 | $3,252,103 | $3,902,524 | $4,552,944 | $5,203,365 | $5,853,786 |
| 202 | Other fabricated metal manufacturing | $36,534 | $73,068 | $109,602 | $146,136 | $182,670 | $219,203 | $255,737 | $292,271 | $328,805 |
| 203 | Farm machinery and equipment manufacturing | $122,576 | $245,152 | $367,727 | $490,303 | $612,879 | $735,455 | $858,030 | $980,606 | $1,103,182 |
| 207 | Other industrial machinery manufacturing | $640,789 | $1,281,577 | $1,922,366 | $2,563,154 | $3,203,943 | $3,844,732 | $4,485,520 | $5,126,309 | $5,767,097 |
| 214 | Air purification and ventilation equipment manufacturing | | | | $4,147,330 | $5,184,163 | $6,220,996 | $7,257,828 | $8,294,661 | $9,331,494 |
| 216 | Air conditioning, refrigeration, and warm air heating equipment manufacturing | $220,336 | $440,672 | $661,009 | $881,345 | $1,101,681 | $1,322,017 | $1,542,354 | $1,762,690 | $1,983,026 |
| 226 | Pump and pumping equipment manufacturing | $490,206 | $980,411 | $1,470,617 | $1,960,823 | $2,451,028 | $2,941,234 | $3,431,439 | $3,921,645 | $4,411,851 |
| 228 | Material handling equipment manufacturing | $1,493,933 | $2,987,866 | $4,481,799 | $5,975,732 | $7,469,665 | $8,963,597 | $10,457,530 | $11,951,463 | $13,445,396 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 230 | Other general purpose machinery manufacturing | | | $64,690 | $86,254 | $107,817 | $129,381 | $150,944 | $172,508 | $194,071 |
| 251 | Industrial process variable instruments manufacturing | | | | | | $257,113 | $299,965 | $342,817 | $385,669 |
| 357 | Insurance carriers | $485,112 | $970,224 | $1,455,335 | $1,940,447 | $2,425,559 | $2,910,671 | $3,395,783 | $3,880,895 | $4,366,006 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | $484,498 | $968,996 | $1,453,494 | $1,937,991 | $2,422,489 | $2,906,987 | $3,391,485 | $3,875,983 | $4,360,481 |
| 390 | Waste management and remediation services | $1,500,216 | $3,000,433 | $4,500,649 | $6,000,866 | $7,501,082 | $9,001,299 | $10,501,515 | $12,001,732 | $13,501,948 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | $1,714,125 | $3,428,250 | $5,142,374 | $6,856,499 | $8,570,624 | $10,284,749 | $11,998,874 | $13,712,999 | $15,427,123 |
| **Total** | | **$29,317,127** | **$58,634,253** | **$92,260,103** | **$127,160,801** | **$158,951,001** | **$230,725,378** | **$277,110,249** | **$316,697,428** | **$357,865,330** |

Table B.3. Scenario 1 Switchgrass production function and IMPLAN® industry sectors for switchgrass production.

| Counties | Total Acre | Total "Cash" Cost | Labor Cost | Proprietor Income | EMPLOYMENT | VALUE ADDED | TOTAL VALUE OF PRODUCTION |
|---|---|---|---|---|---|---|---|
| Caddo | 38541.5 | 6553768.701 | 1138523.618 | 1623563.296 | 48.947705 | 2762086.914 | 9315855.615 |
| Canadian | 21412.7 | 3641111.089 | 632535.4405 | 902011.4367 | 27.194129 | 1534546.877 | 5175657.967 |
| Cleveland | 7773.7 | 1321874.648 | 229636.6527 | 327467.6386 | 9.872599 | 557104.2913 | 1878978.939 |
| Garvin | 7653.929 | 1301508.253 | 226098.5934 | 322422.2771 | 9.72048983 | 548520.8706 | 1850029.123 |
| Grady | 19940.62 | 3390792.035 | 589049.9029 | 839999.967 | 25.3245874 | 1429049.87 | 4819841.905 |
| McClain | 13327.1 | 2266199.573 | 393685.1994 | 561404.9894 | 16.925417 | 955090.1889 | 3221289.762 |
| Oklahoma | 8466.7 | 1439715.461 | 250108.0113 | 356660.3105 | 10.752709 | 606768.3218 | 2046483.783 |
| Stephens | 16022.4 | 2724520.416 | 473304.9005 | 674944.6844 | 20.348448 | 1148249.585 | 3872770.001 |
| Total acre for plant1 | 133138.649 | $22639490.18 | **$3,932,942** | **$5,608,475** | **169** | $9541416.919 | **$32,180,907** |

Table B.3. Scenario 1 Switchgrass production function and IMPLAN® industry sectors for switchgrass production. (Continued)
Note: Data from Scenario 1 used only used as example. Switchgrass production functions for other scenarios too large to be viewed in document.

| Fertilizer DAP | Fertilizer Urea | Fert App., Swathing, Baling | Hauling | Operating Capital | IMPLAN Sector 319 | IMPLAN Sector 130 | IMPLAN Sector 19 | IMPLAN Sector 335 | IMPLAN Sector 354 |
|---|---|---|---|---|---|---|---|---|---|
| 1082736.322 | 0 | 4107704.281 | 1073803.31 | 289524.7865 | 0.116225108 | 0 | 0.440936877 | 0.1152662 | 0.031078711 |
| 601541.4048 | 0 | 2282138.46 | 596578.445 | 160852.7794 | 0.116225108 | 0 | 0.440936877 | 0.1152662 | 0.031078711 |
| 218384.5297 | 0 | 828511.1055 | 216582.769 | 58396.24387 | 0.116225108 | 0 | 0.440936877 | 0.1152662 | 0.031078711 |
| 215019.8341 | 0 | 815746.0639 | 213245.8336 | 57496.52089 | 0.116225108 | 0 | 0.440936877 | 0.1152662 | 0.031078711 |
| 560186.6447 | 0 | 2125246.037 | 555564.8784 | 149794.4748 | 0.116225108 | 0 | 0.440936877 | 0.1152662 | 0.031078711 |
| 374394.7496 | 0 | 1420385.448 | 371305.8416 | 100113.5343 | 0.116225108 | 0 | 0.440936877 | 0.1152662 | 0.031078711 |
| 237852.7982 | 0 | 902370.1683 | 235890.4165 | 63602.07854 | 0.116225108 | 0 | 0.440936877 | 0.1152662 | 0.031078711 |
| 450113.1106 | 0 | 1707647.11 | 446399.4955 | 120360.7005 | 0.116225108 | 0 | 0.440936877 | 0.1152662 | 0.031078711 |

**APPENDIX C:** IMPLAN® RESULT TABLES

Table C.1 Projected Economic Impacts from 50% Cooperative Ownership for Cellulosic Ethanol Production Scenario 1

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 51.8 | $1,820,397.6 | $3,233,630.0 | $5,223,687.7 |
| Indirect Effect | 6.7 | $215,422.6 | $334,774.9 | $636,849.1 |
| Induced Effect | 123.5 | $3,861,438.6 | $6,987,389.8 | $11,041,662.9 |
| Total Effect | 182.0 | $5,897,258.8 | $10,555,794.6 | $16,902,199.7 |

Table C.2 Top Ten Industries Impacted By 50% Cooperative Ownership for Cellulosic Ethanol Production Scenario 1

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 31.9 | 987,967.9 | 1,246,393.5 | 1,901,475.4 |
| 413 | Food services and drinking places | 14.5 | 302,111.9 | 433,409.6 | 831,414.9 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 8.8 | 383,672.7 | 435,857.7 | 435,857.7 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 8.6 | 238,357.0 | 307,607.4 | 419,552.6 |
| 390 | Waste management and remediation services | 8.3 | 214,104.3 | 379,332.7 | 1,054,947.8 |
| 438 | * Employment and payroll only (state & local govt, education) | 6.0 | 273,923.6 | 311,181.1 | 311,181.1 |
| 394 | Offices of physicians, dentists, and other health practitioners | 6.0 | 311,845.2 | 332,691.6 | 588,492.7 |
| 398 | Nursing and residential care facilities | 5.2 | 148,777.5 | 160,584.3 | 273,398.5 |
| 329 | Retail Stores - General merchandise | 4.9 | 126,999.7 | 207,326.5 | 244,135.8 |
| 324 | Retail Stores - Food and beverage | 4.8 | 96,643.2 | 157,264.1 | 186,200.3 |

**Top Ten for Labor Income** .

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 31.9 | 987,967.9 | 1,246,393.5 | 1,901,475.4 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 8.8 | 383,672.7 | 435,857.7 | 435,857.7 |
| 31 | Electric power generation, transmission, and distribution | 4.0 | 357,272.3 | 1,231,836.1 | 1,749,427.9 |
| 394 | Offices of physicians, dentists, and other health practitioners | 6.0 | 311,845.2 | 332,691.6 | 588,492.7 |
| 413 | Food services and drinking places | 14.5 | 302,111.9 | 433,409.6 | 831,414.9 |
| 438 | * Employment and payroll only (state & local govt, education) | 6.0 | 273,923.6 | 311,181.1 | 311,181.1 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 8.6 | 238,357.0 | 307,607.4 | 419,552.6 |
| 390 | Waste management and remediation services | 8.3 | 214,104.3 | 379,332.7 | 1,054,947.8 |
| 319 | Wholesale trade businesses | 3.5 | 174,854.3 | 299,820.2 | 466,562.1 |
| 320 | Retail Stores - Motor vehicle and parts | 3.7 | 156,232.7 | 189,049.5 | 223,592.3 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 1,584,377.6 | 2,352,983.4 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 31.9 | 987,967.9 | 1,246,393.5 | 1,901,475.4 |
| 31 | Electric power generation, transmission, and distribution | 4.0 | 357,272.3 | 1,231,836.1 | 1,749,427.9 |
| 390 | Waste management and remediation services | 8.3 | 214,104.3 | 379,332.7 | 1,054,947.8 |
| 413 | Food services and drinking places | 14.5 | 302,111.9 | 433,409.6 | 831,414.9 |
| 354 | Monetary authorities and depository credit intermediation activities | 3.2 | 155,460.1 | 323,355.7 | 669,338.2 |
| 394 | Offices of physicians, dentists, and other health practitioners | 6.0 | 311,845.2 | 332,691.6 | 588,492.7 |
| 319 | Wholesale trade businesses | 3.5 | 174,854.3 | 299,820.2 | 466,562.1 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 8.8 | 383,672.7 | 435,857.7 | 435,857.7 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 8.6 | 238,357.0 | 307,607.4 | 419,552.6 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 1,584,377.6 | 2,352,983.4 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 31.9 | 987,967.9 | 1,246,393.5 | 1,901,475.4 |
| 31 | Electric power generation, transmission, and distribution | 4.0 | 357,272.3 | 1,231,836.1 | 1,749,427.9 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 8.8 | 383,672.7 | 435,857.7 | 435,857.7 |
| 413 | Food services and drinking places | 14.5 | 302,111.9 | 433,409.6 | 831,414.9 |
| 390 | Waste management and remediation services | 8.3 | 214,104.3 | 379,332.7 | 1,054,947.8 |
| 394 | Offices of physicians, dentists, and other health practitioners | 6.0 | 311,845.2 | 332,691.6 | 588,492.7 |
| 354 | Monetary authorities and depository credit intermediation activities | 3.2 | 155,460.1 | 323,355.7 | 669,338.2 |
| 438 | * Employment and payroll only (state & local govt, education) | 6.0 | 273,923.6 | 311,181.1 | 311,181.1 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 8.6 | 238,357.0 | 307,607.4 | 419,552.6 |

Table C.3. Projected Economic Impacts from 100% Cooperative Ownership for Cellulosic Ethanol Production Scenario 1

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 52 | $1,933,639.04 | $3,434,784.34 | $5,336,510.92 |
| Indirect Effect | 7 | $228,823.40 | $355,600.20 | $682,556.55 |
| Induced Effect | 210 | $6,943,928.51 | $12,671,056.49 | $19,733,849.11 |
| Total Effect | 269 | $9,106,390.95 | $16,461,441.02 | $25,752,916.59 |

Table C.4. Top Ten Industries Impacted By 100% Cooperative Ownership for Cellulosic Ethanol Production Scenario 1

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 32.2 | 1,057,717.5 | 1,334,387.7 | 1,892,075.1 |
| 413 | Food services and drinking places | 24.4 | 540,471.7 | 775,360.5 | 1,500,142.4 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 13.9 | 644,996.6 | 732,725.3 | 763,509.2 |
| 394 | Offices of physicians, dentists, and other health practitioners | 10.2 | 569,779.4 | 607,868.3 | 1,127,181.1 |
| 438 | * Employment and payroll only (state & local govt, education) | 9.5 | 460,496.1 | 523,130.1 | 545,108.3 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 9.4 | 275,769.1 | 355,889.0 | 551,385.4 |
| 398 | Nursing and residential care facilities | 9.0 | 271,780.9 | 293,349.1 | 531,873.8 |
| 390 | Waste management and remediation services | 8.4 | 229,925.9 | 407,364.1 | 1,107,676.0 |
| 329 | Retail Stores - General merchandise | 8.4 | 233,674.8 | 381,473.2 | 433,537.8 |
| 324 | Retail Stores - Food and beverage | 8.3 | 177,940.2 | 289,556.0 | 330,879.5 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 32.2 | 1,057,717.5 | 1,334,387.7 | 1,892,075.1 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 13.9 | 644,996.6 | 732,725.3 | 763,509.2 |
| 394 | Offices of physicians, dentists, and other health practitioners | 10.2 | 569,779.4 | 607,868.3 | 1,127,181.1 |
| 413 | Food services and drinking places | 24.4 | 540,471.7 | 775,360.5 | 1,500,142.4 |
| 438 | * Employment and payroll only (state & local govt, education) | 9.5 | 460,496.1 | 523,130.1 | 545,108.3 |
| 31 | Electric power generation, transmission, and distribution | 4.1 | 388,043.3 | 1,337,931.2 | 1,808,829.8 |
| 319 | Wholesale trade businesses | 5.8 | 306,006.7 | 524,705.4 | 732,709.1 |
| 320 | Retail Stores - Motor vehicle and parts | 6.5 | 287,539.7 | 347,937.7 | 397,163.4 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 9.4 | 275,769.1 | 355,889.0 | 551,385.4 |
| 354 | Monetary authorities and depository credit intermediation activities | 5.3 | 272,775.1 | 567,369.6 | 1,184,951.7 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 2,928,606.8 | 3,848,343.8 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 32.2 | 1,057,717.5 | 1,334,387.7 | 1,892,075.1 |
| 31 | Electric power generation, transmission, and distribution | 4.1 | 388,043.3 | 1,337,931.2 | 1,808,829.8 |
| 413 | Food services and drinking places | 24.4 | 540,471.7 | 775,360.5 | 1,500,142.4 |
| 354 | Monetary authorities and depository credit intermediation activities | 5.3 | 272,775.1 | 567,369.6 | 1,184,951.7 |
| 394 | Offices of physicians, dentists, and other health practitioners | 10.2 | 569,779.4 | 607,868.3 | 1,127,181.1 |
| 390 | Waste management and remediation services | 8.4 | 229,925.9 | 407,364.1 | 1,107,676.0 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 13.9 | 644,996.6 | 732,725.3 | 763,509.2 |
| 319 | Wholesale trade businesses | 5.8 | 306,006.7 | 524,705.4 | 732,709.1 |
| 432 | Other state and local government enterprises | 2.1 | 122,268.8 | 137,339.0 | 574,324.9 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 2,928,606.8 | 3,848,343.8 |
| 31 | Electric power generation, transmission, and distribution | 4.1 | 388,043.3 | 1,337,931.2 | 1,808,829.8 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 32.2 | 1,057,717.5 | 1,334,387.7 | 1,892,075.1 |
| 413 | Food services and drinking places | 24.4 | 540,471.7 | 775,360.5 | 1,500,142.4 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 13.9 | 644,996.6 | 732,725.3 | 763,509.2 |
| 394 | Offices of physicians, dentists, and other health practitioners | 10.2 | 569,779.4 | 607,868.3 | 1,127,181.1 |
| 354 | Monetary authorities and depository credit intermediation activities | 5.3 | 272,775.1 | 567,369.6 | 1,184,951.7 |
| 319 | Wholesale trade businesses | 5.8 | 306,006.7 | 524,705.4 | 732,709.1 |
| 438 | * Employment and payroll only (state & local govt, education) | 9.5 | 460,496.1 | 523,130.1 | 545,108.3 |
| 390 | Waste management and remediation services | 8.4 | 229,925.9 | 407,364.1 | 1,107,676.0 |

Table C.5. Projected Economic Impacts from Private Ownership for Cellulosic Ethanol Production Scenario 1

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 51.8 | 1,933,639.0 | 3,434,784.3 | 5,336,510.9 |
| Indirect Effect | 6.7 | 228,823.4 | 355,600.2 | 682,556.6 |
| Induced Effect | 40.3 | 1,373,056.6 | 2,383,011.7 | 3,687,517.8 |
| Total Effect | 98.8 | 3,535,519.1 | 6,173,396.2 | 9,706,585.2 |

Table C.6. Top Ten Industries Impacted By Private Ownership for Cellulosic Ethanol Production Scenario 1

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 31.7 | 1,041,466.9 | 1,313,886.4 | 1,863,005.6 |
| 390 | Waste management and remediation services | 8.2 | 225,020.4 | 398,672.9 | 1,084,043.5 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 7.9 | 231,503.1 | 298,762.4 | 462,877.9 |
| 413 | Food services and drinking places | 5.0 | 110,121.7 | 157,980.5 | 305,655.6 |
| 31 | Electric power generation, transmission, and distribution | 3.9 | 371,292.8 | 1,280,177.3 | 1,730,748.9 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 3.9 | 179,581.4 | 204,007.0 | 212,577.9 |
| 438 | * Employment and payroll only (state & local govt, education) | 2.7 | 128,212.3 | 145,651.0 | 151,770.3 |
| 394 | Offices of physicians, dentists, and other health practitioners | 1.8 | 102,250.4 | 109,085.7 | 202,279.5 |
| 398 | Nursing and residential care facilities | 1.6 | 48,834.1 | 52,709.5 | 95,568.1 |
| 33 | Water, sewage and other treatment and delivery systems | 1.6 | 110,095.5 | 209,841.8 | 296,821.5 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 31.7 | 1,041,466.9 | 1,313,886.4 | 1,863,005.6 |
| 31 | Electric power generation, transmission, and distribution | 3.9 | 371,292.8 | 1,280,177.3 | 1,730,748.9 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 7.9 | 231,503.1 | 298,762.4 | 462,877.9 |
| 390 | Waste management and remediation services | 8.2 | 225,020.4 | 398,672.9 | 1,084,043.5 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 3.9 | 179,581.4 | 204,007.0 | 212,577.9 |
| 438 | * Employment and payroll only (state & local govt, education) | 2.7 | 128,212.3 | 145,651.0 | 151,770.3 |
| 413 | Food services and drinking places | 5.0 | 110,121.7 | 157,980.5 | 305,655.6 |
| 33 | Water, sewage and other treatment and delivery systems | 1.6 | 110,095.5 | 209,841.8 | 296,821.5 |
| 394 | Offices of physicians, dentists, and other health practitioners | 1.8 | 102,250.4 | 109,085.7 | 202,279.5 |
| 319 | Wholesale trade businesses | 1.3 | 70,267.2 | 120,486.2 | 168,249.4 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 31.7 | 1,041,466.9 | 1,313,886.4 | 1,863,005.6 |
| 31 | Electric power generation, transmission, and distribution | 3.9 | 371,292.8 | 1,280,177.3 | 1,730,748.9 |
| 390 | Waste management and remediation services | 8.2 | 225,020.4 | 398,672.9 | 1,084,043.5 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 487,093.9 | 640,067.1 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 7.9 | 231,503.1 | 298,762.4 | 462,877.9 |
| 413 | Food services and drinking places | 5.0 | 110,121.7 | 157,980.5 | 305,655.6 |
| 33 | Water, sewage and other treatment and delivery systems | 1.6 | 110,095.5 | 209,841.8 | 296,821.5 |
| 354 | Monetary authorities and depository credit intermediation activities | 1.2 | 61,792.4 | 128,527.6 | 268,429.9 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 3.9 | 179,581.4 | 204,007.0 | 212,577.9 |
| 394 | Offices of physicians, dentists, and other health practitioners | 1.8 | 102,250.4 | 109,085.7 | 202,279.5 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 31.7 | 1,041,466.9 | 1,313,886.4 | 1,863,005.6 |
| 31 | Electric power generation, transmission, and distribution | 3.9 | 371,292.8 | 1,280,177.3 | 1,730,748.9 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 487,093.9 | 640,067.1 |
| 390 | Waste management and remediation services | 8.2 | 225,020.4 | 398,672.9 | 1,084,043.5 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 7.9 | 231,503.1 | 298,762.4 | 462,877.9 |
| 33 | Water, sewage and other treatment and delivery systems | 1.6 | 110,095.5 | 209,841.8 | 296,821.5 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 3.9 | 179,581.4 | 204,007.0 | 212,577.9 |
| 413 | Food services and drinking places | 5.0 | 110,121.7 | 157,980.5 | 305,655.6 |
| 438 | * Employment and payroll only (state & local govt, education) | 2.7 | 128,212.3 | 145,651.0 | 151,770.3 |
| 354 | Monetary authorities and depository credit intermediation activities | 1.2 | 61,792.4 | 128,527.6 | 268,429.9 |

Table C.7. Projected Economic Impacts from Switchgrass Production for Scenario 1

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 169.0 | 9,541,416.8 | 9,541,416.8 | $32,180,907.1 |
| Indirect Effect | 122.9 | 4,553,850.1 | 6,439,878.2 | $11,239,092.2 |
| Induced Effect | 165.2 | 6,356,543.2 | 10,746,172.9 | $16,887,026.4 |
| Total Effect | 457.1 | 20,451,810.1 | 26,727,467.9 | $60,307,025.6 |

Table C.8. Top Ten Industries Impacted By Switchgrass Production Scenario 1

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 169.0 | 9,541,590.3 | 9,541,590.3 | 32,181,492.0 |
| 19 | Support activities for agriculture and forestry | 46.1 | 939,058.5 | 810,981.8 | 1,106,982.6 |
| 335 | Transport by truck | 26.9 | 1,224,669.8 | 1,575,218.5 | 3,519,599.6 |
| 319 | Wholesale trade businesses | 24.4 | 1,533,546.7 | 2,633,720.2 | 4,038,460.7 |
| 413 | Food services and drinking places | 16.9 | 329,248.4 | 474,093.3 | 930,864.7 |
| 360 | Real estate establishments | 9.3 | 78,908.2 | 585,672.3 | 778,936.0 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 9.2 | 463,764.0 | 526,842.6 | 526,842.6 |
| 438 | * Employment and payroll only (state & local govt, education) | 7.4 | 377,749.7 | 429,129.1 | 429,129.1 |
| 394 | Offices of physicians, dentists, and other health practitioners | 7.2 | 534,614.8 | 570,335.0 | 905,569.1 |
| 354 | Monetary authorities and depository credit intermediation activities | 7.1 | 385,381.2 | 801,936.3 | 1,594,105.3 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 169.0 | 9,541,590.3 | 9,541,590.3 | 32,181,492.0 |
| 319 | Wholesale trade businesses | 24.4 | 1,533,546.7 | 2,633,720.2 | 4,038,460.7 |
| 335 | Transport by truck | 26.9 | 1,224,669.8 | 1,575,218.5 | 3,519,599.6 |
| 19 | Support activities for agriculture and forestry | 46.1 | 939,058.5 | 810,981.8 | 1,106,982.6 |
| 394 | Offices of physicians, dentists, and other health practitioners | 7.2 | 534,614.8 | 570,335.0 | 905,569.1 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 9.2 | 463,764.0 | 526,842.6 | 526,842.6 |
| 354 | Monetary authorities and depository credit intermediation activities | 7.1 | 385,381.2 | 801,936.3 | 1,594,105.3 |
| 438 | * Employment and payroll only (state & local govt, education) | 7.4 | 377,749.7 | 429,129.1 | 429,129.1 |
| 397 | Private hospitals | 6.1 | 370,784.6 | 395,813.3 | 796,875.9 |
| 413 | Food services and drinking places | 16.9 | 329,248.4 | 474,093.3 | 930,864.7 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 169.0 | 9,541,590.3 | 9,541,590.3 | 32,181,492.0 |
| 319 | Wholesale trade businesses | 24.4 | 1,533,546.7 | 2,633,720.2 | 4,038,460.7 |
| 335 | Transport by truck | 26.9 | 1,224,669.8 | 1,575,218.5 | 3,519,599.6 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 1,340,942.4 | 1,991,453.7 |
| 354 | Monetary authorities and depository credit intermediation activities | 7.1 | 385,381.2 | 801,936.3 | 1,594,105.3 |
| 19 | Support activities for agriculture and forestry | 46.1 | 939,058.5 | 810,981.8 | 1,106,982.6 |
| 413 | Food services and drinking places | 16.9 | 329,248.4 | 474,093.3 | 930,864.7 |
| 394 | Offices of physicians, dentists, and other health practitioners | 7.2 | 534,614.8 | 570,335.0 | 905,569.1 |
| 357 | Insurance carriers | 4.0 | 213,734.2 | 573,559.0 | 869,705.0 |
| 397 | Private hospitals | 6.1 | 370,784.6 | 395,813.3 | 796,875.9 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 169.0 | 9,541,590.3 | 9,541,590.3 | 32,181,492.0 |
| 319 | Wholesale trade businesses | 24.4 | 1,533,546.7 | 2,633,720.2 | 4,038,460.7 |
| 335 | Transport by truck | 26.9 | 1,224,669.8 | 1,575,218.5 | 3,519,599.6 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 1,340,942.4 | 1,991,453.7 |
| 19 | Support activities for agriculture and forestry | 46.1 | 939,058.5 | 810,981.8 | 1,106,982.6 |
| 354 | Monetary authorities and depository credit intermediation activities | 7.1 | 385,381.2 | 801,936.3 | 1,594,105.3 |
| 360 | Real estate establishments | 9.3 | 78,908.2 | 585,672.3 | 778,936.0 |
| 357 | Insurance carriers | 4.0 | 213,734.2 | 573,559.0 | 869,705.0 |
| 394 | Offices of physicians, dentists, and other health practitioners | 7.2 | 534,614.8 | 570,335.0 | 905,569.1 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 9.2 | 463,764.0 | 526,842.6 | 526,842.6 |

Table C.9. Projected Economic Impacts from Ethanol Production for Scenario 2

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 89.7 | 4,118,264.5 | 8,018,621.8 | 12,596,866.7 |
| Indirect Effect | 16.5 | 587,465.9 | 912,017.7 | 1,732,459.0 |
| Induced Effect | 97.9 | 3,560,298.5 | 5,842,058.4 | 9,106,465.8 |
| Total Effect | 204.1 | 8,266,029.0 | 14,772,697.9 | 23,435,791.5 |

Table C.10. Top Ten Industries Impacted By Ethanol Production Scenario 2

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 53.9 | 2,066,592.1 | 2,604,275.4 | 3,782,990.8 |
| 390 | Waste management and remediation services | 14.3 | 337,233.1 | 594,029.1 | 1,855,125.8 |
| 413 | Food services and drinking places | 11.7 | 215,271.1 | 309,158.1 | 622,076.9 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 10.6 | 431,801.7 | 555,183.4 | 888,068.5 |
| 31 | Electric power generation, transmission, and distribution | 10.3 | 1,168,272.8 | 4,011,917.2 | 5,657,776.8 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 8.1 | 354,315.7 | 402,507.7 | 402,507.7 |
| 438 | * Employment and payroll only (state & local govt, education) | 5.9 | 262,489.5 | 298,191.8 | 298,191.8 |
| 397 | Private hospitals | 4.4 | 255,192.5 | 272,391.3 | 563,788.9 |
| 398 | Nursing and residential care facilities | 4.2 | 112,980.9 | 121,930.5 | 211,609.3 |
| 394 | Offices of physicians, dentists, and other health practitioners | 4.1 | 281,122.9 | 299,874.4 | 487,361.3 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 53.9 | 2,066,592.1 | 2,604,275.4 | 3,782,990.8 |
| 31 | Electric power generation, transmission, and distribution | 10.3 | 1,168,272.8 | 4,011,917.2 | 5,657,776.8 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 10.6 | 431,801.7 | 555,183.4 | 888,068.5 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 8.1 | 354,315.7 | 402,507.7 | 402,507.7 |
| 390 | Waste management and remediation services | 14.3 | 337,233.1 | 594,029.1 | 1,855,125.8 |
| 440 | * Employment and payroll only (federal govt, military) | 3.3 | 332,038.6 | 479,735.5 | 479,735.5 |
| 394 | Offices of physicians, dentists, and other health practitioners | 4.1 | 281,122.9 | 299,874.4 | 487,361.3 |
| 438 | * Employment and payroll only (state & local govt, education) | 5.9 | 262,489.5 | 298,191.8 | 298,191.8 |
| 397 | Private hospitals | 4.4 | 255,192.5 | 272,391.3 | 563,788.9 |
| 33 | Water, sewage and other treatment and delivery systems | 3.7 | 225,868.8 | 427,909.9 | 642,343.0 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 10.3 | 1,168,272.8 | 4,011,917.2 | 5,657,776.8 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 53.9 | 2,066,592.1 | 2,604,275.4 | 3,782,990.8 |
| 390 | Waste management and remediation services | 14.3 | 337,233.1 | 594,029.1 | 1,855,125.8 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 945,232.3 | 1,403,778.9 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 10.6 | 431,801.7 | 555,183.4 | 888,068.5 |
| 33 | Water, sewage and other treatment and delivery systems | 3.7 | 225,868.8 | 427,909.9 | 642,343.0 |
| 413 | Food services and drinking places | 11.7 | 215,271.1 | 309,158.1 | 622,076.9 |
| 397 | Private hospitals | 4.4 | 255,192.5 | 272,391.3 | 563,788.9 |
| 354 | Monetary authorities and depository credit intermediation activities | 2.6 | 129,667.7 | 269,782.4 | 549,458.6 |
| 394 | Offices of physicians, dentists, and other health practitioners | 4.1 | 281,122.9 | 299,874.4 | 487,361.3 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 10.3 | 1,168,272.8 | 4,011,917.2 | 5,657,776.8 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 53.9 | 2,066,592.1 | 2,604,275.4 | 3,782,990.8 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 945,232.3 | 1,403,778.9 |
| 390 | Waste management and remediation services | 14.3 | 337,233.1 | 594,029.1 | 1,855,125.8 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 10.6 | 431,801.7 | 555,183.4 | 888,068.5 |
| 440 | * Employment and payroll only (federal govt, military) | 3.3 | 332,038.6 | 479,735.5 | 479,735.5 |
| 33 | Water, sewage and other treatment and delivery systems | 3.7 | 225,868.8 | 427,909.9 | 642,343.0 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 8.1 | 354,315.7 | 402,507.7 | 402,507.7 |
| 413 | Food services and drinking places | 11.7 | 215,271.1 | 309,158.1 | 622,076.9 |
| 394 | Offices of physicians, dentists, and other health practitioners | 4.1 | 281,122.9 | 299,874.4 | 487,361.3 |

Table C.11. Projected Economic Impacts from Switchgrass Production for Scenario 2

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 345.0 | 20,702,553.0 | 20,702,553.0 | 61,331,790.6 |
| Indirect Effect | 263.4 | 9,018,753.5 | 11,977,517.0 | 21,273,865.2 |
| Induced Effect | 316.8 | 12,847,963.7 | 21,793,567.4 | 34,325,691.0 |
| Total Effect | 925.1 | 42,569,270.2 | 54,473,637.3 | 116,931,346.8 |

Table C.12. Top Ten Industries Impacted By Switchgrass Production Scenario 2

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 345.0 | 20,703,080.5 | 20,703,080.5 | 61,333,353.5 |
| 19 | Support activities for agriculture and forestry | 125.9 | 2,588,080.7 | 2,229,556.5 | 2,880,289.8 |
| 335 | Transport by truck | 59.0 | 2,895,362.9 | 3,723,417.7 | 8,356,922.9 |
| 413 | Food services and drinking places | 32.7 | 672,974.0 | 968,971.3 | 1,923,575.8 |
| 319 | Wholesale trade businesses | 26.8 | 1,765,098.9 | 3,031,098.7 | 4,173,851.9 |
| 360 | Real estate establishments | 16.9 | 154,384.2 | 1,145,469.3 | 1,581,014.5 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 16.8 | 885,071.3 | 1,005,453.7 | 1,047,695.7 |
| 354 | Monetary authorities and depository credit intermediation activities | 15.2 | 870,367.9 | 1,811,511.9 | 3,644,525.2 |
| 394 | Offices of physicians, dentists, and other health practitioners | 13.9 | 1,090,460.8 | 1,163,311.7 | 1,937,126.9 |
| 438 | * Employment and payroll only (state & local govt, education) | 13.3 | 720,609.7 | 818,623.0 | 853,015.7 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 345.0 | 20,703,080.5 | 20,703,080.5 | 61,333,353.5 |
| 335 | Transport by truck | 59.0 | 2,895,362.9 | 3,723,417.7 | 8,356,922.9 |
| 19 | Support activities for agriculture and forestry | 125.9 | 2,588,080.7 | 2,229,556.5 | 2,880,289.8 |
| 319 | Wholesale trade businesses | 26.8 | 1,765,098.9 | 3,031,098.7 | 4,173,851.9 |
| 394 | Offices of physicians, dentists, and other health practitioners | 13.9 | 1,090,460.8 | 1,163,311.7 | 1,937,126.9 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 16.8 | 885,071.3 | 1,005,453.7 | 1,047,695.7 |
| 354 | Monetary authorities and depository credit intermediation activities | 15.2 | 870,367.9 | 1,811,511.9 | 3,644,525.2 |
| 397 | Private hospitals | 12.0 | 776,124.8 | 828,509.2 | 1,731,252.7 |
| 438 | * Employment and payroll only (state & local govt, education) | 13.3 | 720,609.7 | 818,623.0 | 853,015.7 |
| 413 | Food services and drinking places | 32.7 | 672,974.0 | 968,971.3 | 1,923,575.8 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 345.0 | 20,703,080.5 | 20,703,080.5 | 61,333,353.5 |
| 335 | Transport by truck | 59.0 | 2,895,362.9 | 3,723,417.7 | 8,356,922.9 |
| 319 | Wholesale trade businesses | 26.8 | 1,765,098.9 | 3,031,098.7 | 4,173,851.9 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 2,792,352.5 | 3,669,297.7 |
| 354 | Monetary authorities and depository credit intermediation activities | 15.2 | 870,367.9 | 1,811,511.9 | 3,644,525.2 |
| 19 | Support activities for agriculture and forestry | 125.9 | 2,588,080.7 | 2,229,556.5 | 2,880,289.8 |
| 394 | Offices of physicians, dentists, and other health practitioners | 13.9 | 1,090,460.8 | 1,163,311.7 | 1,937,126.9 |
| 413 | Food services and drinking places | 32.7 | 672,974.0 | 968,971.3 | 1,923,575.8 |
| 357 | Insurance carriers | 7.4 | 419,936.1 | 1,126,935.1 | 1,901,414.5 |
| 397 | Private hospitals | 12.0 | 776,124.8 | 828,509.2 | 1,731,252.7 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 345.0 | 20,703,080.5 | 20,703,080.5 | 61,333,353.5 |
| 335 | Transport by truck | 59.0 | 2,895,362.9 | 3,723,417.7 | 8,356,922.9 |
| 319 | Wholesale trade businesses | 26.8 | 1,765,098.9 | 3,031,098.7 | 4,173,851.9 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 2,792,352.5 | 3,669,297.7 |
| 19 | Support activities for agriculture and forestry | 125.9 | 2,588,080.7 | 2,229,556.5 | 2,880,289.8 |
| 354 | Monetary authorities and depository credit intermediation activities | 15.2 | 870,367.9 | 1,811,511.9 | 3,644,525.2 |
| 394 | Offices of physicians, dentists, and other health practitioners | 13.9 | 1,090,460.8 | 1,163,311.7 | 1,937,126.9 |
| 360 | Real estate establishments | 16.9 | 154,384.2 | 1,145,469.3 | 1,581,014.5 |
| 357 | Insurance carriers | 7.4 | 419,936.1 | 1,126,935.1 | 1,901,414.5 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 16.8 | 885,071.3 | 1,005,453.7 | 1,047,695.7 |

Table C.13. Projected Economic Impacts from Ethanol Production for Scenario 3

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 131.5 | 6,083,011.4 | 12,188,725.8 | 19,210,598.5 |
| Indirect Effect | 24.0 | 849,683.7 | 1,311,945.0 | 2,527,555.1 |
| Induced Effect | 150.7 | 5,318,770.2 | 8,764,825.2 | 13,709,889.2 |
| Total Effect | 306.2 | 12,251,465.3 | 22,265,496.1 | 35,448,042.8 |

Table C.14. Top Ten Industries Impacted By Ethanol Production Scenario 3

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 75.5 | 2,777,700.7 | 3,502,461.3 | 5,100,328.8 |
| 390 | Waste management and remediation services | 23.0 | 687,696.2 | 1,202,329.9 | 3,291,654.9 |
| 413 | Food services and drinking places | 18.1 | 322,656.0 | 463,420.1 | 942,592.7 |
| 31 | Electric power generation, transmission, and distribution | 16.2 | 1,842,805.3 | 6,332,485.1 | 8,930,376.6 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 14.8 | 577,024.1 | 742,064.9 | 1,187,445.0 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 12.1 | 527,501.8 | 599,249.6 | 599,249.6 |
| 438 | * Employment and payroll only (state & local govt, education) | 11.8 | 533,228.6 | 605,755.3 | 605,755.3 |
| 398 | Nursing and residential care facilities | 7.2 | 180,625.4 | 194,927.9 | 349,189.0 |
| 33 | Water, sewage and other treatment and delivery systems | 6.5 | 343,731.3 | 652,583.5 | 979,544.9 |
| 397 | Private hospitals | 6.4 | 358,113.7 | 382,250.0 | 800,401.8 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 75.5 | 2,777,700.7 | 3,502,461.3 | 5,100,328.8 |
| 31 | Electric power generation, transmission, and distribution | 16.2 | 1,842,805.3 | 6,332,485.1 | 8,930,376.6 |
| 390 | Waste management and remediation services | 23.0 | 687,696.2 | 1,202,329.9 | 3,291,654.9 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 14.8 | 577,024.1 | 742,064.9 | 1,187,445.0 |
| 438 | * Employment and payroll only (state & local govt, education) | 11.8 | 533,228.6 | 605,755.3 | 605,755.3 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 12.1 | 527,501.8 | 599,249.6 | 599,249.6 |
| 440 | * Employment and payroll only (federal govt, military) | 4.4 | 419,001.2 | 605,380.6 | 605,380.6 |
| 394 | Offices of physicians, dentists, and other health practitioners | 6.0 | 390,816.0 | 416,869.4 | 687,110.9 |
| 397 | Private hospitals | 6.4 | 358,113.7 | 382,250.0 | 800,401.8 |
| 33 | Water, sewage and other treatment and delivery systems | 6.5 | 343,731.3 | 652,583.5 | 979,544.9 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 16.2 | 1,842,805.3 | 6,332,485.1 | 8,930,376.6 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 75.5 | 2,777,700.7 | 3,502,461.3 | 5,100,328.8 |
| 390 | Waste management and remediation services | 23.0 | 687,696.2 | 1,202,329.9 | 3,291,654.9 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 1,495,259.3 | 2,220,632.2 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 14.8 | 577,024.1 | 742,064.9 | 1,187,445.0 |
| 33 | Water, sewage and other treatment and delivery systems | 6.5 | 343,731.3 | 652,583.5 | 979,544.9 |
| 413 | Food services and drinking places | 18.1 | 322,656.0 | 463,420.1 | 942,592.7 |
| 354 | Monetary authorities and depository credit intermediation activities | 4.1 | 200,899.1 | 417,899.1 | 859,623.8 |
| 397 | Private hospitals | 6.4 | 358,113.7 | 382,250.0 | 800,401.8 |
| 394 | Offices of physicians, dentists, and other health practitioners | 6.0 | 390,816.0 | 416,869.4 | 687,110.9 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 16.2 | 1,842,805.3 | 6,332,485.1 | 8,930,376.6 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 75.5 | 2,777,700.7 | 3,502,461.3 | 5,100,328.8 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 1,495,259.3 | 2,220,632.2 |
| 390 | Waste management and remediation services | 23.0 | 687,696.2 | 1,202,329.9 | 3,291,654.9 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 14.8 | 577,024.1 | 742,064.9 | 1,187,445.0 |
| 33 | Water, sewage and other treatment and delivery systems | 6.5 | 343,731.3 | 652,583.5 | 979,544.9 |
| 438 | * Employment and payroll only (state & local govt, education) | 11.8 | 533,228.6 | 605,755.3 | 605,755.3 |
| 440 | * Employment and payroll only (federal govt, military) | 4.4 | 419,001.2 | 605,380.6 | 605,380.6 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 12.1 | 527,501.8 | 599,249.6 | 599,249.6 |
| 413 | Food services and drinking places | 18.1 | 322,656.0 | 463,420.1 | 942,592.7 |

Table C.15. Projected Economic Impacts from Switchgrass Production for Scenario 3

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 509.0 | 28,735,421.1 | 28,735,421.1 | 96,917,674.0 |
| Indirect Effect | 562.1 | 16,620,692.7 | 21,782,205.3 | 40,090,693.0 |
| Induced Effect | 565.8 | 21,678,542.5 | 36,728,914.1 | 58,840,037.1 |
| Total Effect | 1,636.9 | 67,034,656.3 | 87,246,540.4 | 195,848,404.1 |

Table C.16. Top Ten Industries Impacted By Switchgrass Production Scenario 3

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 509.0 | 28,737,280.0 | 28,737,280.0 | 96,923,943.8 |
| 19 | Support activities for agriculture and forestry | 326.7 | 6,401,672.7 | 5,511,660.4 | 7,557,191.6 |
| 335 | Transport by truck | 88.1 | 4,175,610.5 | 5,367,692.2 | 11,788,541.1 |
| 413 | Food services and drinking places | 56.1 | 1,075,702.2 | 1,547,780.8 | 3,058,786.2 |
| 319 | Wholesale trade businesses | 40.5 | 2,648,697.4 | 4,553,819.3 | 6,966,982.3 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 33.3 | 1,605,707.9 | 1,824,107.2 | 1,824,107.1 |
| 360 | Real estate establishments | 31.2 | 279,835.5 | 2,074,550.5 | 2,759,123.0 |
| 438 | * Employment and payroll only (state & local govt, education) | 30.5 | 1,507,009.4 | 1,711,984.3 | 1,711,984.3 |
| 354 | Monetary authorities and depository credit intermediation activities | 23.5 | 1,331,041.8 | 2,767,502.0 | 5,442,659.8 |
| 394 | Offices of physicians, dentists, and other health practitioners | 23.1 | 1,788,290.6 | 1,907,504.4 | 2,988,725.1 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 509.0 | 28,737,280.0 | 28,737,280.0 | 96,923,943.8 |
| 19 | Support activities for agriculture and forestry | 326.7 | 6,401,672.7 | 5,511,660.4 | 7,557,191.6 |
| 335 | Transport by truck | 88.1 | 4,175,610.5 | 5,367,692.2 | 11,788,541.1 |
| 319 | Wholesale trade businesses | 40.5 | 2,648,697.4 | 4,553,819.3 | 6,966,982.3 |
| 394 | Offices of physicians, dentists, and other health practitioners | 23.1 | 1,788,290.6 | 1,907,504.4 | 2,988,725.1 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 33.3 | 1,605,707.9 | 1,824,107.2 | 1,824,107.1 |
| 438 | * Employment and payroll only (state & local govt, education) | 30.5 | 1,507,009.4 | 1,711,984.3 | 1,711,984.3 |
| 354 | Monetary authorities and depository credit intermediation activities | 23.5 | 1,331,041.8 | 2,767,502.0 | 5,442,659.8 |
| 397 | Private hospitals | 21.7 | 1,262,560.0 | 1,347,760.4 | 2,776,933.8 |
| 413 | Food services and drinking places | 56.1 | 1,075,702.2 | 1,547,780.8 | 3,058,786.2 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 509.0 | 28,737,280.0 | 28,737,280.0 | 96,923,943.8 |
| 335 | Transport by truck | 88.1 | 4,175,610.5 | 5,367,692.2 | 11,788,541.1 |
| 19 | Support activities for agriculture and forestry | 326.7 | 6,401,672.7 | 5,511,660.4 | 7,557,191.6 |
| 319 | Wholesale trade businesses | 40.5 | 2,648,697.4 | 4,553,819.3 | 6,966,982.3 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 4,467,360.1 | 6,634,544.3 |
| 354 | Monetary authorities and depository credit intermediation activities | 23.5 | 1,331,041.8 | 2,767,502.0 | 5,442,659.8 |
| 130 | Fertilizer manufacturing | 1.4 | 612,455.3 | 1,182,916.2 | 3,374,553.6 |
| 413 | Food services and drinking places | 56.1 | 1,075,702.2 | 1,547,780.8 | 3,058,786.2 |
| 394 | Offices of physicians, dentists, and other health practitioners | 23.1 | 1,788,290.6 | 1,907,504.4 | 2,988,725.1 |
| 397 | Private hospitals | 21.7 | 1,262,560.0 | 1,347,760.4 | 2,776,933.8 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 509.0 | 28,737,280.0 | 28,737,280.0 | 96,923,943.8 |
| 19 | Support activities for agriculture and forestry | 326.7 | 6,401,672.7 | 5,511,660.4 | 7,557,191.6 |
| 335 | Transport by truck | 88.1 | 4,175,610.5 | 5,367,692.2 | 11,788,541.1 |
| 319 | Wholesale trade businesses | 40.5 | 2,648,697.4 | 4,553,819.3 | 6,966,982.3 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 4,467,360.1 | 6,634,544.3 |
| 354 | Monetary authorities and depository credit intermediation activities | 23.5 | 1,331,041.8 | 2,767,502.0 | 5,442,659.8 |
| 360 | Real estate establishments | 31.2 | 279,835.5 | 2,074,550.5 | 2,759,123.0 |
| 394 | Offices of physicians, dentists, and other health practitioners | 23.1 | 1,788,290.6 | 1,907,504.4 | 2,988,725.1 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 33.3 | 1,605,707.9 | 1,824,107.2 | 1,824,107.1 |
| 438 | * Employment and payroll only (state & local govt, education) | 30.5 | 1,507,009.4 | 1,711,984.3 | 1,711,984.3 |

Table C.17. Projected Economic Impacts from Ethanol Production for Scenario 4

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 173.9 | 8,162,595.8 | 17,291,161.4 | 27,185,389.7 |
| Indirect Effect | 34.1 | 1,202,502.6 | 1,853,453.3 | 3,619,303.4 |
| Induced Effect | 201.8 | 7,151,820.1 | 11,609,103.5 | 18,129,395.9 |
| Total Effect | 409.7 | 16,516,918.6 | 30,753,718.2 | 48,934,088.9 |

Table C.18. Top Ten Industries Impacted By Ethanol Production Scenario 4

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 84.9 | 3,137,926.1 | 3,956,656.9 | 5,759,784.2 |
| 390 | Waste management and remediation services | 33.0 | 1,112,600.2 | 1,942,742.6 | 4,996,003.9 |
| 31 | Electric power generation, transmission, and distribution | 32.3 | 2,857,166.8 | 9,809,844.1 | 13,833,967.4 |
| 413 | Food services and drinking places | 25.3 | 447,171.0 | 642,103.8 | 1,311,225.0 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 20.9 | 769,017.0 | 989,228.8 | 1,583,379.8 |
| 438 | * Employment and payroll only (state & local govt, education) | 20.0 | 962,803.6 | 1,093,758.6 | 1,093,758.7 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 16.3 | 732,152.8 | 831,736.1 | 831,736.1 |
| 398 | Nursing and residential care facilities | 9.4 | 236,287.4 | 255,001.7 | 454,640.0 |
| 33 | Water, sewage and other treatment and delivery systems | 8.9 | 462,955.5 | 878,761.6 | 1,319,128.5 |
| 397 | Private hospitals | 8.6 | 437,592.4 | 467,089.9 | 1,032,692.5 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 84.9 | 3,137,926.1 | 3,956,656.9 | 5,759,784.2 |
| 31 | Electric power generation, transmission, and distribution | 32.3 | 2,857,166.8 | 9,809,844.1 | 13,833,967.4 |
| 390 | Waste management and remediation services | 33.0 | 1,112,600.2 | 1,942,742.6 | 4,996,003.9 |
| 438 | * Employment and payroll only (state & local govt, education) | 20.0 | 962,803.6 | 1,093,758.6 | 1,093,758.7 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 20.9 | 769,017.0 | 989,228.8 | 1,583,379.8 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 16.3 | 732,152.8 | 831,736.1 | 831,736.1 |
| 394 | Offices of physicians, dentists, and other health practitioners | 8.1 | 506,488.8 | 540,291.3 | 899,801.6 |
| 440 | * Employment and payroll only (federal govt, military) | 5.2 | 488,431.3 | 705,694.5 | 705,694.5 |
| 33 | Water, sewage and other treatment and delivery systems | 8.9 | 462,955.5 | 878,761.6 | 1,319,128.5 |
| 413 | Food services and drinking places | 25.3 | 447,171.0 | 642,103.8 | 1,311,225.0 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 32.3 | 2,857,166.8 | 9,809,844.1 | 13,833,967.4 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 84.9 | 3,137,926.1 | 3,956,656.9 | 5,759,784.2 |
| 390 | Waste management and remediation services | 33.0 | 1,112,600.2 | 1,942,742.6 | 4,996,003.9 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 1,918,907.9 | 2,849,799.4 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 20.9 | 769,017.0 | 989,228.8 | 1,583,379.8 |
| 33 | Water, sewage and other treatment and delivery systems | 8.9 | 462,955.5 | 878,761.6 | 1,319,128.5 |
| 413 | Food services and drinking places | 25.3 | 447,171.0 | 642,103.8 | 1,311,225.0 |
| 354 | Monetary authorities and depository credit intermediation activities | 5.8 | 270,907.2 | 563,785.4 | 1,176,911.4 |
| 438 | * Employment and payroll only (state & local govt, education) | 20.0 | 962,803.6 | 1,093,758.6 | 1,093,758.7 |
| 397 | Private hospitals | 8.6 | 437,592.4 | 467,089.9 | 1,032,692.5 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 32.3 | 2,857,166.8 | 9,809,844.1 | 13,833,967.4 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 84.9 | 3,137,926.1 | 3,956,656.9 | 5,759,784.2 |
| 390 | Waste management and remediation services | 33.0 | 1,112,600.2 | 1,942,742.6 | 4,996,003.9 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 1,918,907.9 | 2,849,799.4 |
| 438 | * Employment and payroll only (state & local govt, education) | 20.0 | 962,803.6 | 1,093,758.6 | 1,093,758.7 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 20.9 | 769,017.0 | 989,228.8 | 1,583,379.8 |
| 33 | Water, sewage and other treatment and delivery systems | 8.9 | 462,955.5 | 878,761.6 | 1,319,128.5 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 16.3 | 732,152.8 | 831,736.1 | 831,736.1 |
| 440 | * Employment and payroll only (federal govt, military) | 5.2 | 488,431.3 | 705,694.5 | 705,694.5 |
| 413 | Food services and drinking places | 25.3 | 447,171.0 | 642,103.8 | 1,311,225.0 |

Table C.19. Projected Economic Impacts from Switchgrass Production for Scenario 4

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 705.0 | 39,758,657.2 | 39,758,657.2 | 132,590,769.0 |
| Indirect Effect | 728.5 | 21,428,955.0 | 28,217,770.9 | 52,552,507.2 |
| Induced Effect | 755.5 | 28,567,396.6 | 48,296,714.3 | 77,719,853.1 |
| Total Effect | 2,189.0 | 89,755,008.8 | 116,273,142.4 | 262,863,129.3 |

Table C.20. Top Ten Industries Impacted By Switchgrass Production Scenario 4

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 705.0 | 39,761,223.2 | 39,761,223.2 | 132,599,326.3 |
| 19 | Support activities for agriculture and forestry | 408.5 | 7,936,635.4 | 6,833,001.7 | 9,377,550.1 |
| 335 | Transport by truck | 119.4 | 5,584,130.3 | 7,180,511.3 | 15,863,909.7 |
| 413 | Food services and drinking places | 75.9 | 1,445,858.5 | 2,080,832.6 | 4,123,379.7 |
| 319 | Wholesale trade businesses | 53.8 | 3,442,715.3 | 5,918,340.7 | 9,065,280.7 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 45.1 | 2,138,628.2 | 2,429,512.3 | 2,429,512.3 |
| 438 | * Employment and payroll only (state & local govt, education) | 41.9 | 2,047,240.3 | 2,325,694.4 | 2,325,694.5 |
| 360 | Real estate establishments | 38.6 | 348,810.4 | 2,585,389.8 | 3,438,532.4 |
| 354 | Monetary authorities and depository credit intermediation activities | 32.5 | 1,795,720.7 | 3,734,644.5 | 7,399,142.6 |
| 394 | Offices of physicians, dentists, and other health practitioners | 31.0 | 2,365,156.7 | 2,522,821.1 | 3,966,870.7 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 705.0 | 39,761,223.2 | 39,761,223.2 | 132,599,326.3 |
| 19 | Support activities for agriculture and forestry | 408.5 | 7,936,635.4 | 6,833,001.7 | 9,377,550.1 |
| 335 | Transport by truck | 119.4 | 5,584,130.3 | 7,180,511.3 | 15,863,909.7 |
| 319 | Wholesale trade businesses | 53.8 | 3,442,715.3 | 5,918,340.7 | 9,065,280.7 |
| 394 | Offices of physicians, dentists, and other health practitioners | 31.0 | 2,365,156.7 | 2,522,821.1 | 3,966,870.7 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 45.1 | 2,138,628.2 | 2,429,512.3 | 2,429,512.3 |
| 438 | * Employment and payroll only (state & local govt, education) | 41.9 | 2,047,240.3 | 2,325,694.4 | 2,325,694.5 |
| 354 | Monetary authorities and depository credit intermediation activities | 32.5 | 1,795,720.7 | 3,734,644.5 | 7,399,142.6 |
| 397 | Private hospitals | 29.0 | 1,655,623.7 | 1,767,338.2 | 3,672,215.9 |
| 413 | Food services and drinking places | 75.9 | 1,445,858.5 | 2,080,832.6 | 4,123,379.7 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 705.0 | 39,761,223.2 | 39,761,223.2 | 132,599,326.3 |
| 335 | Transport by truck | 119.4 | 5,584,130.3 | 7,180,511.3 | 15,863,909.7 |
| 19 | Support activities for agriculture and forestry | 408.5 | 7,936,635.4 | 6,833,001.7 | 9,377,550.1 |
| 319 | Wholesale trade businesses | 53.8 | 3,442,715.3 | 5,918,340.7 | 9,065,280.7 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 6,048,439.0 | 8,982,627.8 |
| 354 | Monetary authorities and depository credit intermediation activities | 32.5 | 1,795,720.7 | 3,734,644.5 | 7,399,142.6 |
| 130 | Fertilizer manufacturing | 1.8 | 819,243.6 | 1,582,313.7 | 4,513,931.3 |
| 413 | Food services and drinking places | 75.9 | 1,445,858.5 | 2,080,832.6 | 4,123,379.7 |
| 394 | Offices of physicians, dentists, and other health practitioners | 31.0 | 2,365,156.7 | 2,522,821.1 | 3,966,870.7 |
| 397 | Private hospitals | 29.0 | 1,655,623.7 | 1,767,338.2 | 3,672,215.9 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 705.0 | 39,761,223.2 | 39,761,223.2 | 132,599,326.3 |
| 335 | Transport by truck | 119.4 | 5,584,130.3 | 7,180,511.3 | 15,863,909.7 |
| 19 | Support activities for agriculture and forestry | 408.5 | 7,936,635.4 | 6,833,001.7 | 9,377,550.1 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 6,048,439.0 | 8,982,627.8 |
| 319 | Wholesale trade businesses | 53.8 | 3,442,715.3 | 5,918,340.7 | 9,065,280.7 |
| 354 | Monetary authorities and depository credit intermediation activities | 32.5 | 1,795,720.7 | 3,734,644.5 | 7,399,142.6 |
| 360 | Real estate establishments | 38.6 | 348,810.4 | 2,585,389.8 | 3,438,532.4 |
| 394 | Offices of physicians, dentists, and other health practitioners | 31.0 | 2,365,156.7 | 2,522,821.1 | 3,966,870.7 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 45.1 | 2,138,628.2 | 2,429,512.3 | 2,429,512.3 |
| 438 | * Employment and payroll only (state & local govt, education) | 41.9 | 2,047,240.3 | 2,325,694.4 | 2,325,694.5 |

Table C.21. Projected Economic Impacts from Ethanol Production for Scenario 5

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 228.0 | 10,241,436.1 | 21,618,835.5 | 34,150,852.2 |
| Indirect Effect | 42.8 | 1,504,398.2 | 2,321,770.3 | 4,550,184.9 |
| Induced Effect | 252.8 | 8,908,851.1 | 14,465,435.6 | 22,573,129.8 |
| Total Effect | 523.7 | 20,654,685.4 | 38,406,041.4 | 61,274,166.9 |

Table C.22. Top Ten Industries Impacted By Ethanol Production Scenario 5

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 110.9 | 3,958,262.7 | 4,992,959.2 | 7,284,473.1 |
| 390 | Waste management and remediation services | 42.3 | 1,417,662.7 | 2,475,978.3 | 6,386,665.1 |
| 31 | Electric power generation, transmission, and distribution | 40.2 | 3,535,974.1 | 12,140,292.0 | 17,120,392.0 |
| 413 | Food services and drinking places | 31.6 | 554,228.3 | 795,865.7 | 1,630,014.1 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 26.0 | 952,376.1 | 1,225,262.6 | 1,960,881.6 |
| 438 | * Employment and payroll only (state & local govt, education) | 26.0 | 1,236,452.7 | 1,404,627.9 | 1,404,627.9 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 21.2 | 935,889.5 | 1,063,183.8 | 1,063,183.9 |
| 398 | Nursing and residential care facilities | 11.6 | 291,928.3 | 315,069.5 | 562,928.8 |
| 33 | Water, sewage and other treatment and delivery systems | 11.4 | 579,747.5 | 1,100,262.1 | 1,651,624.4 |
| 397 | Private hospitals | 10.4 | 529,568.9 | 565,268.3 | 1,249,619.5 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 110.9 | 3,958,262.7 | 4,992,959.2 | 7,284,473.1 |
| 31 | Electric power generation, transmission, and distribution | 40.2 | 3,535,974.1 | 12,140,292.0 | 17,120,392.0 |
| 390 | Waste management and remediation services | 42.3 | 1,417,662.7 | 2,475,978.3 | 6,386,665.1 |
| 438 | * Employment and payroll only (state & local govt, education) | 26.0 | 1,236,452.7 | 1,404,627.9 | 1,404,627.9 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 26.0 | 952,376.1 | 1,225,262.6 | 1,960,881.6 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 21.2 | 935,889.5 | 1,063,183.8 | 1,063,183.9 |
| 394 | Offices of physicians, dentists, and other health practitioners | 9.9 | 621,400.4 | 662,877.1 | 1,105,231.0 |
| 440 | * Employment and payroll only (federal govt, military) | 6.3 | 583,356.7 | 842,844.4 | 842,844.4 |
| 33 | Water, sewage and other treatment and delivery systems | 11.4 | 579,747.5 | 1,100,262.1 | 1,651,624.4 |
| 413 | Food services and drinking places | 31.6 | 554,228.3 | 795,865.7 | 1,630,014.1 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 40.2 | 3,535,974.1 | 12,140,292.0 | 17,120,392.0 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 110.9 | 3,958,262.7 | 4,992,959.2 | 7,284,473.1 |
| 390 | Waste management and remediation services | 42.3 | 1,417,662.7 | 2,475,978.3 | 6,386,665.1 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 2,406,184.3 | 3,573,460.9 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 26.0 | 952,376.1 | 1,225,262.6 | 1,960,881.6 |
| 33 | Water, sewage and other treatment and delivery systems | 11.4 | 579,747.5 | 1,100,262.1 | 1,651,624.4 |
| 413 | Food services and drinking places | 31.6 | 554,228.3 | 795,865.7 | 1,630,014.1 |
| 354 | Monetary authorities and depository credit intermediation activities | 7.3 | 343,825.0 | 715,644.2 | 1,493,849.6 |
| 438 | * Employment and payroll only (state & local govt, education) | 26.0 | 1,236,452.7 | 1,404,627.9 | 1,404,627.9 |
| 397 | Private hospitals | 10.4 | 529,568.9 | 565,268.3 | 1,249,619.5 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 40.2 | 3,535,974.1 | 12,140,292.0 | 17,120,392.0 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 110.9 | 3,958,262.7 | 4,992,959.2 | 7,284,473.1 |
| 390 | Waste management and remediation services | 42.3 | 1,417,662.7 | 2,475,978.3 | 6,386,665.1 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 2,406,184.3 | 3,573,460.9 |
| 438 | * Employment and payroll only (state & local govt, education) | 26.0 | 1,236,452.7 | 1,404,627.9 | 1,404,627.9 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 26.0 | 952,376.1 | 1,225,262.6 | 1,960,881.6 |
| 33 | Water, sewage and other treatment and delivery systems | 11.4 | 579,747.5 | 1,100,262.1 | 1,651,624.4 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 21.2 | 935,889.5 | 1,063,183.8 | 1,063,183.9 |
| 440 | * Employment and payroll only (federal govt, military) | 6.3 | 583,356.7 | 842,844.4 | 842,844.4 |
| 413 | Food services and drinking places | 31.6 | 554,228.3 | 795,865.7 | 1,630,014.1 |

Table C.23. Projected Economic Impacts from Switchgrass Production for Scenario 5

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 898.0 | 50,689,025.3 | 50,689,025.3 | 167,122,696.8 |
| Indirect Effect | 872.3 | 25,720,891.6 | 33,844,043.7 | 63,470,394.4 |
| Induced Effect | 901.7 | 34,174,877.5 | 57,753,136.2 | 92,636,912.7 |
| Total Effect | 2,672.1 | 110,584,794.4 | 142,286,205.3 | 323,230,003.8 |

Table C.24. Top Ten Industries Impacted By Switchgrass Production Scenario 5

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 898.1 | 50,692,112.3 | 50,692,112.3 | 167,132,874.7 |
| 19 | Support activities for agriculture and forestry | 479.9 | 9,445,605.1 | 8,138,631.0 | 11,152,683.6 |
| 335 | Transport by truck | 146.5 | 6,822,889.5 | 8,774,307.4 | 19,417,945.9 |
| 413 | Food services and drinking places | 91.8 | 1,740,821.8 | 2,505,147.1 | 4,972,296.0 |
| 319 | Wholesale trade businesses | 64.8 | 4,118,567.2 | 7,079,530.7 | 10,847,734.9 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 52.5 | 2,483,657.0 | 2,821,469.9 | 2,821,469.5 |
| 438 | * Employment and payroll only (state & local govt, education) | 49.8 | 2,406,726.7 | 2,734,076.1 | 2,734,076.1 |
| 360 | Real estate establishments | 44.8 | 405,969.0 | 3,008,583.4 | 4,001,373.3 |
| 354 | Monetary authorities and depository credit intermediation activities | 41.3 | 2,225,387.0 | 4,628,506.4 | 9,238,871.3 |
| 394 | Offices of physicians, dentists, and other health practitioners | 36.8 | 2,774,170.7 | 2,959,134.4 | 4,669,647.7 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 898.1 | 50,692,112.3 | 50,692,112.3 | 167,132,874.7 |
| 19 | Support activities for agriculture and forestry | 479.9 | 9,445,605.1 | 8,138,631.0 | 11,152,683.6 |
| 335 | Transport by truck | 146.5 | 6,822,889.5 | 8,774,307.4 | 19,417,945.9 |
| 319 | Wholesale trade businesses | 64.8 | 4,118,567.2 | 7,079,530.7 | 10,847,734.9 |
| 394 | Offices of physicians, dentists, and other health practitioners | 36.8 | 2,774,170.7 | 2,959,134.4 | 4,669,647.7 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 52.5 | 2,483,657.0 | 2,821,469.9 | 2,821,469.5 |
| 438 | * Employment and payroll only (state & local govt, education) | 49.8 | 2,406,726.7 | 2,734,076.1 | 2,734,076.1 |
| 354 | Monetary authorities and depository credit intermediation activities | 41.3 | 2,225,387.0 | 4,628,506.4 | 9,238,871.3 |
| 397 | Private hospitals | 33.9 | 1,929,939.2 | 2,060,159.5 | 4,292,487.2 |
| 413 | Food services and drinking places | 91.8 | 1,740,821.8 | 2,505,147.1 | 4,972,296.0 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 898.1 | 50,692,112.3 | 50,692,112.3 | 167,132,874.7 |
| 335 | Transport by truck | 146.5 | 6,822,889.5 | 8,774,307.4 | 19,417,945.9 |
| 19 | Support activities for agriculture and forestry | 479.9 | 9,445,605.1 | 8,138,631.0 | 11,152,683.6 |
| 319 | Wholesale trade businesses | 64.8 | 4,118,567.2 | 7,079,530.7 | 10,847,734.9 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 7,303,869.4 | 10,847,087.1 |
| 354 | Monetary authorities and depository credit intermediation activities | 41.3 | 2,225,387.0 | 4,628,506.4 | 9,238,871.3 |
| 130 | Fertilizer manufacturing | 2.2 | 822,163.1 | 1,584,461.1 | 5,043,484.3 |
| 413 | Food services and drinking places | 91.8 | 1,740,821.8 | 2,505,147.1 | 4,972,296.0 |
| 394 | Offices of physicians, dentists, and other health practitioners | 36.8 | 2,774,170.7 | 2,959,134.4 | 4,669,647.7 |
| 397 | Private hospitals | 33.9 | 1,929,939.2 | 2,060,159.5 | 4,292,487.2 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 898.1 | 50,692,112.3 | 50,692,112.3 | 167,132,874.7 |
| 335 | Transport by truck | 146.5 | 6,822,889.5 | 8,774,307.4 | 19,417,945.9 |
| 19 | Support activities for agriculture and forestry | 479.9 | 9,445,605.1 | 8,138,631.0 | 11,152,683.6 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 7,303,869.4 | 10,847,087.1 |
| 319 | Wholesale trade businesses | 64.8 | 4,118,567.2 | 7,079,530.7 | 10,847,734.9 |
| 354 | Monetary authorities and depository credit intermediation activities | 41.3 | 2,225,387.0 | 4,628,506.4 | 9,238,871.3 |
| 360 | Real estate establishments | 44.8 | 405,969.0 | 3,008,583.4 | 4,001,373.3 |
| 394 | Offices of physicians, dentists, and other health practitioners | 36.8 | 2,774,170.7 | 2,959,134.4 | 4,669,647.7 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 52.5 | 2,483,657.0 | 2,821,469.9 | 2,821,469.5 |
| 438 | * Employment and payroll only (state & local govt, education) | 49.8 | 2,406,726.7 | 2,734,076.1 | 2,734,076.1 |

Table C.25. Projected Economic Impacts from Ethanol Production for Scenario 6

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 246.1 | 11,746,510.8 | 25,759,094.6 | 40,611,039.6 |
| Indirect Effect | 50.5 | 1,767,397.0 | 2,732,877.3 | 5,328,908.6 |
| Induced Effect | 304.0 | 10,747,710.8 | 17,425,013.4 | 27,334,999.5 |
| Total Effect | 600.7 | 24,261,618.5 | 45,916,985.2 | 73,274,947.7 |

Table C.26. Top Ten Industries Impacted By Ethanol Production Scenario 6

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 110.2 | 3,944,004.3 | 4,974,386.0 | 7,255,925.0 |
| 390 | Waste management and remediation services | 50.6 | 1,771,758.7 | 3,094,471.0 | 7,802,025.7 |
| 31 | Electric power generation, transmission, and distribution | 47.7 | 4,473,851.7 | 15,360,108.4 | 21,661,209.3 |
| 413 | Food services and drinking places | 39.1 | 670,875.8 | 963,510.7 | 1,990,691.8 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 30.4 | 1,106,172.8 | 1,422,538.0 | 2,278,149.4 |
| 438 | * Employment and payroll only (state & local govt, education) | 30.3 | 1,433,403.3 | 1,628,366.6 | 1,628,366.6 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 25.6 | 1,121,294.1 | 1,273,806.1 | 1,273,806.2 |
| 397 | Private hospitals | 13.7 | 698,522.5 | 745,608.1 | 1,641,905.2 |
| 398 | Nursing and residential care facilities | 13.0 | 336,173.3 | 362,819.5 | 640,763.4 |
| 394 | Offices of physicians, dentists, and other health practitioners | 12.3 | 852,363.7 | 909,119.9 | 1,471,100.8 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 47.7 | 4,473,851.7 | 15,360,108.4 | 21,661,209.3 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 110.2 | 3,944,004.3 | 4,974,386.0 | 7,255,925.0 |
| 390 | Waste management and remediation services | 50.6 | 1,771,758.7 | 3,094,471.0 | 7,802,025.7 |
| 438 | * Employment and payroll only (state & local govt, education) | 30.3 | 1,433,403.3 | 1,628,366.6 | 1,628,366.6 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 25.6 | 1,121,294.1 | 1,273,806.1 | 1,273,806.2 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 30.4 | 1,106,172.8 | 1,422,538.0 | 2,278,149.4 |
| 394 | Offices of physicians, dentists, and other health practitioners | 12.3 | 852,363.7 | 909,119.9 | 1,471,100.8 |
| 33 | Water, sewage and other treatment and delivery systems | 10.7 | 723,980.8 | 1,371,855.2 | 2,057,870.4 |
| 397 | Private hospitals | 13.7 | 698,522.5 | 745,608.1 | 1,641,905.2 |
| 413 | Food services and drinking places | 39.1 | 670,875.8 | 963,510.7 | 1,990,691.8 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 47.7 | 4,473,851.7 | 15,360,108.4 | 21,661,209.3 |
| 390 | Waste management and remediation services | 50.6 | 1,771,758.7 | 3,094,471.0 | 7,802,025.7 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 110.2 | 3,944,004.3 | 4,974,386.0 | 7,255,925.0 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 2,912,142.0 | 4,324,866.3 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 30.4 | 1,106,172.8 | 1,422,538.0 | 2,278,149.4 |
| 33 | Water, sewage and other treatment and delivery systems | 10.7 | 723,980.8 | 1,371,855.2 | 2,057,870.4 |
| 413 | Food services and drinking places | 39.1 | 670,875.8 | 963,510.7 | 1,990,691.8 |
| 354 | Monetary authorities and depository credit intermediation activities | 8.4 | 417,865.7 | 869,459.9 | 1,783,457.1 |
| 397 | Private hospitals | 13.7 | 698,522.5 | 745,608.1 | 1,641,905.2 |
| 438 | * Employment and payroll only (state & local govt, education) | 30.3 | 1,433,403.3 | 1,628,366.6 | 1,628,366.6 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 47.7 | 4,473,851.7 | 15,360,108.4 | 21,661,209.3 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 110.2 | 3,944,004.3 | 4,974,386.0 | 7,255,925.0 |
| 390 | Waste management and remediation services | 50.6 | 1,771,758.7 | 3,094,471.0 | 7,802,025.7 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 2,912,142.0 | 4,324,866.3 |
| 438 | * Employment and payroll only (state & local govt, education) | 30.3 | 1,433,403.3 | 1,628,366.6 | 1,628,366.6 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 30.4 | 1,106,172.8 | 1,422,538.0 | 2,278,149.4 |
| 33 | Water, sewage and other treatment and delivery systems | 10.7 | 723,980.8 | 1,371,855.2 | 2,057,870.4 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 25.6 | 1,121,294.1 | 1,273,806.1 | 1,273,806.2 |
| 413 | Food services and drinking places | 39.1 | 670,875.8 | 963,510.7 | 1,990,691.8 |
| 440 | * Employment and payroll only (federal govt, military) | 7.2 | 631,338.0 | 912,168.7 | 912,168.7 |

Table C.27. Projected Economic Impacts from Switchgrass Production for Scenario 6

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 1,083.0 | 61,130,671.6 | 61,130,671.6 | 201,548,949.4 |
| Indirect Effect | 1,071.7 | 30,716,317.1 | 39,987,709.0 | 75,212,562.4 |
| Induced Effect | 1,074.0 | 40,231,653.6 | 68,159,380.0 | 109,773,526.4 |
| Total Effect | 3,228.8 | 132,078,642.4 | 169,277,760.6 | 386,535,038.1 |

Table C.28. Top Ten Industries Impacted By Switchgrass Production Scenario 6

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 1,083.1 | 61,134,675.2 | 61,134,675.2 | 201,562,149.0 |
| 19 | Support activities for agriculture and forestry | 600.4 | 11,839,849.4 | 10,200,438.4 | 13,975,334.8 |
| 335 | Transport by truck | 173.2 | 7,970,506.6 | 10,252,945.9 | 22,808,023.3 |
| 413 | Food services and drinking places | 109.5 | 2,059,040.2 | 2,963,119.7 | 5,901,271.7 |
| 319 | Wholesale trade businesses | 75.4 | 4,743,420.3 | 8,153,140.2 | 12,500,133.1 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 63.8 | 2,967,134.0 | 3,370,706.7 | 3,370,706.1 |
| 438 | * Employment and payroll only (state & local govt, education) | 61.2 | 2,919,806.9 | 3,316,942.5 | 3,316,942.1 |
| 360 | Real estate establishments | 51.3 | 462,046.2 | 3,424,601.9 | 4,554,672.2 |
| 354 | Monetary authorities and depository credit intermediation activities | 49.8 | 2,644,535.6 | 5,500,851.4 | 11,031,366.9 |
| 394 | Offices of physicians, dentists, and other health practitioners | 43.2 | 3,224,838.8 | 3,439,861.8 | 5,443,013.2 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 1,083.1 | 61,134,675.2 | 61,134,675.2 | 201,562,149.0 |
| 19 | Support activities for agriculture and forestry | 600.4 | 11,839,849.4 | 10,200,438.4 | 13,975,334.8 |
| 335 | Transport by truck | 173.2 | 7,970,506.6 | 10,252,945.9 | 22,808,023.3 |
| 319 | Wholesale trade businesses | 75.4 | 4,743,420.3 | 8,153,140.2 | 12,500,133.1 |
| 394 | Offices of physicians, dentists, and other health practitioners | 43.2 | 3,224,838.8 | 3,439,861.8 | 5,443,013.2 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 63.8 | 2,967,134.0 | 3,370,706.7 | 3,370,706.1 |
| 438 | * Employment and payroll only (state & local govt, education) | 61.2 | 2,919,806.9 | 3,316,942.5 | 3,316,942.1 |
| 354 | Monetary authorities and depository credit intermediation activities | 49.8 | 2,644,535.6 | 5,500,851.4 | 11,031,366.9 |
| 397 | Private hospitals | 39.5 | 2,244,403.8 | 2,395,839.5 | 4,994,982.2 |
| 413 | Food services and drinking places | 109.5 | 2,059,040.2 | 2,963,119.7 | 5,901,271.7 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 1,083.1 | 61,134,675.2 | 61,134,675.2 | 201,562,149.0 |
| 335 | Transport by truck | 173.2 | 7,970,506.6 | 10,252,945.9 | 22,808,023.3 |
| 19 | Support activities for agriculture and forestry | 600.4 | 11,839,849.4 | 10,200,438.4 | 13,975,334.8 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 8,824,885.1 | 13,105,970.0 |
| 319 | Wholesale trade businesses | 75.4 | 4,743,420.3 | 8,153,140.2 | 12,500,133.1 |
| 354 | Monetary authorities and depository credit intermediation activities | 49.8 | 2,644,535.6 | 5,500,851.4 | 11,031,366.9 |
| 413 | Food services and drinking places | 109.5 | 2,059,040.2 | 2,963,119.7 | 5,901,271.7 |
| 130 | Fertilizer manufacturing | 2.5 | 860,087.0 | 1,657,285.2 | 5,523,512.1 |
| 394 | Offices of physicians, dentists, and other health practitioners | 43.2 | 3,224,838.8 | 3,439,861.8 | 5,443,013.2 |
| 397 | Private hospitals | 39.5 | 2,244,403.8 | 2,395,839.5 | 4,994,982.2 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 1,083.1 | 61,134,675.2 | 61,134,675.2 | 201,562,149.0 |
| 335 | Transport by truck | 173.2 | 7,970,506.6 | 10,252,945.9 | 22,808,023.3 |
| 19 | Support activities for agriculture and forestry | 600.4 | 11,839,849.4 | 10,200,438.4 | 13,975,334.8 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 8,824,885.1 | 13,105,970.0 |
| 319 | Wholesale trade businesses | 75.4 | 4,743,420.3 | 8,153,140.2 | 12,500,133.1 |
| 354 | Monetary authorities and depository credit intermediation activities | 49.8 | 2,644,535.6 | 5,500,851.4 | 11,031,366.9 |
| 394 | Offices of physicians, dentists, and other health practitioners | 43.2 | 3,224,838.8 | 3,439,861.8 | 5,443,013.2 |
| 360 | Real estate establishments | 51.3 | 462,046.2 | 3,424,601.9 | 4,554,672.2 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 63.8 | 2,967,134.0 | 3,370,706.7 | 3,370,706.1 |
| 438 | * Employment and payroll only (state & local govt, education) | 61.2 | 2,919,806.9 | 3,316,942.5 | 3,316,942.1 |

Table C.29. Projected Economic Impacts from Ethanol Production for Scenario 7

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 237.2 | 12,664,714.8 | 27,455,190.3 | 43,521,188.2 |
| Indirect Effect | 52.5 | 1,833,791.3 | 2,900,002.1 | 5,608,682.8 |
| Induced Effect | 303.9 | 11,244,203.5 | 18,501,195.0 | 28,245,010.1 |
| Total Effect | 593.6 | 25,742,709.6 | 48,856,387.4 | 77,374,881.2 |

Table C.30. Top Ten Industries Impacted By Ethanol Production Scenario 7

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 92.4 | 4,338,785.2 | 5,466,233.7 | 7,853,549.1 |
| 390 | Waste management and remediation services | 52.0 | 1,922,531.7 | 3,358,521.6 | 8,247,038.2 |
| 31 | Electric power generation, transmission, and distribution | 48.1 | 4,560,758.8 | 15,656,617.7 | 22,079,489.5 |
| 413 | Food services and drinking places | 42.0 | 742,100.7 | 1,066,533.6 | 2,175,924.8 |
| 438 | * Employment and payroll only (state & local govt, education) | 28.1 | 1,324,585.1 | 1,504,747.6 | 1,504,747.6 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 26.2 | 850,884.3 | 1,094,711.1 | 1,758,087.1 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 23.6 | 1,102,922.5 | 1,252,935.7 | 1,252,935.9 |
| 440 | * Employment and payroll only (federal govt, military) | 14.4 | 1,468,162.4 | 2,121,228.0 | 2,121,227.9 |
| 33 | Water, sewage and other treatment and delivery systems | 11.9 | 826,063.8 | 1,565,172.7 | 2,348,366.9 |
| 394 | Offices of physicians, dentists, and other health practitioners | 11.8 | 762,301.9 | 813,131.6 | 1,341,480.3 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 48.1 | 4,560,758.8 | 15,656,617.7 | 22,079,489.5 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 92.4 | 4,338,785.2 | 5,466,233.7 | 7,853,549.1 |
| 390 | Waste management and remediation services | 52.0 | 1,922,531.7 | 3,358,521.6 | 8,247,038.2 |
| 440 | * Employment and payroll only (federal govt, military) | 14.4 | 1,468,162.4 | 2,121,228.0 | 2,121,227.9 |
| 438 | * Employment and payroll only (state & local govt, education) | 28.1 | 1,324,585.1 | 1,504,747.6 | 1,504,747.6 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 23.6 | 1,102,922.5 | 1,252,935.7 | 1,252,935.9 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 26.2 | 850,884.3 | 1,094,711.1 | 1,758,087.1 |
| 33 | Water, sewage and other treatment and delivery systems | 11.9 | 826,063.8 | 1,565,172.7 | 2,348,366.9 |
| 394 | Offices of physicians, dentists, and other health practitioners | 11.8 | 762,301.9 | 813,131.6 | 1,341,480.3 |
| 413 | Food services and drinking places | 42.0 | 742,100.7 | 1,066,533.6 | 2,175,924.8 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 48.1 | 4,560,758.8 | 15,656,617.7 | 22,079,489.5 |
| 390 | Waste management and remediation services | 52.0 | 1,922,531.7 | 3,358,521.6 | 8,247,038.2 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 92.4 | 4,338,785.2 | 5,466,233.7 | 7,853,549.1 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 3,009,542.7 | 4,469,517.0 |
| 33 | Water, sewage and other treatment and delivery systems | 11.9 | 826,063.8 | 1,565,172.7 | 2,348,366.9 |
| 413 | Food services and drinking places | 42.0 | 742,100.7 | 1,066,533.6 | 2,175,924.8 |
| 440 | * Employment and payroll only (federal govt, military) | 14.4 | 1,468,162.4 | 2,121,228.0 | 2,121,227.9 |
| 354 | Monetary authorities and depository credit intermediation activities | 9.1 | 410,246.4 | 853,363.9 | 1,808,772.7 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 26.2 | 850,884.3 | 1,094,711.1 | 1,758,087.1 |
| 438 | * Employment and payroll only (state & local govt, education) | 28.1 | 1,324,585.1 | 1,504,747.6 | 1,504,747.6 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 48.1 | 4,560,758.8 | 15,656,617.7 | 22,079,489.5 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 92.4 | 4,338,785.2 | 5,466,233.7 | 7,853,549.1 |
| 390 | Waste management and remediation services | 52.0 | 1,922,531.7 | 3,358,521.6 | 8,247,038.2 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 3,009,542.7 | 4,469,517.0 |
| 440 | * Employment and payroll only (federal govt, military) | 14.4 | 1,468,162.4 | 2,121,228.0 | 2,121,227.9 |
| 33 | Water, sewage and other treatment and delivery systems | 11.9 | 826,063.8 | 1,565,172.7 | 2,348,366.9 |
| 438 | * Employment and payroll only (state & local govt, education) | 28.1 | 1,324,585.1 | 1,504,747.6 | 1,504,747.6 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 23.6 | 1,102,922.5 | 1,252,935.7 | 1,252,935.9 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 26.2 | 850,884.3 | 1,094,711.1 | 1,758,087.1 |
| 413 | Food services and drinking places | 42.0 | 742,100.7 | 1,066,533.6 | 2,175,924.8 |

Table C.31. Projected Economic Impacts from Switchgrass Production for Scenario 7

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 1,299.0 | 73,329,026.1 | 73,329,026.1 | 236,213,287.0 |
| Indirect Effect | 1,227.4 | 35,718,729.6 | 46,541,721.5 | 87,296,040.9 |
| Induced Effect | 1,268.0 | 47,318,096.3 | 80,306,013.6 | 129,531,154.7 |
| Total Effect | 3,794.3 | 156,365,852.0 | 200,176,761.3 | 453,040,482.6 |

Table C.32. Top Ten Industries Impacted By Switchgrass Production Scenario 7

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 1,299.1 | 73,333,808.0 | 73,333,808.0 | 236,228,690.6 |
| 19 | Support activities for agriculture and forestry | 685.1 | 13,847,078.7 | 11,936,949.0 | 16,310,589.4 |
| 335 | Transport by truck | 198.1 | 9,128,532.0 | 11,742,612.4 | 26,105,780.8 |
| 413 | Food services and drinking places | 129.6 | 2,431,042.9 | 3,498,521.8 | 6,972,109.3 |
| 319 | Wholesale trade businesses | 89.7 | 5,622,340.8 | 9,663,831.8 | 14,818,889.0 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 74.2 | 3,436,181.7 | 3,903,551.6 | 3,903,550.8 |
| 438 | * Employment and payroll only (state & local govt, education) | 70.9 | 3,377,302.7 | 3,836,664.3 | 3,836,663.7 |
| 360 | Real estate establishments | 59.7 | 537,861.5 | 3,986,574.7 | 5,302,088.4 |
| 354 | Monetary authorities and depository credit intermediation activities | 58.8 | 3,110,576.1 | 6,470,561.1 | 12,991,538.4 |
| 394 | Offices of physicians, dentists, and other health practitioners | 51.2 | 3,813,051.5 | 4,067,317.0 | 6,441,453.2 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 1,299.1 | 73,333,808.0 | 73,333,808.0 | 236,228,690.6 |
| 19 | Support activities for agriculture and forestry | 685.1 | 13,847,078.7 | 11,936,949.0 | 16,310,589.4 |
| 335 | Transport by truck | 198.1 | 9,128,532.0 | 11,742,612.4 | 26,105,780.8 |
| 319 | Wholesale trade businesses | 89.7 | 5,622,340.8 | 9,663,831.8 | 14,818,889.0 |
| 394 | Offices of physicians, dentists, and other health practitioners | 51.2 | 3,813,051.5 | 4,067,317.0 | 6,441,453.2 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 74.2 | 3,436,181.7 | 3,903,551.6 | 3,903,550.8 |
| 438 | * Employment and payroll only (state & local govt, education) | 70.9 | 3,377,302.7 | 3,836,664.3 | 3,836,663.7 |
| 354 | Monetary authorities and depository credit intermediation activities | 58.8 | 3,110,576.1 | 6,470,561.1 | 12,991,538.4 |
| 397 | Private hospitals | 46.5 | 2,636,275.6 | 2,814,152.0 | 5,869,795.0 |
| 413 | Food services and drinking places | 129.6 | 2,431,042.9 | 3,498,521.8 | 6,972,109.3 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 1,299.1 | 73,333,808.0 | 73,333,808.0 | 236,228,690.6 |
| 335 | Transport by truck | 198.1 | 9,128,532.0 | 11,742,612.4 | 26,105,780.8 |
| 19 | Support activities for agriculture and forestry | 685.1 | 13,847,078.7 | 11,936,949.0 | 16,310,589.4 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 10,492,993.5 | 15,583,304.7 |
| 319 | Wholesale trade businesses | 89.7 | 5,622,340.8 | 9,663,831.8 | 14,818,889.0 |
| 354 | Monetary authorities and depository credit intermediation activities | 58.8 | 3,110,576.1 | 6,470,561.1 | 12,991,538.4 |
| 413 | Food services and drinking places | 129.6 | 2,431,042.9 | 3,498,521.8 | 6,972,109.3 |
| 130 | Fertilizer manufacturing | 2.9 | 1,040,899.8 | 2,007,006.7 | 6,464,835.6 |
| 394 | Offices of physicians, dentists, and other health practitioners | 51.2 | 3,813,051.5 | 4,067,317.0 | 6,441,453.2 |
| 397 | Private hospitals | 46.5 | 2,636,275.6 | 2,814,152.0 | 5,869,795.0 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 1,299.1 | 73,333,808.0 | 73,333,808.0 | 236,228,690.6 |
| 19 | Support activities for agriculture and forestry | 685.1 | 13,847,078.7 | 11,936,949.0 | 16,310,589.4 |
| 335 | Transport by truck | 198.1 | 9,128,532.0 | 11,742,612.4 | 26,105,780.8 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 10,492,993.5 | 15,583,304.7 |
| 319 | Wholesale trade businesses | 89.7 | 5,622,340.8 | 9,663,831.8 | 14,818,889.0 |
| 354 | Monetary authorities and depository credit intermediation activities | 58.8 | 3,110,576.1 | 6,470,561.1 | 12,991,538.4 |
| 394 | Offices of physicians, dentists, and other health practitioners | 51.2 | 3,813,051.5 | 4,067,317.0 | 6,441,453.2 |
| 360 | Real estate establishments | 59.7 | 537,861.5 | 3,986,574.7 | 5,302,088.4 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 74.2 | 3,436,181.7 | 3,903,551.6 | 3,903,550.8 |
| 438 | * Employment and payroll only (state & local govt, education) | 70.9 | 3,377,302.7 | 3,836,664.3 | 3,836,663.7 |

Table C.33. Projected Economic Impacts from Ethanol Production for Scenario 8

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 344.8 | 16,743,501.0 | 36,691,773.5 | 57,929,383.5 |
| Indirect Effect | 68.4 | 2,400,823.5 | 3,774,364.8 | 7,446,203.7 |
| Induced Effect | 381.4 | 13,556,460.0 | 21,955,825.4 | 34,295,927.1 |
| Total Effect | 794.6 | 32,700,784.5 | 62,421,963.6 | 99,671,514.3 |

Table C.34. Top Ten Industries Impacted By Ethanol Production Scenario 8

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 158.9 | 5,876,071.4 | 7,418,137.6 | 10,797,866.5 |
| 31 | Electric power generation, transmission, and distribution | 68.0 | 6,310,111.7 | 21,665,096.7 | 30,552,617.9 |
| 390 | Waste management and remediation services | 60.0 | 2,259,343.2 | 3,940,592.6 | 9,583,807.4 |
| 413 | Food services and drinking places | 51.1 | 869,752.4 | 1,249,042.4 | 2,587,323.0 |
| 438 | * Employment and payroll only (state & local govt, education) | 37.0 | 1,759,834.4 | 1,999,197.1 | 1,999,197.3 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 36.2 | 1,264,419.9 | 1,626,392.1 | 2,605,281.3 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 33.9 | 1,487,876.9 | 1,690,249.4 | 1,690,249.5 |
| 397 | Private hospitals | 16.3 | 827,535.7 | 883,314.5 | 1,949,203.4 |
| 398 | Nursing and residential care facilities | 15.8 | 415,838.1 | 448,813.3 | 787,493.1 |
| 394 | Offices of physicians, dentists, and other health practitioners | 15.1 | 1,002,316.7 | 1,069,056.6 | 1,750,067.1 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 68.0 | 6,310,111.7 | 21,665,096.7 | 30,552,617.9 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 158.9 | 5,876,071.4 | 7,418,137.6 | 10,797,866.5 |
| 390 | Waste management and remediation services | 60.0 | 2,259,343.2 | 3,940,592.6 | 9,583,807.4 |
| 438 | * Employment and payroll only (state & local govt, education) | 37.0 | 1,759,834.4 | 1,999,197.1 | 1,999,197.3 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 33.9 | 1,487,876.9 | 1,690,249.4 | 1,690,249.5 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 36.2 | 1,264,419.9 | 1,626,392.1 | 2,605,281.3 |
| 394 | Offices of physicians, dentists, and other health practitioners | 15.1 | 1,002,316.7 | 1,069,056.6 | 1,750,067.1 |
| 440 | * Employment and payroll only (federal govt, military) | 10.8 | 985,945.6 | 1,424,512.3 | 1,424,512.3 |
| 33 | Water, sewage and other treatment and delivery systems | 13.9 | 947,011.0 | 1,794,490.3 | 2,692,256.7 |
| 413 | Food services and drinking places | 51.1 | 869,752.4 | 1,249,042.4 | 2,587,323.0 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 68.0 | 6,310,111.7 | 21,665,096.7 | 30,552,617.9 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 158.9 | 5,876,071.4 | 7,418,137.6 | 10,797,866.5 |
| 390 | Waste management and remediation services | 60.0 | 2,259,343.2 | 3,940,592.6 | 9,583,807.4 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 3,627,891.6 | 5,387,836.7 |
| 33 | Water, sewage and other treatment and delivery systems | 13.9 | 947,011.0 | 1,794,490.3 | 2,692,256.7 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 36.2 | 1,264,419.9 | 1,626,392.1 | 2,605,281.3 |
| 413 | Food services and drinking places | 51.1 | 869,752.4 | 1,249,042.4 | 2,587,323.0 |
| 354 | Monetary authorities and depository credit intermediation activities | 11.1 | 540,663.3 | 1,124,768.7 | 2,320,847.5 |
| 438 | * Employment and payroll only (state & local govt, education) | 37.0 | 1,759,834.4 | 1,999,197.1 | 1,999,197.3 |
| 397 | Private hospitals | 16.3 | 827,535.7 | 883,314.5 | 1,949,203.4 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 68.0 | 6,310,111.7 | 21,665,096.7 | 30,552,617.9 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 158.9 | 5,876,071.4 | 7,418,137.6 | 10,797,866.5 |
| 390 | Waste management and remediation services | 60.0 | 2,259,343.2 | 3,940,592.6 | 9,583,807.4 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 3,627,891.6 | 5,387,836.7 |
| 438 | * Employment and payroll only (state & local govt, education) | 37.0 | 1,759,834.4 | 1,999,197.1 | 1,999,197.3 |
| 33 | Water, sewage and other treatment and delivery systems | 13.9 | 947,011.0 | 1,794,490.3 | 2,692,256.7 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 33.9 | 1,487,876.9 | 1,690,249.4 | 1,690,249.5 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 36.2 | 1,264,419.9 | 1,626,392.1 | 2,605,281.3 |
| 440 | * Employment and payroll only (federal govt, military) | 10.8 | 985,945.6 | 1,424,512.3 | 1,424,512.3 |
| 413 | Food services and drinking places | 51.1 | 869,752.4 | 1,249,042.4 | 2,587,323.0 |

Table C.35. Projected Economic Impacts from Switchgrass Production for Scenario 8

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 1,554.0 | 87,714,870.2 | 87,714,870.2 | 279,232,366.4 |
| Indirect Effect | 1,512.1 | 44,615,236.0 | 57,040,819.6 | 105,863,405.4 |
| Induced Effect | 1,523.7 | 56,668,692.3 | 96,102,442.5 | 154,937,308.3 |
| Total Effect | 4,589.8 | 188,998,798.5 | 240,858,132.4 | 540,033,080.1 |

Table C.36. Top Ten Industries Impacted By Switchgrass Production Scenario 8

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 1,554.1 | 87,722,928.4 | 87,722,928.4 | 279,258,019.0 |
| 19 | Support activities for agriculture and forestry | 870.6 | 18,940,243.8 | 16,344,776.6 | 22,163,610.6 |
| 335 | Transport by truck | 231.0 | 10,603,160.5 | 13,640,190.7 | 30,372,759.9 |
| 413 | Food services and drinking places | 157.1 | 2,930,850.7 | 4,217,635.1 | 8,424,490.2 |
| 319 | Wholesale trade businesses | 106.1 | 6,625,507.6 | 11,387,674.9 | 17,465,848.3 |
| 438 | * Employment and payroll only (state & local govt, education) | 90.2 | 4,298,439.2 | 4,883,088.4 | 4,883,087.6 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 87.9 | 4,059,327.7 | 4,611,454.4 | 4,611,453.1 |
| 354 | Monetary authorities and depository credit intermediation activities | 70.9 | 3,733,690.7 | 7,766,867.2 | 15,618,885.8 |
| 360 | Real estate establishments | 70.7 | 637,736.7 | 4,726,382.3 | 6,286,022.7 |
| 394 | Offices of physicians, dentists, and other health practitioners | 61.3 | 4,531,949.0 | 4,834,199.9 | 7,672,261.7 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 1,554.1 | 87,722,928.4 | 87,722,928.4 | 279,258,019.0 |
| 19 | Support activities for agriculture and forestry | 870.6 | 18,940,243.8 | 16,344,776.6 | 22,163,610.6 |
| 335 | Transport by truck | 231.0 | 10,603,160.5 | 13,640,190.7 | 30,372,759.9 |
| 319 | Wholesale trade businesses | 106.1 | 6,625,507.6 | 11,387,674.9 | 17,465,848.3 |
| 394 | Offices of physicians, dentists, and other health practitioners | 61.3 | 4,531,949.0 | 4,834,199.9 | 7,672,261.7 |
| 438 | * Employment and payroll only (state & local govt, education) | 90.2 | 4,298,439.2 | 4,883,088.4 | 4,883,087.6 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 87.9 | 4,059,327.7 | 4,611,454.4 | 4,611,453.1 |
| 354 | Monetary authorities and depository credit intermediation activities | 70.9 | 3,733,690.7 | 7,766,867.2 | 15,618,885.8 |
| 397 | Private hospitals | 54.5 | 3,095,071.3 | 3,303,899.4 | 6,890,749.4 |
| 413 | Food services and drinking places | 157.1 | 2,930,850.7 | 4,217,635.1 | 8,424,490.2 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 1,554.1 | 87,722,928.4 | 87,722,928.4 | 279,258,019.0 |
| 335 | Transport by truck | 231.0 | 10,603,160.5 | 13,640,190.7 | 30,372,759.9 |
| 19 | Support activities for agriculture and forestry | 870.6 | 18,940,243.8 | 16,344,776.6 | 22,163,610.6 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 12,626,103.6 | 18,751,219.1 |
| 319 | Wholesale trade businesses | 106.1 | 6,625,507.6 | 11,387,674.9 | 17,465,848.3 |
| 354 | Monetary authorities and depository credit intermediation activities | 70.9 | 3,733,690.7 | 7,766,867.2 | 15,618,885.8 |
| 413 | Food services and drinking places | 157.1 | 2,930,850.7 | 4,217,635.1 | 8,424,490.2 |
| 394 | Offices of physicians, dentists, and other health practitioners | 61.3 | 4,531,949.0 | 4,834,199.9 | 7,672,261.7 |
| 130 | Fertilizer manufacturing | 3.4 | 1,228,665.3 | 2,369,046.0 | 7,631,012.3 |
| 397 | Private hospitals | 54.5 | 3,095,071.3 | 3,303,899.4 | 6,890,749.4 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 1,554.1 | 87,722,928.4 | 87,722,928.4 | 279,258,019.0 |
| 19 | Support activities for agriculture and forestry | 870.6 | 18,940,243.8 | 16,344,776.6 | 22,163,610.6 |
| 335 | Transport by truck | 231.0 | 10,603,160.5 | 13,640,190.7 | 30,372,759.9 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 12,626,103.6 | 18,751,219.1 |
| 319 | Wholesale trade businesses | 106.1 | 6,625,507.6 | 11,387,674.9 | 17,465,848.3 |
| 354 | Monetary authorities and depository credit intermediation activities | 70.9 | 3,733,690.7 | 7,766,867.2 | 15,618,885.8 |
| 438 | * Employment and payroll only (state & local govt, education) | 90.2 | 4,298,439.2 | 4,883,088.4 | 4,883,087.6 |
| 394 | Offices of physicians, dentists, and other health practitioners | 61.3 | 4,531,949.0 | 4,834,199.9 | 7,672,261.7 |
| 360 | Real estate establishments | 70.7 | 637,736.7 | 4,726,382.3 | 6,286,022.7 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 87.9 | 4,059,327.7 | 4,611,454.4 | 4,611,453.1 |

Table C.37. Projected Economic Impacts from Ethanol Production for Scenario 9

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 458.0 | 19,111,605.0 | 41,605,141.1 | 66,680,465.1 |
| Indirect Effect | 78.4 | 2,731,667.1 | 4,316,626.8 | 8,487,563.2 |
| Induced Effect | 434.9 | 15,367,817.8 | 25,011,087.0 | 38,972,538.5 |
| Total Effect | 971.3 | 37,211,090.0 | 70,932,854.9 | 114,140,566.8 |

Table C.38. Top Ten Industries Impacted By Ethanol Production Scenario 9

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 195.9 | 6,298,154.1 | 7,963,991.5 | 12,119,093.1 |
| 390 | Waste management and remediation services | 82.9 | 2,737,850.4 | 4,772,553.2 | 11,745,921.7 |
| 31 | Electric power generation, transmission, and distribution | 81.9 | 7,017,174.1 | 24,109,736.7 | 34,240,140.3 |
| 413 | Food services and drinking places | 58.4 | 977,940.0 | 1,404,714.4 | 2,928,981.7 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 55.0 | 1,806,705.8 | 2,323,830.8 | 3,169,524.2 |
| 438 | * Employment and payroll only (state & local govt, education) | 44.0 | 2,072,990.8 | 2,354,947.3 | 2,354,947.2 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 39.9 | 1,727,652.5 | 1,962,637.9 | 1,962,638.2 |
| 2 | Grain farming | 33.5 | 305,166.5 | 572,497.6 | 1,437,452.9 |
| 33 | Water, sewage and other treatment and delivery systems | 18.0 | 1,083,805.1 | 2,053,678.4 | 3,013,950.5 |
| 398 | Nursing and residential care facilities | 17.5 | 454,181.2 | 490,219.3 | 863,630.5 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 81.9 | 7,017,174.1 | 24,109,736.7 | 34,240,140.3 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 195.9 | 6,298,154.1 | 7,963,991.5 | 12,119,093.1 |
| 390 | Waste management and remediation services | 82.9 | 2,737,850.4 | 4,772,553.2 | 11,745,921.7 |
| 438 | * Employment and payroll only (state & local govt, education) | 44.0 | 2,072,990.8 | 2,354,947.3 | 2,354,947.2 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 55.0 | 1,806,705.8 | 2,323,830.8 | 3,169,524.2 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 39.9 | 1,727,652.5 | 1,962,637.9 | 1,962,638.2 |
| 394 | Offices of physicians, dentists, and other health practitioners | 17.0 | 1,123,743.9 | 1,198,656.2 | 1,963,378.2 |
| 440 | * Employment and payroll only (federal govt, military) | 12.2 | 1,107,813.7 | 1,600,589.5 | 1,600,589.4 |
| 33 | Water, sewage and other treatment and delivery systems | 18.0 | 1,083,805.1 | 2,053,678.4 | 3,013,950.5 |
| 413 | Food services and drinking places | 58.4 | 977,940.0 | 1,404,714.4 | 2,928,981.7 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 81.9 | 7,017,174.1 | 24,109,736.7 | 34,240,140.3 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 195.9 | 6,298,154.1 | 7,963,991.5 | 12,119,093.1 |
| 390 | Waste management and remediation services | 82.9 | 2,737,850.4 | 4,772,553.2 | 11,745,921.7 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 4,212,992.1 | 6,256,778.7 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 55.0 | 1,806,705.8 | 2,323,830.8 | 3,169,524.2 |
| 33 | Water, sewage and other treatment and delivery systems | 18.0 | 1,083,805.1 | 2,053,678.4 | 3,013,950.5 |
| 413 | Food services and drinking places | 58.4 | 977,940.0 | 1,404,714.4 | 2,928,981.7 |
| 354 | Monetary authorities and depository credit intermediation activities | 12.6 | 621,095.1 | 1,291,936.3 | 2,657,643.6 |
| 438 | * Employment and payroll only (state & local govt, education) | 44.0 | 2,072,990.8 | 2,354,947.3 | 2,354,947.2 |
| 397 | Private hospitals | 17.3 | 879,632.5 | 938,926.1 | 2,071,307.6 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 31 | Electric power generation, transmission, and distribution | 81.9 | 7,017,174.1 | 24,109,736.7 | 34,240,140.3 |
| 417 | Commercial and industrial machinery and equipment repair and maintenance | 195.9 | 6,298,154.1 | 7,963,991.5 | 12,119,093.1 |
| 390 | Waste management and remediation services | 82.9 | 2,737,850.4 | 4,772,553.2 | 11,745,921.7 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 4,212,992.1 | 6,256,778.7 |
| 438 | * Employment and payroll only (state & local govt, education) | 44.0 | 2,072,990.8 | 2,354,947.3 | 2,354,947.2 |
| 368 | Accounting, tax preparation, bookkeeping, and payroll services | 55.0 | 1,806,705.8 | 2,323,830.8 | 3,169,524.2 |
| 33 | Water, sewage and other treatment and delivery systems | 18.0 | 1,083,805.1 | 2,053,678.4 | 3,013,950.5 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 39.9 | 1,727,652.5 | 1,962,637.9 | 1,962,638.2 |
| 440 | * Employment and payroll only (federal govt, military) | 12.2 | 1,107,813.7 | 1,600,589.5 | 1,600,589.4 |
| 413 | Food services and drinking places | 58.4 | 977,940.0 | 1,404,714.4 | 2,928,981.7 |

Table C.39. Projected Economic Impacts from Switchgrass Production for Scenario 9

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|---|---|---|---|---|
| Direct Effect | 1,842.0 | 103,954,556.7 | 103,954,556.7 | 323,056,301.7 |
| Indirect Effect | 1,602.3 | 48,340,775.8 | 62,658,920.0 | 117,249,078.7 |
| Induced Effect | 1,715.9 | 63,564,738.7 | 108,061,566.3 | 174,427,295.4 |
| Total Effect | 5,160.2 | 215,860,071.2 | 274,675,043.0 | 614,732,675.8 |

Table C.40. Top Ten Industries Impacted By Switchgrass Production Scenario 9

**Top Ten for Employment**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 1,842.2 | 103,963,705.9 | 103,963,705.9 | 323,084,734.5 |
| 19 | Support activities for agriculture and forestry | 886.1 | 19,272,398.5 | 16,628,516.6 | 22,549,395.7 |
| 335 | Transport by truck | 259.3 | 11,836,216.1 | 15,227,735.8 | 33,993,938.1 |
| 413 | Food services and drinking places | 178.3 | 3,314,287.9 | 4,769,371.0 | 9,539,149.8 |
| 319 | Wholesale trade businesses | 122.5 | 7,601,108.7 | 13,064,151.0 | 20,044,668.7 |
| 438 | * Employment and payroll only (state & local govt, education) | 99.7 | 4,748,748.5 | 5,394,646.4 | 5,394,645.9 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 97.1 | 4,464,590.3 | 5,071,838.6 | 5,071,837.4 |
| 354 | Monetary authorities and depository credit intermediation activities | 81.5 | 4,272,580.0 | 8,887,705.8 | 17,899,194.6 |
| 360 | Real estate establishments | 78.2 | 706,010.3 | 5,232,273.3 | 6,958,850.6 |
| 394 | Offices of physicians, dentists, and other health practitioners | 69.6 | 5,120,055.9 | 5,461,551.7 | 8,677,732.8 |

**Top Ten for Labor Income**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 1,842.2 | 103,963,705.9 | 103,963,705.9 | 323,084,734.5 |
| 19 | Support activities for agriculture and forestry | 886.1 | 19,272,398.5 | 16,628,516.6 | 22,549,395.7 |
| 335 | Transport by truck | 259.3 | 11,836,216.1 | 15,227,735.8 | 33,993,938.1 |
| 319 | Wholesale trade businesses | 122.5 | 7,601,108.7 | 13,064,151.0 | 20,044,668.7 |
| 394 | Offices of physicians, dentists, and other health practitioners | 69.6 | 5,120,055.9 | 5,461,551.7 | 8,677,732.8 |
| 438 | * Employment and payroll only (state & local govt, education) | 99.7 | 4,748,748.5 | 5,394,646.4 | 5,394,645.9 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 97.1 | 4,464,590.3 | 5,071,838.6 | 5,071,837.4 |
| 354 | Monetary authorities and depository credit intermediation activities | 81.5 | 4,272,580.0 | 8,887,705.8 | 17,899,194.6 |
| 397 | Private hospitals | 61.1 | 3,465,137.7 | 3,698,934.4 | 7,715,962.8 |
| 413 | Food services and drinking places | 178.3 | 3,314,287.9 | 4,769,371.0 | 9,539,149.8 |

**Top Ten for Output**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 1,842.2 | 103,963,705.9 | 103,963,705.9 | 323,084,734.5 |
| 335 | Transport by truck | 259.3 | 11,836,216.1 | 15,227,735.8 | 33,993,938.1 |
| 19 | Support activities for agriculture and forestry | 886.1 | 19,272,398.5 | 16,628,516.6 | 22,549,395.7 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 14,431,420.3 | 21,432,319.8 |
| 319 | Wholesale trade businesses | 122.5 | 7,601,108.7 | 13,064,151.0 | 20,044,668.7 |
| 354 | Monetary authorities and depository credit intermediation activities | 81.5 | 4,272,580.0 | 8,887,705.8 | 17,899,194.6 |
| 413 | Food services and drinking places | 178.3 | 3,314,287.9 | 4,769,371.0 | 9,539,149.8 |
| 130 | Fertilizer manufacturing | 3.9 | 1,399,864.2 | 2,699,142.4 | 8,694,296.7 |
| 394 | Offices of physicians, dentists, and other health practitioners | 69.6 | 5,120,055.9 | 5,461,551.7 | 8,677,732.8 |
| 397 | Private hospitals | 61.1 | 3,465,137.7 | 3,698,934.4 | 7,715,962.8 |

**Top Ten for Value Added**

| Sector | Description | Total Employment | Total Labor Income | Total Value Added | Total Output |
|---|---|---|---|---|---|
| 10 | All other crop farming | 1,842.2 | 103,963,705.9 | 103,963,705.9 | 323,084,734.5 |
| 19 | Support activities for agriculture and forestry | 886.1 | 19,272,398.5 | 16,628,516.6 | 22,549,395.7 |
| 335 | Transport by truck | 259.3 | 11,836,216.1 | 15,227,735.8 | 33,993,938.1 |
| 361 | Imputed rental activity for owner-occupied dwellings | 0.0 | 0.0 | 14,431,420.3 | 21,432,319.8 |
| 319 | Wholesale trade businesses | 122.5 | 7,601,108.7 | 13,064,151.0 | 20,044,668.7 |
| 354 | Monetary authorities and depository credit intermediation activities | 81.5 | 4,272,580.0 | 8,887,705.8 | 17,899,194.6 |
| 394 | Offices of physicians, dentists, and other health practitioners | 69.6 | 5,120,055.9 | 5,461,551.7 | 8,677,732.8 |
| 438 | * Employment and payroll only (state & local govt, education) | 99.7 | 4,748,748.5 | 5,394,646.4 | 5,394,645.9 |
| 360 | Real estate establishments | 78.2 | 706,010.3 | 5,232,273.3 | 6,958,850.6 |
| 437 | * Employment and payroll only (state & local govt, non-education) | 97.1 | 4,464,590.3 | 5,071,838.6 | 5,071,837.4 |

VITA

James Dakota Moss

Candidate for the Degree of

Master of Science

Thesis: MEASURING THE ECONOMIC IMPACTS OF SWITCHGRASS AND CELLULOSIC ETHANOL PRODUCTION IN OKLAHOMA

Major Field: Agricultural Economics

Biographical:

Education: Completed the requirements for the Master of Science in Agricultural Economics at Oklahoma State University, Stillwater, Oklahoma in May, 2012. Received Bachelors of Science degree in Agribusiness from Oklahoma State University, Stillwater, OK in May, 2010.

Experience: Graduate Research Assistant in the Department of Agricultural Economics at Oklahoma State University, Stillwater, Oklahoma, Dec 2010- May 2012

Name: James Dakota Moss Date of Degree: May, 2012

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: MEASURING THE ECONOMIC IMPACTS OF SWITCHGRASS AND CELLULOSIC ETHANOL PRODUCTION IN OKLAHOMA

Pages in Study: 129 Candidate for the Degree of Master of Science

Major Field: Agricultural Economics

Scope and Method of Study: Oklahoma, being a major agricultural based state, will have the opportunity to become a large contributor to the production of alternative energy sources such as cellulosic ethanol from switchgrass. The goal of this study is to measure the economic impacts of switchgrass production for cellulosic biomass and the operation of cellulosic ethanol plants in Oklahoma. Utilizing results from a comprehensive linear mathematical programming model the locations for cellulosic ethanol plants and switchgrass production areas were found for nine different scenarios. With information on optimal plant locations and switchgrass production areas IMPLAN® study area data and industry accounts are edited to show how the two activities will impact the study area. Also with a large agricultural cooperative presence in Oklahoma the model will show how different management practices such as coop owned vs. private ownership will affect the study area.

Findings and Conclusions: In scenario one, for single plant additional impact assessments made for varying levels of cooperative and private ownership. By retaining plant profits in the region through cash patronage to producer owners cooperative ownership was measured for 50% cooperative ownership and 100% cooperative ownership. For the 100% privately owned no profits are retained in the region. For the 100% privately owned scenario there is a combined industry output for switchgrass production and ethanol production of $70 million, and a combined employment impact of 556 employees for the region. In the 100% cooperative owned scenario there is a combined industry output for switchgrass production and ethanol production of $86.1 million, and a combined employment impact of 726 employees in the region. Because of the induced impacts that result from the cooperative membership model industry output is $16.1 million higher than the privately owned and employment has 170 more jobs. In all other scenarios private equity ownership is assumed with the establishment of a single plant in the state and the switchgrass production area of only eight counties to supply it a combined economic impact for industry output of $70 million and an employment impact of 556 jobs from the two activities. In the ninth scenario switchgrass production and ethanol production have a combined industry output impact of $728.9 million and the total employee impact is 6,132. From the range of industry output and employment from scenarios one through nine the results show that the production of switchgrass for cellulosic ethanol production will have a large economic impact on the state of Oklahoma.

ADVISER'S APPROVAL: Dr. Rodney Holcomb