MODELING POTENTIAL CROP LAND SHIFTS INTO BIOFUEL PRODUCTION FOR THE STATE OF OKLAHOMA

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INTRODUCTION

Background

The constant concern of high petroleum prices, environmental degradation, unstable oil supply, and geopolitical issues have contributed to the high level of interest in biofuels. Federal and State policy incentives have also contributed to the interest in biofuel production. These factors initially came about at a time of historically low agriculture commodity prices, and have led to a relatively quick expansion in the production of and interest in biofuels (De La Torre Ugarte et al., 2003). The *Energy Policy Act of 2005* includes a provision designed to double the production and use of ethanol in fuels by 2012. The 2005 act also provides that beginning in 2013, a minimum of 250 million gallons per year of ethanol be produced from cellulosic sources such as corn stover, wheat straw, and switchgrass. However, cellulose-based ethanol production has not reached commercialization, making it difficult to predict progress toward the 2013 goal of 250 million gallons.

The Problem

Using agriculture crops to produce transportation fuel could help reduce the dependency on imported oil while benefiting agriculture and rural economies. This study investigates Oklahoma's current production of biofuel feedstock crops and the state's potential for increased biofuel feedstock production. A detailed model was developed to compare the net returns above variable cost for all existing crops with net returns above variable costs for biofuel feedstock crops to determine the potential for increased biofuel feedstock crop production in Oklahoma.

The production of ethanol has already had major impacts in the grain market. Ethanol demand for corn has influenced corn basis levels, the demand for storage infrastructure and impacted unit-train loading and river market facilities. The majority of US ethanol production is currently centered in the Midwest grain belt, close to the source of feedstocks. Biodiesel production is more spread out but is also focused near feedstock supplies. However, ethanol production is expanding into the Southern Plains which includes Oklahoma, a typically grain deficit region. The region's advantages in terms of lower natural gas prices (an important input in ethanol production), distance to ethanol markets and demand for distillers grain by-products could offset the rail transportation cost for the grain inputs. Ethanol project organizers in the Southern Plains also anticipate increased production of corn and grain sorghum and/or shifts of winter wheat production into winter barley a potential ethanol feedstock.

There is also recent interest in biodiesel production in the Southern Plains region. New varieties of winter canola, both conventional and herbicide resistant, have been released. Winter wheat producers are adopting winter canola as a rotational crop to achieve diversification and for the agronomic advantages that can be gained from rotating between grass and broadleaf crops. Canola adoption could increase dramatically if the number of crushing and biodiesel production facilities were to increase in the area.   The production of other oilseed crops, such as soybeans, could also increase if the biodiesel industry were to expand into the Southern Plains.

The commercialization of cellulosic-based ethanol (ethanol that comes from feedstocks such as switchgrass, corn stover, wheat straw and wood products residues) could have an even greater impact on the agricultural industry (Epplin, 1996). Researchers in the Department of Biosystems and Engineering at Oklahoma State University (OSU) have developed pilot-scale equipment for the production of ethanol from switchgrass. Potential conversions of 75 gallons or higher from each ton of switchgrass coupled with expected switchgrass yields of 4-6 tons/acre (estimated to be equivalent to the yield of pasture hay) have led to excitement over the future role of dedicated biofuel crops in the region's agriculture. US President George W. Bush mentioned switchgrass in both his 2006 and 2007 State of the Union addresses. A 2006 *New York Times* article included the statement "You could turn Oklahoma into an OPEC member by converting all of its farmland into switchgrass (Pollack, 2006)."

Research and development is ongoing in an attempt to develop economically competitive methods to produce ethanol from cellulose. However, as of this writing no economically competitive commercial size facility exists in the United States (De La Torre Ugarte *et al*., 2003). Technological breakthroughs have not occurred at the rate anticipated. Several conversion technologies that would enable use of cellulosic biomass as a biorefinery feedstock are under development. Examples include gasification, pyrolysis, liquefaction, fermentation, and anaerobic digestion (Epplin, 1996). A number of technical and infrastructure challenges must be overcome before cellulosic ethanol will be able to compete with grain-ethanol and gasoline in the transportation fuel market.

If and when an economically competitive bioconversion system is developed, it is anticipated that the agricultural community will be actively engaged in the production, harvest, storage, and transportation of feedstock to biorefineries. Currently, ethanol plants post a competitive price and the infrastructure for production, harvest, storage, transportation, and price risk management of corn grain is well developed. Relative to corn grain, cellulosic material such as switchgrass is bulky and difficult to transport. Thus, a new infrastructure will have to be developed for harvesting, storing, and transporting cellulosic biomass.

Purpose of the Study

The purpose of this study is to determine the amount and regional distribution of biofuel feedstock crops that are currently produced in Oklahoma and to model the potential cropland changes for increased biofuel feedstock production. The study considers potential production of both biodiesel feedstocks (soybeans and winter canola), and grain based ethanol feedstocks (corn, grain sorghum, and hulless barley). The additional possibility of cellulosic based ethanol feedstocks such as corn stover, wheat straw or switchgrass are considered in a second scenario. The potential land conversion into biofuel feedstocks are modeled over a wide range of biofuel price levels. This provides a projection of the price response of land conversion. It should be emphasized that all land in farms is currently in use. It should be realized that a biofuels industry would bid resources from current use with possible negative impacts on some agriculture sectors.

Outline of Work

This study provides an important first step in identifying and quantifying Oklahoma's potential in the biofuel industry. This study projects when producers would have an economic incentive to convert their current crops into biofuel feedstock crops. The study projects the price response of crop land conversion, the regional distribution of biofuel feedstock crops and the biofuel price level required to maximize biofuel feedstock production. The study projects the percent of crop acres converted at various biofuel price levels and the resulting biofuel production. The study did not attempt to model the likelihood or time path of such conversions. A significant investment in infrastructure will also be required before Oklahoma can realize the potential identified in this report.

OBJECTIVES

The overall objective of this research study is to determine the likelihood of producing bioenergy in Oklahoma and identifying the implications it may have on current crop and farmland production. The specific objectives of this study include:

1. Determine the amount of biofuel that can be produced from biofuel feedstock crops currently produced in Oklahoma.
2. Project potential cropland shifts into feedstock crops for gain-based biofuel production at various biofuel price levels.

3. Expand the previous projection of cropland shift to consider the possibility of production of cellulosi-based ethanol feedstocks.

The previously mentioned objectives represent an important first step in identifying and quantifying the potential impacts of biofuel production on the agriculture economy in Oklahoma. This study models the potential shifts in crop land required to produce a calculated number of gallons of biofuel. The study did not attempt to model the likelihood or time path of such conversions. The time-path for the development of a biofuel refining infrastructure is also not considered. Full development of the grain-based biofuel industry identified in this study could require an investment of up to $1 billion while full development of a cellulosic based industry could require $10 billion or more infrastructure investment. There are inherent limitations in this model however this study has provided the initial step in determining if Oklahoma has a future in the biofuel industry and if further research could be deemed necessary. It should also be noted that this study attempts to project crop acres with an economic incentive to convert and is not a prediction of actual conversions, but rather an upper limit on likely conversion rates.

CHAPTER II

REVIEW OF LITERATURE

LITERATURE OVERIEW

Several studies have investigated the potential production and feasibility of grain-based ethanol, cellulosic ethanol and biodiesel, as well as the economic and environmental impacts the production of bioenergy could potentially have on agriculture and rural economies. Conclusions as to potential biofuel production and impacts has varied. The following review summarizes previous studies of biofuel potential and impacts and identifies areas for additional research.

Biofuel crop production, like other alternative crops, can have both positive and negative impacts on agriculture producers, rural economies and consumers. There are numerous benefits that come from the production of bioenergy such as increasing corn prices for farmers, increased opportunities for rural economies, and the potential for cleaner air (De La Torre Ugarte et al.). While all those may be benefits to our economy, there are also downfalls. Diverting grain crops into biofuel feedstocks puts upward pressure on feed and food prices. The impacts and implications of the developmental of the biofuel industries are inherently difficult to project.

A combination of articles written by De La Torre Ugarte et al,, Tenenbaum, Wilson, and Kenkel et al., have examined the positive and negative impacts of increased biofuel production. As a result of energy security concerns, demand for alternative energy sources are increasing. Biomass energy systems are being produced to provide energy in the 21st century. Large scale production of bioenergy crops will have serious impacts on the agriculture sector in terms of quantities of grain crops available for livestock feed, prices of food for both human and animal consumption, and production location (De La Torre Ugarte et al., 2003). To produce bioenergy on the level needed to make an economic profit a significant amount of land would need to be converted to crop acres and bioenergy producing crops would need to increase their yields significantly. Tenenbaum's (2005: p.A750-A753) article compared the rising costs and demand for fuel for vehicles and farm use to the potential use of bioenergy based fuels. The study identified the importance of projecting production costs and biofuel demand in forecasting biofuel production. In addition, Wilson (2006: p.11-16) addressed the competition between export demand and domestic biofuel production for U.S. corn supply. Yhe study also examined the attitudes of producers toward ethanol production. Uncertainties relating to the biofuel industries have been identified by various studies. Among these uncertainties are the rate of expansion of the biofuel industries, political mandates and incentives for biofuel production and use, technological advances in grain crop production and biofuel transformation and consumer acceptance of biofuels.

Durante and Miltenberger, and Pimental both examine the positive and negative impacts of ethanol production. The authors examine economic, both argue that increased production of ethanol might not be the wisest decision for our nation. Durante and

Miltenberger (2004) and Pimental's (2006) both examine the energy balance of ethanol production and conclude that it requires more energy to produce one gallon of ethanol than one gallon of ethanol actually contains. Other studies have concluded that the energy balance is positive with the consensus opinion placing the energy balance at around 1.3-1. Pimental's (2006) article also examined the competing uses of cropland for biofuel versus food crop production. The study concluded that it requires 11 acres of farmland to produce enough ethanol to run one vehicle for one year. That same 11 acres is able to produce enough food to supply seven people for one year.

Numerous studies have examined the implications of the commercialization of technologies to produce ethanol from cellulosic feedstocks. If commercialized, these technologies could produce ethanol from crop residues such as corn stover and wheat straw, forest residues and dedicated energy crops such as switchgrass. Numerous studies have examined the potential advantages of switchgrass as a dedicated energy crop. A major rationale fro switchgrass as a cellulosic feedstock is the plant's ability to produce a high level of biomass with minimal inputs (Samson). In particular, Swanson examined the concept buring switchgrass pellets as a heat source. "This use of the biomass crop offered the highest net energy yield per hectare, the highest energy output to intput ratio, the greatest economic advantage over fossil fuels and the most significant potential to offset greenhouse gases." Swanson also concludes that switchgrass yields a higher percentage of biofuels per acre relative to other potential dedicated energy crops. Switchgrass yields have been examined in numerous small scale studies. However there is relatively little information on typical farm level yields.

Projecting the potential for switchgrass production is difficult. Less than 12,000 acres of switchgrass are currently produced in Oklahoma. There is no certainty that switchgrass can be grown in all parts of Oklahoma due to such differences in climate throughout the year. (Epplin, 1996). Some studies have projected commercial switchgrass yields of 8-12 tons/acres (Epplin, 1996). However county average yields of alfalfa hay (a high input and intensively managed crop) average only 3-4 tons/acre (Oklahoam Ag. Statistics). Additional research is needed to accurately project switchgrass yields under wide scale farm production.

CHAPTER III

METHODOLOGY

RESEARCH DESIGN

A mathematical programming model created in excel is used to project the potential gallons of biofuel that can be produced from Oklahoma crop and farmland as well as the percent of acres converted in order to produce each of the biofuel crops. The model calculates the expected returns for all major crops in each county of Oklahoma. The expected returns are based on five years of average annual yield and prices for each county. Cost of production is based on the OSU Enterprise Budgets with the variable costs based on the expected yields in each county. The model allows the county acreage of each crop to switch to a biofuel crop when the expected return from the biofuel crop exceeds the expected returns of the existing crop.

Table I. Cost of Crop Production Per Acre

Corn	$ 94.08
Alfalfa	$ 50.60
All Other Hays	$ 26.02
Barley	$ 40.93
Cotton	$ 120.07
Oats	$ 49.24
Peanuts	$ 470.61
Rye	$ 59.91
Sorghum	$ 129.83
Soybeans	$ 70.00
Switchgrass	$ 46.54
Wheat	$ 40.93

The gross return of the biofuel feedstock crop was based on the historical county level yield, the conversion rate of the feedstock into biofuel and price of the biofuel. The expected net revenue received by the producer for the production of the biofuel feedstock crop was based on the gross revenue less the cost of production for the feedstock costs, the per unit cost of transformation and a 15% return for the owners of the biofuel refineries.

Yields of the potential biofuel feedstock crop were based on the historical yields of that crop in the particular county. The model therefore only allowed shifts into biofuel feedstock crops when the feedstock crop had been historically produced in a particular county. This means for example, that if Grant County had not historically produced corn then the crop acres could not convert into corn production.

Data for the model was collected from the USDA Statistical Services website, all Oklahoma crop yields and acres in production on a county by county basis was collected for the years 2000 thru 2004. The model results represent the number of crop acres that have an economic incentive to convert to a biofuel feedstock at a particular biofuel price level. The model does not attempt to model the time path of crop land conversion. Historically, there has been a gradual adoption of new technology or market opportunity (hybrid corn took 10 years); so even though there may be incentive to convert not all farmers are going to change there cropping patterns.

Additional formulas were used to reflect the potential gallons of biofuel that could be produced in Oklahoma from grain-based ethanol, cellulosic-based ethanol and biodiesel. First it was determined whether or not the biofuel crop revenue above variable cost exceeded that of the existing grain crop; then if that was the case the number of gallons of biofuel that could be produced was calculated. The net revenues of the biofuel production activities reflected the variable production costs of the crop, plus a 15% return on equity because it is being assumed that the farmer will initially earn a 15% profit. Biofuel revenues in excess of these costs were assumed to accrue to the feedstock producer. This provides an upper limit on the possible biofuel crop adoption. An additional scenario representing cellulosic – based ethanol production using switchgrass feedstock was also developed. County level estimates of switchgrass yield and production costs were estimated based on existing pasture hay crop production data. There was also an adjustment factor set in the switchgrass model so that if the situation arises where engineers are able to genetically modify the crop to increase yields it can easily be changed on a per county basis. Cellulosic ethanol production from corn stover, wheat straw and switchgrass production on Conservation Reserve Program (CRP) acres was also modeled. The programming model was used to project the potential shift in crop acres to grain-based ethanol, cellulosic-based ethanol, and grain-based biodiesel crops at various biofuel prices.

ANALYSIS OF DATA

Land currently enrolled in the CRP is a potential land resource for the production of biofuel feedstocks. The CRP is a voluntary program which offered financial incentives to private landowners to protect highly erodible and environmentally sensitive cropland by planting trees, grass, and other long-term cover (USDA). Landowners signed 10-15 year contracts with the USDA, agreeing to take the land out of production for the length of the contract. Farmers are paid for the lost production on the CRP acres. The average CRP rental rate for the state of Oklahoma is approximately $35 per acre per year. The majority of the CRP acres are located in the Panhandle and western part of the state and perennial grasses grow on most of these acres. Most of the CRP land is located in the area of the state that traditionally has the least amount of annual precipitation which limits yield potential. This cropland was enrolled in the CRP because it is “highly erodible” which is correlated with poor soil quality and limited productivity compared with other intensively cropped land. It has been estimated that as currently managed average annual production on Oklahoma’s CRP acres is approximately 1.56 dry tons of biomass per acre. With changes in federal policy, these lands have potential to be more intensively managed. However, research would be required to determine yield potential and management systems to maintain the environmental benefits of the CRP. Use of CRP lands to produce bioenergy feedstock would have minimal impacts on other crop and livestock industries due to the fact that it is currently not in any kind of production.

Grains and oilseeds are currently the primary potential biofuel feedstocks. Grain that is produced in Oklahoma that could be used for ethanol production consists mainly of corn and grain sorghum, while soybeans is the primary crop currently produced that could be used for producing biodiesel. Average corn and grain sorghum yields from 2000 to 2004 were determined and used to estimate potential for biofuel production (NASS, 2006). A conversion factor of 2.8 gallons of ethanol per bushel of grain was used for both corn and grain sorghum. For estimating biodiesel production, first all crops were converted to pounds then multiplied by acres to derive the total number of pounds of product produced. Next the oil content in the crop was accounted for to determine an effective extraction rate, then the final number of pounds of product produced was divided by 7.6 pounds to determine a total number of gallons of biodiesel produced because for every 7.6 pounds of product, one gallon of biodiesel is produced.

Wheat production dominates crop acreage in the western part of the state. Winter wheat production is widespread throughout the western region and into the panhandle. Growers in this region often use winter wheat for fall-winter forage for cattle, which was not included in potential revenue above variable costs for dual purpose wheat production. Winter wheat is well suited for this region due to the growth habits of the crop. It grows during a time of the year that growing conditions are the least harsh. It will most likely take a relatively high ethanol or biodiesel price level to convert winter wheat into barley for ethanol production or canola for biodiesel production.

If price levels were significant, farmers would have some potential incentive to change current cropping patterns and to increase production of biofuel feedstocks in the state. Producers could convert acreage to increase production of existing ethanol feedstock crops (corn and grain sorghum) and/or existing biodiesel feedstock crop (soybeans). In addition to the currently grown feedstocks, a variety of other crops are suitable for production in Oklahoma that have potential as biofuel feedstocks. Crops that may have potential but are not grown or grown on a large scale in the state include hull-less barley and sunflower (two ethanol feedstocks), as well as winter canola, peanuts, and numerous other oilseed crops (biodiesel feedstocks).

In general, summer crops such as corn, grain sorghum, cotton, alfalfa, peanuts and oats are grown in areas of the state with higher precipitation patterns and/or irrigation capacity. Winter crops such as hard red winter wheat and rye are grown in areas which typically receive lower amounts of precipitation during the summer months. This dichotomy is not complete as some land can be transitioned between winter and summer cropping patterns. Table I. provides a summary of the major alternative biofuel crops for the major crops produced in Oklahoma.

Table II. Alternative Biofuel Crops for Oklahoma

Crop	Harvested Acres	Potential Alternative Crop: Ethanol	Potential Alternative Crop: Biodiesel
Wheat	4,000,000	Hulless Barley	Winter canola
Hay	2,920,000	Corn or sorghum	Soybeans, various oilseeds
Corn	290,000	(current ethanol feedstock)	Soybeans, various oilseeds
Grain Sorghum	270,000	(current ethanol feedstock)	Soybeans, various oilseeds
Soybeans	305,000	Corn or sorghum	(current biodiesel feedstock)
Cotton	240,000	Corn or sorghum	Soybeans, various oilseeds
Rye	70,000	Hulless barley	Winter canola
Alfalfa	55,000	Corn or sorghum	Soybeans, various oilseeds
Oats	45,000	Corn or sorghum	Soybeans
Peanuts	35,000	Corn or sorghum	Soybeans

CHAPTER IV

FINDINGS

General

Again, it should be understood that Oklahoma currently produces grain-based ethanol feedstocks equivalent to 112 million gallons of ethanol production and biodiesel feedstocks equivalent to 16 million gallons of biodiesel (Table II.). Currently, there are three ethanol plants with a combined capacity of 150 million gallons, under consideration. A biodiesel plant with a capacity of 15 million gallons has recently begun production. (Kenkel and Ragan, 2007). Anticipated biofuel production exceed available feedstocks if these plants are built.

Table III. Oklahoma's Current Potential Biofuel Production

Crop	Land in Production (acres)	Total Annual Yields (bushels)	Potential Biofuel (gallons)
Corn (ethanol)	200,000	26 million	75 million
Sorgum (ethanol)	310,000	13 million	37 million
Soybeans (biodiesel)	238,000	9 million	16 million

* Based on a conversion rate of 2.8 gallons of ethanol/bushel was assumed for the conversion of corn and sorghum and based on a conversion rate of 1.34 gallons of biodiesel from every 60 pounds (bushel) of soybeans.

Precipitation is an important technical factor. Precipitation in Oklahoma increases from west to east and crop yields tend to increase as precipitation increases.

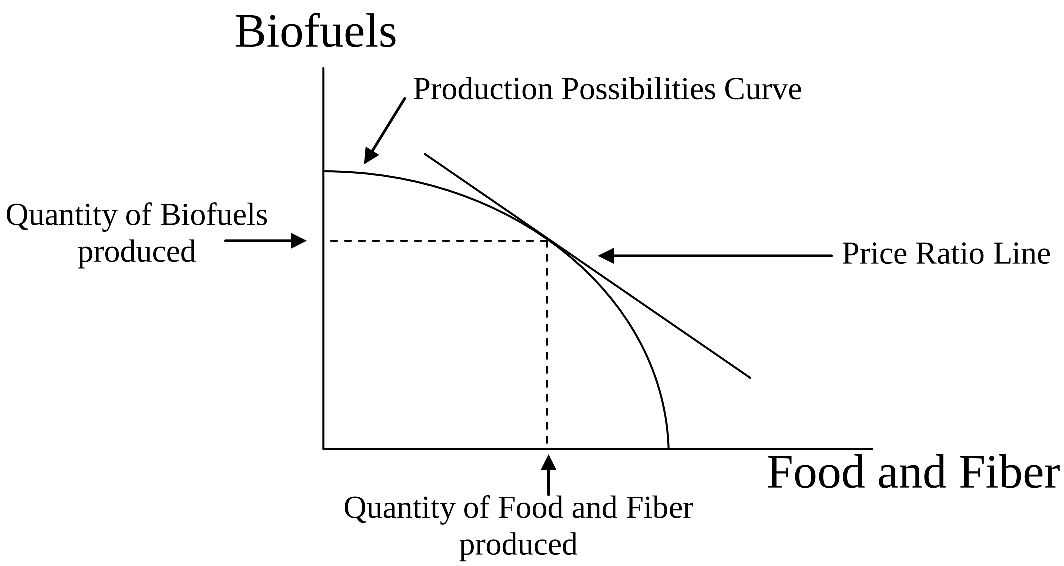
Rain fed crops grown on good soils in eastern Oklahoma generally yield more than rain fed crops grown in western Oklahoma. A review of past variety trial data from Oklahoma State University indicates that yield of summer grown crops is reduced by approximately 2% when rainfall is reduced by 1 inch. By this measure yield decreases up to 40% might be expected when moving from 40 inches of annual rainfall in the east to 20 inches of rainfall in western Oklahoma.

Cropping intensity or the number of crops grown during a given period of time is also a function of precipitation. Under rain fed conditions cropping intensity on good soils in eastern Oklahoma can be higher than that in the western part of the state. A typical crop rotation on good soils in eastern Oklahoma may consist of three crops in two years. In western Oklahoma one crop per year is typical.

Environmental factors greatly influence cropping decisions of Oklahoma producers. Factors such as precipitation and temperature play a key role in determining yield potential. Soils also determine what crops can be grown and influence the potential yield of crops. The environmental factors, the climate and soils, largely determine the technical feasibility of a particular species. However, economic factors including crop, livestock, and input prices, and financial incentives associated with government policies largely determine what is economic feasible. Farmers respond to economic incentives subject to technical possibilities.

Increasing the production of grain feed stocks for biofuels in Oklahoma will require shifting land from current crop allocations. A producer's crop selection decision is based on a number of factors. Climate and agronomic conditions limit the potential alternatives and impact the anticipated yields of various crops. These anticipated production levels coupled with the costs of production and the anticipated prices determine the anticipated economic returns for alternative crops. Producers shift acreage into alternative crops when the anticipated return from an alternate crop exceeds the anticipated return of their present crop. Economists illustrate this concept using a production possibilities curve such as the one depicted in Figure 1. The curve illustrates possible output combinations and how relative prices (depicted by the price line) determine the amount of each commodity produced. Changes in the price of biofuels crops and/or food and fiber crops would change the slope of the line and lead to a different allocation. Changes in technology for biofuels and/or food and fiber crops would change the shape of the curve and also change the amount of biofuel produced.

Figure 1. Production Possibilities Curve for Food and Fiber versus Biofuel



The price of biofuel crops, which is the mechanism that will encourage Oklahoma producers to increase production of biofuel crop is influenced a number of factors. There is obviously a direct relationship between biofuel prices and the prices that a biofuel processor can pay for input crops. The conversion rate between biofuel crops is also important. The processing operation must also cover the fixed and variable costs of operating the biofuel processing facility and must also provide a return for the investors who capitalized the infrastructure. Transportation costs for both the crop inputs and biofuel products also influence the price the biofuel offers for locally grown biofuel crops.

The conversion of land from current crops into dedicated cellulosic energy crops, such as switchgrass, will depend on similar economic forces. Producers will shift acreage into cellulosic crops when the anticipated net returns of those crops exceed that of the current crop. However, in modeling possible production of cellulosic crops there are some additional factors which must be considered. First, some cellulosic production could come from crop residues such as corn stover or wheat straw. Since these residues are currently substantially unused in Oklahoma, they would be available for biofuel use as long as the price for the residual exceeded harvest and transportation cost.

A second factor that must be considered is the limited historical yield information for cellulosic crops such as switchgrass. Producers' crop adoption decisions will be based on perceived yields and production risks. Agricultural producers have also historically been cautious in adopting new cropping systems. The time path of switchgrass adoption will depend upon actual farm level yields and producer perceptions. A third factor is that since spot markets do not exist for mature switchgrass, and switchgrass is not easy to transport, producers would be at the mercy of a single local processor who could exercise monopsony power. A final issue that should be noted is that conversion rates and conversion costs for cellulosic ethanol are also uncertain. These factors influence directly impact the cost of cellulosic ethanol and indirectly impact the potential value of the cellulosic feed stock.

A two-stage approach was used to model Oklahoma's potential biofuel production. The first stage modeled the potential increase of biofuels (ethanol and biodiesel) from grain based biofuel feed stocks. Increased production of these crops represents the potential to increase biofuel production using currently commercialized conversion technologies. The second stage of the projections, considered the additional potential from cellulosic ethanol production. The modeling process considered conversion rates and processing costs for grain based ethanol, cellulosic based ethanol and biodiesel. In both scenarios the biofuel crop potential considered the relative value of the biofuel crop versus current cropping systems. A wide range of biofuel prices were considered. At each biofuel price a potential for biofuel crop production was deemed to exist only when the net returns from the biofuel crop exceeded a producers net returns from currently grown crops. The modeling approach did not attempt was made to model the location of biofuel refineries, the costs of transporting feedstock to the refineries or the time path of biofuel crop adoption.

As a first step, the historical net returns of all existing crops were calculated. Average yields were compiled for every major crop in Oklahoma based on a five year time series of county level crop yields. Average crop prices were also calculated for the same time period. Oklahoma State University crop enterprise budgets were used to calculate the cost of production for each crop.   Enterprise production costs varied with yield levels. The calculated production costs for each crop therefore varied for every county in accordance with yield levels. This information was used to determine the average net returns for every major crop produced in each county of Oklahoma.

As discussed previously, precipitation patterns and other agronomic factors influence regional cropping systems in Oklahoma. These historical cropping patterns were considering in the modeling the potential increase in biofuel crop production. The modeling process allowed cropland currently in summer crop production to shift into either corn or grain sorghum production. The projected return for these biofuel crops was based on county level average yields, a price based on the ethanol value of the grain and production costs based on OSU Enterprise Budgets. The model allowed land in each county to shift into either corn or grain sorghum when the projected return of the biofuel crop exceeded the net return of the current crop.

A similar process was used to allow land currently in winter crop production (hard red winter wheat and rye) to shift into hulless barley. County level yields for hulless barley are not available since hulless barley is not currently produced in Oklahoma.   For this reason, hulless barley yields were based on historical wheat yields. Barley production in each county currently producing winter wheat was projected to be equal to the five year historical average wheat yield. It should be clarified that these yield comparison represented an equal amount of tons/acre. Wheat and barley have different standard bushel weights which contribute to a differential in bushels per acre. However both crops could be expected to produce a similar tonnage per acre.

Methodology

A conversion rate of 2.8 gallons of ethanol per bushel was assumed for the conversion of corn and sorghum. A rate of 2.0 gallons of ethanol/bushel was used for hulless barley. Ethanol production costs were modeled at $.75/gallon with a by-product value of $.25/gallon for a net production cost (excluding feedstock) of $.55/gallon. This cost included a return to the capital investment of the ethanol production facility of 15%. There have been some very optimistic estimates of ethanol production, one being a study that estimated the ethanol cost of production at $0.52/gallon plus $0.24 return on investment for the owners. The study estimated byproduct value at $0.66/bushel of corn used when using 3 gallons/bushel. At the more standard 2.8 gallons/bushel the byproduct credit translates into $0.23/bushel. That puts operating cost net of byproduct with a return on investment for the owners at $0.53 which is very close to the estimate in this study of $0.55. (Elobeid et al., 2006).

Another study conducted by the USDA surveyed ethanol plants in 2002 and estimated the cost of production as $0.42/bushel net of feedstock and adjusted for byproduct credit. The reported cost of construction was $1.57/gallon. Assuming that the administrative cost on the survey included interest, and that the plant was 50% equity, a 15% return on $0.785/bushel (50% of $1.57) = $0.11. The operating cost from the USDA study, net of byproduct and adjusted to include a 15% return for equity investor would therefore be $0.42 + $0.11 or $0.53/gallon. Again, very close to the estimate in this study of $0.55/gallon. (Shapouri and Gallagher, 2005).

The model allowed ethanol prices to vary over a wide range ($1/gallon to $5/gallon). At each price the producer of the biofuel crop was assumed to receive the ethanol value of the grain less the cost of the ethanol production. The relationship between the assumed ethanol price and the amount the ethanol plant would be able to pay for corn is summarized in Table III. As a point of comparison, the ten year average price that farmers received for corn in Oklahoma is $2.51/bushel.

The model assumed that the ethanol plant consistently covered all costs including a 15% return on investment and passed on all residual value to the agricultural producer. This assumption would be realistic if the ethanol facility was organized as a producer-owned cooperative with the members receiving all of the ethanol plant returns. However this assumption may overestimate biofuel crop prices (and hence biofuel crop production) if an ethanol plant was owned by outside investors who might elect to use higher ethanol prices to enhance their return on investment.

Table IV. Potential Corn Prices at Various Ethanol Prices

Ethanol Price, $/gallons	**Maximum Corn Prices, $/bushel**
$1.00	$0.45
$1.50	$0.95
$2.00	$1.45
$2.50	$1.95
$3.00	$2.45
$3.50	$2.95
$4.00	$3.45
$4.50	$3.95
$5.00	$4.45

* Based on a conversion rate of 2.8 gallons/bushels and a cost of ethanol production of $0.50/gallon. The cost of ethanol production included a 15% return to capital at an estimated plant cost of $1.50/gallon capacity. The calculation of maximum corn price did not consider ethanol production or marketing subsidies.

A conversion rate of 75 gallons per dry matter ton was assumed for cellulosic ethanol including corn stover, wheat straw and switchgrass. Cellulosic ethanol production costs (excluding feedstock) were modeled at $1.00 per gallon. This assumption was based on production costs 33% higher than grain based ethanol with no by-product credit. As described with the grain based ethanol model, the producer of the cellulosic biofuel crop was assumed to receive the residual value above the processing costs. The implicit values for switchgrass at various ethanol prices are provided in Table IV. As a point of comparison, Oklahoma have received an average price of $95.60/ton for alfalfa hay during the last ten years and around $50/ton for other types of hay sold.

Table V. Potential Switchgrass Prices at Various Ethanol Prices

Ethanol Price, $/gallons	**Maximum Corn Prices, $/bushel**
$1.50	$37.50
$2.00	$75.00
$2.50	$112.50
$3.00	$150.00
$3.50	$187.50
$4.00	$225.00
$4.50	$258.75
$5.00	$300.00

* Based on a conversion rate of 75 gallons/dry matter ton, and a conversion cost of $1.00/per gallon.

The conversion of oilseed crops (canola and soybeans) into biodiesel was based on an oil content of 20% for soybeans and 38% for canola with an oil extraction efficiency of 85%. This resulted in an effective oil content of 17% for soybeans and 32.3% for canola. Using the standard density of biodiesel of 7.6 lbs/gallon this implied that 1.34 gallons of biodiesel was produced from every 60 lb. bushel of soybeans while 2.6 gallons of biodiesel was produced from a similar weight of canola. The combined cost of oil extraction and biodiesel production was estimated at $.55/gallon of biodiesel. This value included a 15% return to the capital investment in an integrated oilseed crushing biodiesel plant the biodiesel plant with an assumed capital cost of $1.17/gallon. The residual meal feed, which represented the grain weight less the extracted oil, was valued at $195/ton for soybean meal and $145/ton for canola meal. Canola meal is lower in protein and typically sells at a discount relative to soybean meal. (For a more detailed discussion of processing costs, see Appendix.)

As described previously, the producer of the biodiesel crop was assumed to receive the residual value of biodiesel, oilseed meal and glycerol by-products net of the cost of oil extraction and biodiesel production. The amount that the biodiesel plant was assumed to be able to pay for soybeans and canola at various biodiesel prices is summarized in Table V. As a point of comparison, the ten year average soybean price in Oklahoma is $5.55/bushel while prices for canola at receiving points have been in the $.07-$.10 range.

Table VI. Potential Canola and Soybean Prices at Various Biodiesel Prices

Biodiesel Price $/gallon	**Canola Price $/pound**	**Soybean Price $/bushel**
$1.00	$0.04	$5.58
$1.50	$0.06	$6.37
$2.00	$0.08	$7.16
$2.50	$0.10	$7.95
$3.00	$0.12	$8.73
$3.50	$0.14	$9.59
$4.00	$0.16	$10.31
$4.50	$0.18	$11.11
$5.00	$0.20	$11.89

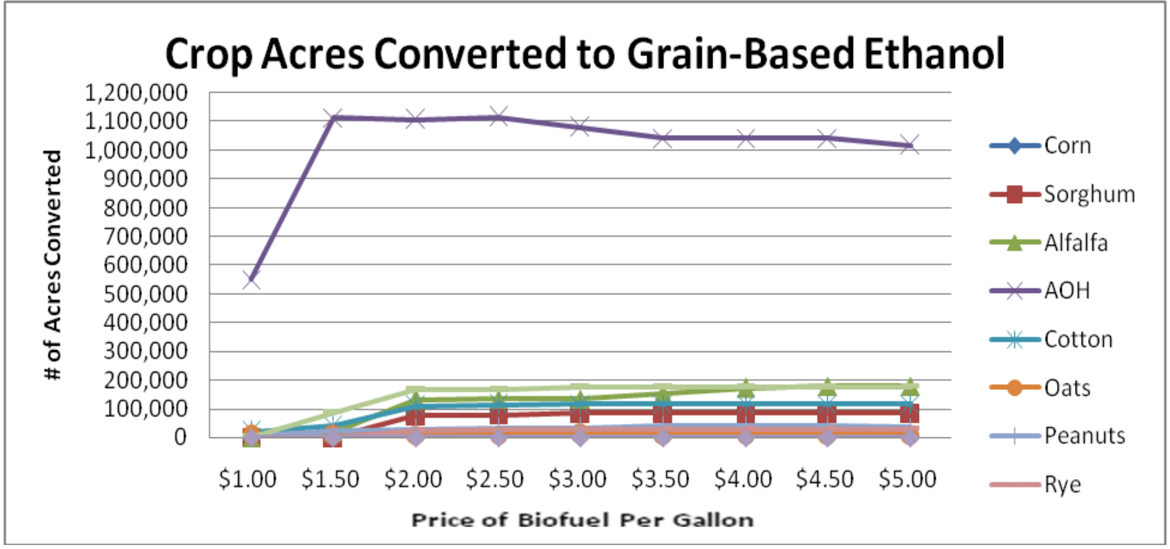
*Based on oil seed contents of 20% and 38% for soybeans and canola, respectively 85% oil extraction efficiency, oil meal values of $195/ton for soybean meal, $145/ton for canola meal, glycerol value of $0.15/gallon of biodiesel and a production cost for an integrated oilseed crushing/biodiesel facility of $0.55/gallon including a 15% return to capital investment.

Predicted Results of the Study

Results for the number of gallons of biofuel produced and crop acres converted were modeled in two different scenarios. The first being, the number of crop acres converted and gallons of biofuel produced when crop land was either put into grain-based ethanol production, cellulosic-based ethanol production, biodiesel production or left as is producing the crop that currently occupies the given acres. The decision was made based upon which option had the highest return above variable costs for the production of the entity.

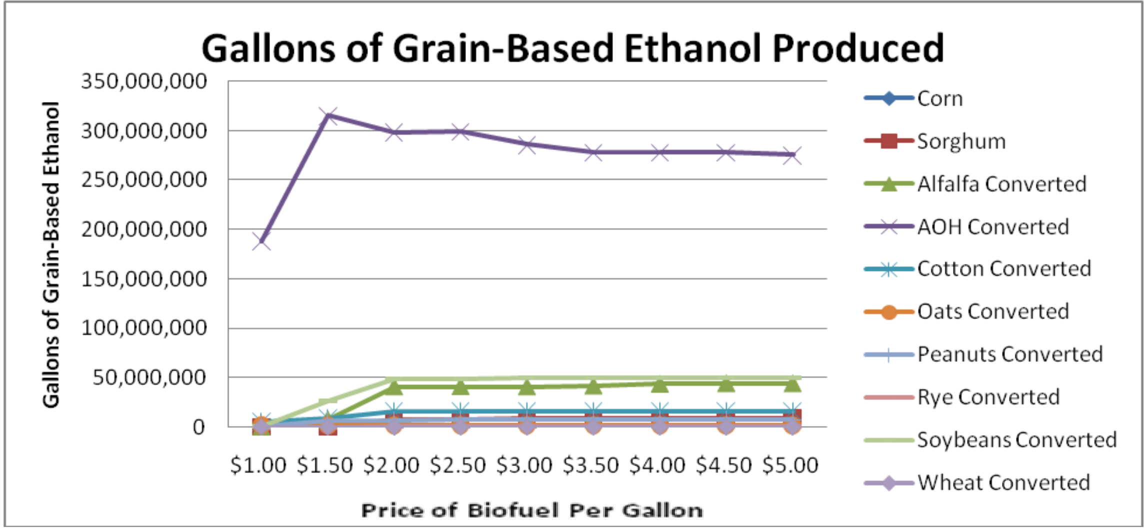
The potential crop land converted into gain-based ethanol feedstocks is provided in Figure 2. The model indicated that corn and sorghum acres would convert to ethanol at price levels above $1.50/gallon. This simply indicates that, at these ethanol prices, the residual value of these crops net the conversion costs in manufacturing ethanol would exceed the historical prices that producers received for these crops in traditional markets. As the table indicates, other crop land converts to an ethanol feedstock (corn, sorghum or hulless barley) as the price for ethanol increases. All crops convert to an ethanol feedstock when the price of ethanol reaches above $1.50/gallon except for wheat acres, which were bid to different resources.

Figure 2. Total Crop Acres Converted to Grain-Based Ethanol Feedstocks at Various Ethanol Prices



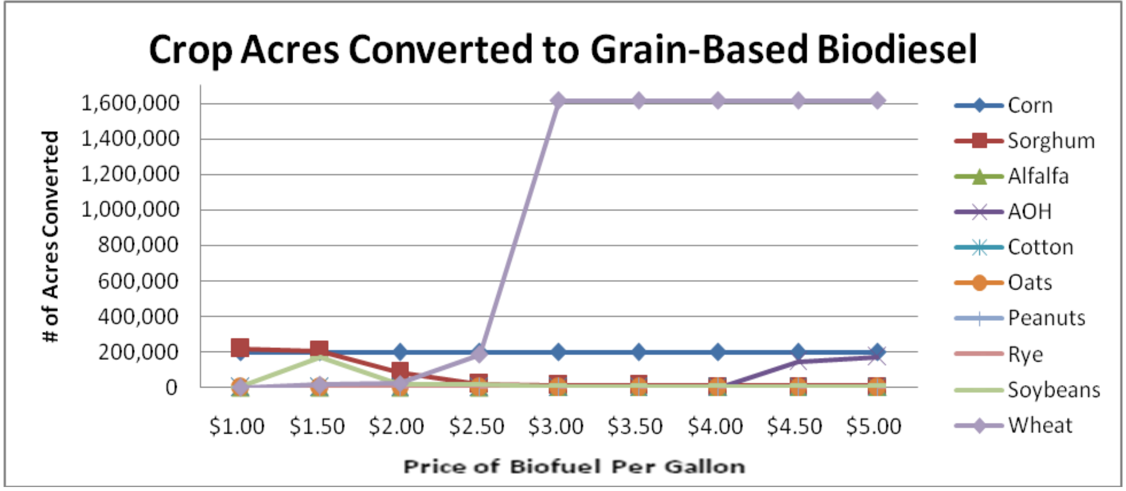
The potential ethanol production associated with this crop land conversion is summarized in Figure 3. As previously, discussed, hard red winter wheat and hay production are the largest two crops in Oklahoma. Not surprisingly, the potential conversions of these acres into ethanol crops have the greatest impact on total ethanol production. The results indicated a total ethanol production of 423,931,357 million gallons at $2.50/gallon ethanol price and a maximum ethanol production of just over 509 million gallons at an ethanol price of $5.00/gallon or higher.

Figure 3. Total Gallons of Grain-Based Ethanol Produced at Various Biofuel Prices



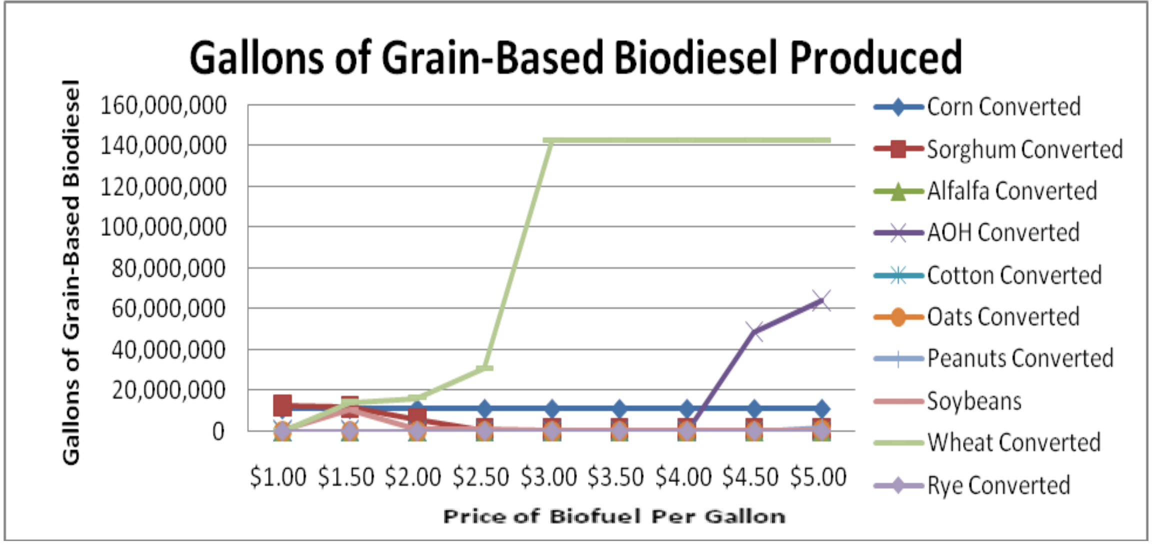
The potential crop land converted into gain-based biodiesel feedstocks is provided in Figure 4. At biodiesel prices above $1.50/gallon the biodiesel value of soybeans exceed the historical grain price return for soybeans. The model also depicts that at a biofuel price above $1.50/gallon wheat acres convert to a gain-based biodiesel feedstock. As you will in further results, grain-based biodiesel is out bid by most other biofuel crops in this scenario, only corn, sorghum, soybeans and wheat convert a significant enough amount of acres into biodiesel feedstock production.

Figure 4. Total Crop Acres Converted to Grain-Based Biodiesel Feedstocks at Various Biofuel Prices.



The potential biodiesel production associated with the crop land conversion is shown in Figure 5. The potential conversion of wheat into canola represents the largest single potential source of biodiesel production. At a biodiesel price of $2.50/gallon the existing soybean production and the predicted conversion of other crops into either soybeans or canola represented approximately 43,860,525 million gallons of biodiesel. The maximum potential for the price range modeled was indicated to be slightly less than 24 million gallons which also indicates that as biofuel prices increase the amount of biodiesel produced decreases due to acres being bid to other resources.

Figure 5. Total Gallons of Grain-Based Biodiesel Produced at Various Biofuel Prices.

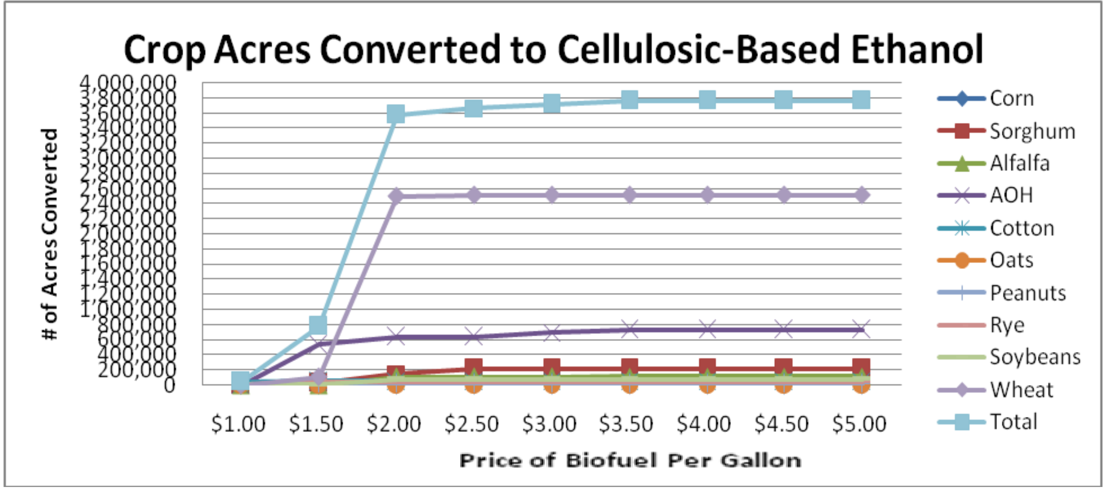


The potential conversion of existing cropland and Conservation Reserve Program Land (CRP) into switchgrass production for use of cellulosic-based ethanol feedstock was based on a conversion rate of 75 gallons/dry ton and processing costs of $1.00/gallon. Switchgrass production costs were based on the OSU Enterprise Budgets. The estimated production costs included fixed costs of $46.70/acre plus variable costs (including harvesting and transportation costs) of $32.60/ton. Switchgrass yields for existing cropland were modeled at 100% of county average alfalfa yields. It should be noted that switchgrass is not agronomically similar to alfalfa hay. However, alfalfa hay has relatively high yielding forage and a high value crop is typically well managed. For these reasons, alfalfa yields were thought to provide a reasonable benchmark for actual switchgrass yields. As previously stated, there is an adjustment factor set into the model in case of the event where switchgrass yields are actually predicted and potentially genetically modified to an even higher yield.

Switchgrass yields on CRP lands were based on estimates developed by Lawrence (2004) with yields varying from 1.66 ton/acre to 4 tons/acre. Switchgrass was not deemed to be a viable crop on CRP lands in 20 counties due to the rainfall conditions and soil types. The model assumed that CRP land converted into switchgrass production when the cellulosic ethanol return for those acres, less ethanol processing costs, exceeded the current county average CRP rental rate. It should be noted that this conversion would require a change in federal policy or a removal of the land from the conservation reserve program. Land enrolled in CRP is currently only allowed to be harvested every third year.

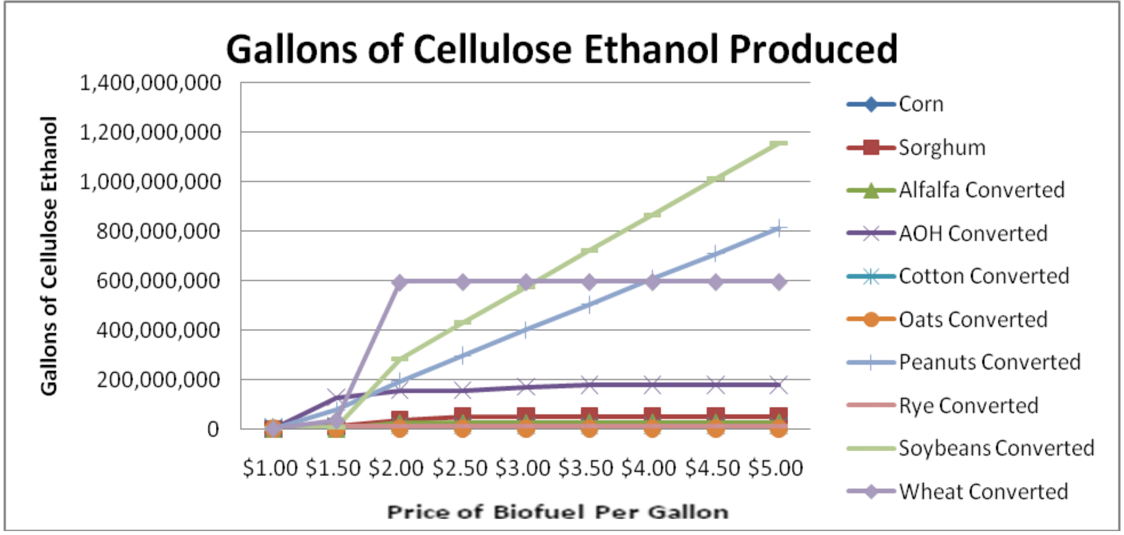
The model suggested that different categories of crop land would be attracted into switchgrass production at different ethanol price levels (Figure 6). Cotton acreage was predicted to convert at prices exceeding $1.50/gallon. This result is likely a function of the procedure to model switchgrass yields as being equal to county level alfalfa yields. Oklahoma counties with existing cotton acreage have relative high average yields for alfalfa. The model results indicated that sorghum acreage would begin to be attracted to switchgrass production at ethanol prices of $2.00/gallon with approximately 70% of the sorghum acres converted at ethanol prices of $2.50/acre or higher. CRP acreage was also predicted to convert when ethanol prices exceeded $2.00/gallon.

Figure 6. Total Crop Acres Converted to Celluosic-Based Ethanol at Various Biofuel Prices



The total amount of cellulosic-ethanol gallons produced, related to the converted crop land acres is illustrated in Figure 7. It is overwhelmingly clear that if switchgrass and cellulosic-based ethanol does progress into mass production, Oklahoma has the greatest amount of biofuel produced from it, verses the other biofuel options. All crops converted to cellulosic ethanol when biofuel prices reached $1.50/gallon except for Alfalfa and it converted at $2.00/gallon. The results indicated that with approximately 49.52% of all crop acres converted to a cellulosic-based feedstock, nearly 1.6 billion gallons of ethanol could be produced when biofuel prices are equal to $2.50/gallon. The maximum potential for cellulosic-based ethanol is approximately 2.9 billion gallons of biofuel with an increase of only 1.59% more crop land converted (51.11%) to a cellulosic-based feedstock.

Figure 7. Total Gallons of Cellulosic-Based Ethanol Produced at Various Biofuel Prices



To summarize the first scenario which was, the number of crop acres converted and gallons of biofuel produced when crop land was either put into grain-based ethanol production, cellulosic-based ethanol production, biodiesel production or left as is producing the crop that currently occupies the given acres, Table VI. illustrates exactly how many gallons of biofuel can potentially be produced and what percent of crop acres must be converted in order to satisfy those potential gallons produced.

Table VII. Total Gallons of Biofuel Produced and Crop Acres Converted

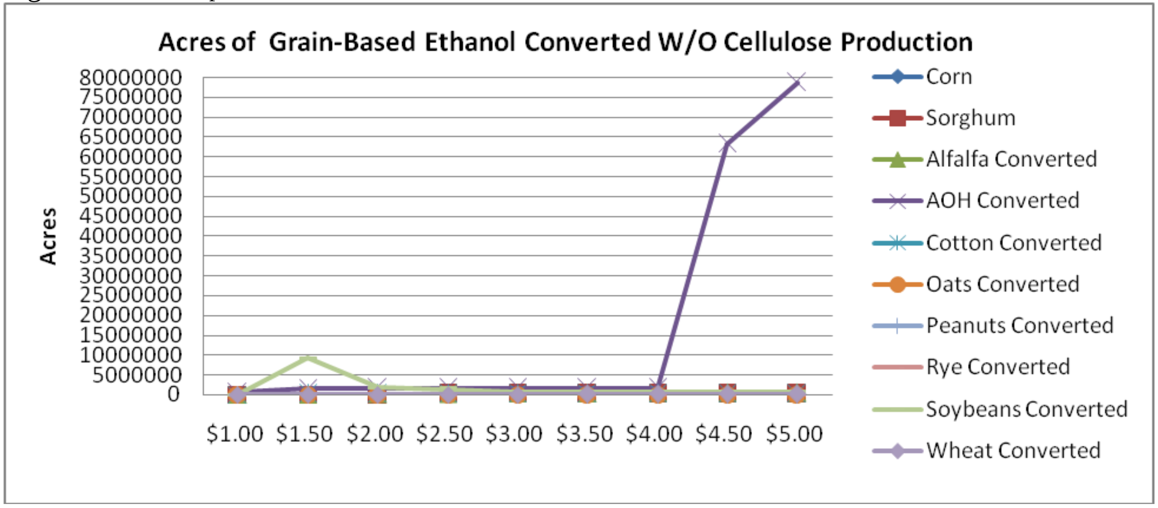
Crop	**Biofuel Produced (gallons)**	**Crop Acres Converted (% of total cropland)**
Grain-Based Ethanol	423,931,357	22.69%
Cellulosic-Based Ethanol	1,575,935,603	49.52%
Grain-Based Biodiesel	43,860,525	5.68%

*Based on a biofuel price of $2.50/gallon.

The second scenario is; the number of crop acres converted and gallons of biofuel produced when crop land was either put into grain-based ethanol production, biodiesel production or left as is producing the crop that currently occupies the given acres. This model is assuming that cellulosic-based ethanol is not produced. The decision was made based upon which option had the highest return above variable costs for the production of the entity.

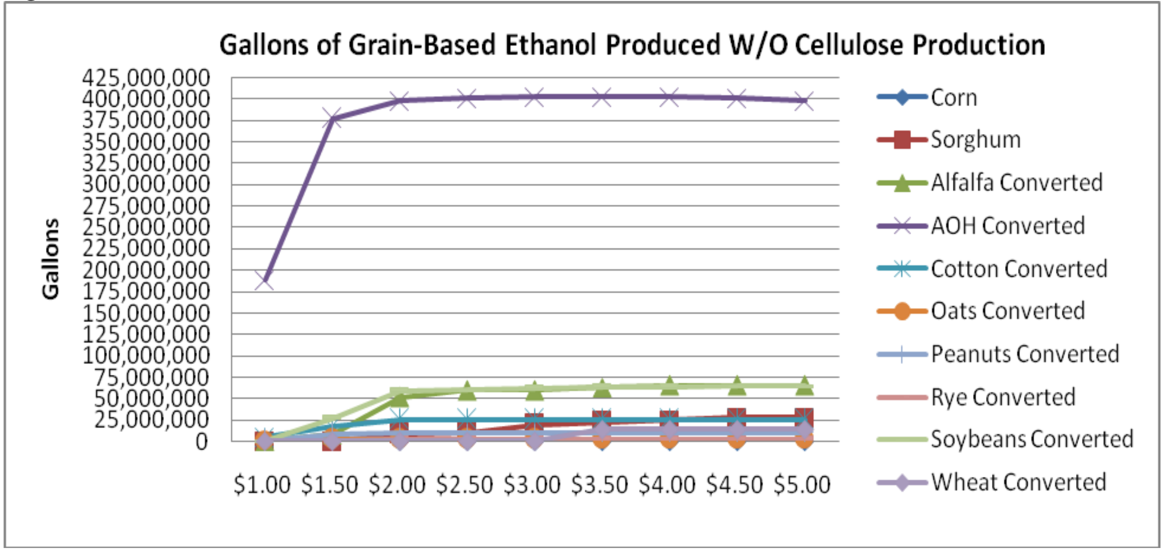
The potential crop land converted into gain-based ethanol feedstocks is provided in Figure 8. The model indicated that at a price of biofuel of $1.00/gallon hay, cotton, oats, and peanuts partially convert. At a price of $1.50/gallon and higher alfalfa and soybeans begin to convert and wheat does not begin to convert until biofuel prices reach $3.50/gallon and higher. As the table indicates, hay provides the biggest benefit to grain-based ethanol because of the large number of crop acres able to potentially convert. All crops convert to an ethanol feedstock when the price of ethanol reaches above $1.50/gallon except for wheat acres, which comes into play at $3.50/gallon and higher, which was previously state.

Figure 8. Total Crop Acres Converted to Ethanol at Various Prices when Cellulosic-Ethanol Is Not Produced.



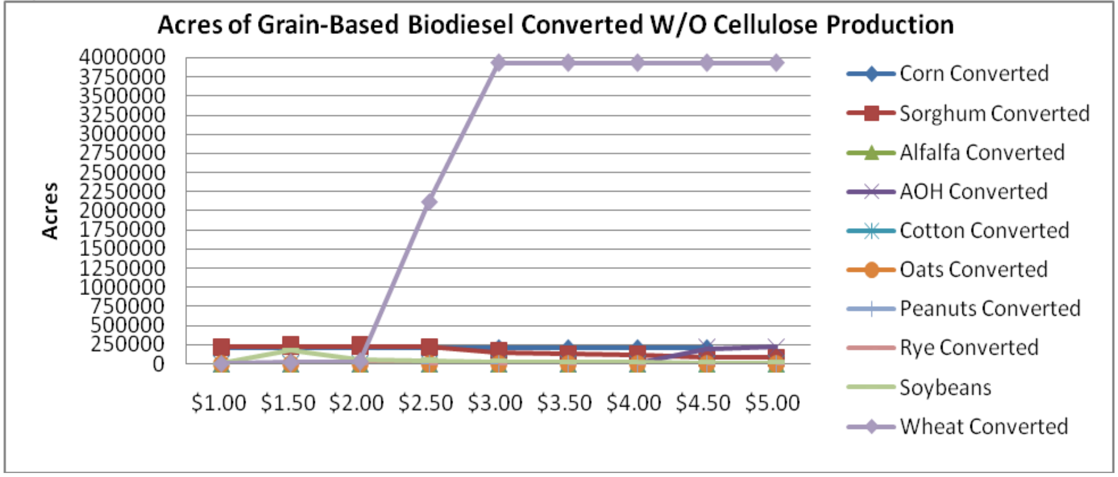
The potential ethanol production associated with this crop land conversion when cellulosic-based ethanol is not produced; is summarized in Figure 9. As previously, discussed, hard red winter wheat and hay production are the largest two crops in Oklahoma. Not surprisingly, the potential conversions of these acres into ethanol crops have the greatest impact on total ethanol production. The results indicated a total ethanol production of 572,338,376 million gallons at $2.50/gallon ethanol price and a maximum ethanol production of just over 890 million gallons at an ethanol price of $5.00/gallon or higher.

Figure 9. Total Gallons of Grain-Based Ethanol Produced at Various Prices When Cellulosic-Ethanol Is Not Produced



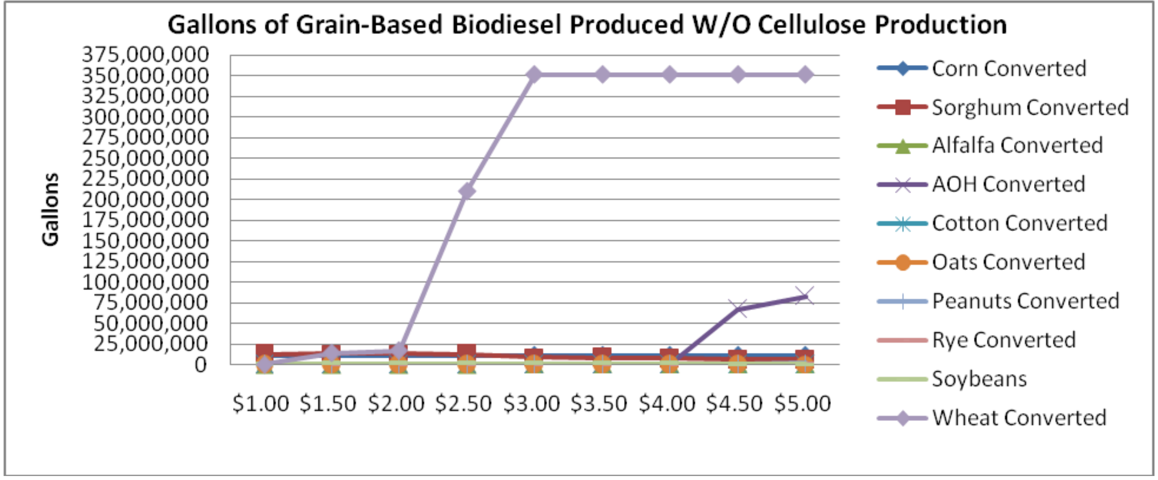
The potential crop land converted into gain-based biodiesel feedstocks is provided in Figure 10. At biodiesel prices above $1.50/gallon the biodiesel value of soybeans exceed the historical grain price return for soybeans. The model also depicts that at a biofuel price above $1.50/gallon wheat acres convert to a gain-based biodiesel feedstock. Some Alfalfa acres are converted at $3.00/gallon and higher, though this is not a significant amount of acres converted. For the most part the only significant amount of acres converted are corn, sorghum, soybean, and wheat acres.

Figure 10. Total Crop Acres Converted to Biodiesel at Various Prices When Cellulosic-Ethanol Is Not Produced.



The potential biodiesel production associated with the crop land conversion when cellulosic-based ethanol is not produced is shown in figure 11. The potential conversion of wheat into canola represents the largest single potential source of biodiesel production. At a biodiesel price of $2.50/gallon the existing soybean production and the predicted conversion of other crops into either soybeans or canola represented approximately 235,574,829 million gallons of biodiesel. The maximum potential for the price range modeled was indicated to be slightly over 28 million gallons which also indicates that as biofuel prices increase the amount of biodiesel produced decreases due to acres being bid to other resources.

Figure 11. Total Gallons of Biodiesel Produced When Cellulosic-Ethanol Is Not Produced.



In summary, the second scenario which was, the number of crop acres converted and gallons of biofuel produced when crop land was either put into grain-based ethanol production, biodiesel production or left as is producing the crop that currently occupies the given acres, with no cellulosic-ethanol produced. Table VII. illustrates exactly how many gallons of biofuel can potentially be produced and what percent of crop acres must be converted in order to satisfy those potential gallons produced.

Table VIII. Total Gallons of Biofuel Produced and Crop Acres Converted

Crop	**Biofuel Produced (gallons)**	**Crop Acres Converted (% of total cropland)**
Grain-Based Ethanol	572,338,376	48.40%
Grain-Based Biodiesel	235,574,829	34.80%

*Based on a biofuel price of $2.50/gallon.

In Conclusion

As previously mentioned, there were two scenarios to evaluate possible levels of biofuel gallons produced and crop acres converted. The results show that if cellulosic-based ethanol is commercialized, then an overwhelming amount of ethanol can be produced when only 49.52% of total crop acres are converted to switchgrass or hulless barley with a biofuel price of $2.50/gallon. If the situation arises where cellulosic-based ethanol is not able to be commercially produced then the next best use of 48.40% of crop land in Oklahoma would be to produce grain-based ethanol from corn and sorghum, while converting all other crops into one of the two previously stated crops.

CHAPTER V

CONCLUSION

Summary and Limitations

This study provides an important first step in identifying Oklahoma's biofuel potential. Several limitations should be identified. First, in examining biofuel crop potential, the study concentrated on the 8.6 million acres of crop land and land enrolled in CRP. Oklahoma has substantial acres of pasture and rangeland. The amount of feedstock that could be produced on existing pasture and rangeland is uncertain. The feasibility of utilizing pasture and rangeland for either grain-based or cellulosic-based biofuel crops was therefore not considered.

Second, the model used to determine potential biofuel crop production assumed that the returns from biofuel sales less the amount needed to cover the operational cost of a biofuel refinery and an "acceptable" return to capital were paid to the producer of the biofuel crop. As noted, this would be a reasonable assumption only if biofuel refineries were organized as farmer owned cooperatives. If the biofuel processing industry were owned by non-farmer investors, the investors would likely choose to capture a portion of the higher revenue from higher biofuel prices in the form of an increased return to capital.

The results therefore likely overstate the actual potential of biofuel crops and the potential size of the biofuel industry.

Another limitation of the study was that no attempt was made to model the size or location of biofuel processing operations or the transportation costs of assembling grain or cellulosic feedstock. The study also did not address the mechanics of creating a biofuel processing infrastructure. Recent reports indicate that the construction cost of grain based ethanol plants are approximately $2.50-$3.00/gallon of capacity. If those costs are indicative of future construction costs, realizing Oklahoma's full potential for grain-based ethanol would require an infrastructure investment approaching $1 billion while realizing the most optimistic scenario of grain and cellulosic ethanol production would require an investment approaching $10 billion. A cooperative structure would enable farmers to garner economic benefits from a biofuels industry and provide the maximum incentive for biofuel crop conversion. However, it may be difficult for a cooperative structure to secure the capital necessary to establish a cellulosic biorefinery. It is highly unlikely that producer groups could raise sufficient capital for this scale of infrastructure.

It is also important to emphasize the inherent uncertainties in projecting Oklahoma's potential in cellulosic ethanol. As of this writing, no economically competitive commercial size cellulosic ethanol production facility exists in the U.S. Cellulosic ethanol conversion rates, processing costs and infrastructure costs can not be accurately forecasted. Switchgrass yield data were produced from controlled experiments from a limited area. Switchgrass production methods, fertilizer requirements, and switchgrass yields from on-farm trials on cropland, pasture land, range land, and CRP acres, across climate zones, remain to be established. Currently, we do not have enough data to truly understand the potential of switchgrass as a feedstock.

Unlike grain crops, switchgrass has no alternative uses and no federal price support network. Infrastructure (harvest, storage, transportation) is not in place to produce and market switchgrass. Conversely, grain production, harvesting, storage, and transportation are virtually seamless as a result of years of infrastructure development and refinements. For cellulosic biofuel feedstock, the development of the appropriate infrastructure would require years.

Finally, while the study projected when producers would have an apparent economic incentive to convert to biofuel feedstock crops, the study did not attempt to model the likelihood or time path of such conversions. Historically, farmers have not immediately adopted new technologies or more profitable alternative crops. For example, the comprehensive adoption of hybrid corn required almost 14 years. The development of an Oklahoma biofuel industry also involves a “chicken and the egg” problem. The lack of a strong local market for biofuel feedstocks may inhibit producers’ conversion into biofuel crops. At the same time, the lack of an established raw material base may inhibit the development of biofuel processing infrastructure.

Biofuel feedstock production represents an additional alternative for Oklahoma producers. However it should be emphasized that all land in farms is currently in use. The overwhelming majority of Oklahoma’s range and pasture acres are used to produce forage to feed the state’s more than five million cattle and calves. A biofuels industry would bid resources from current use with possible negative impacts on some agricultural sectors. The majority of the biofuel potential identified in this study related to the conversion of land currently producing hay and winter wheat. Converting this land to biofuel feedstocks would have clear implications for Oklahoma’s cattle industry.

Conversion into biofuel crops, like any cropping system change, will impact Oklahoma’s existing agribusinesses. Existing facilities including farmer-owned grain elevators, and cotton gins could be impacted. In a more general sense, economic activity resulting from a biofuels industry may reduce some of the state’s current industries. The biofuel industry represents an exciting opportunity for Oklahoma agriculture. As these opportunities are explored, the potential negative impacts on Oklahoma’s livestock industries and existing agribusiness infrastructure and economic infrastructure need to be considered.

Concluding Comment

While this study has a number of limitations it does provide an important first step in identifying and quantifying Oklahoma’s potential in the biofuel industry. Biofuel production could provide the incentives for substantial cropping shifts, largely at the expense of hay and wheat production, which is Oklahoma’s largest crop. This study projected when producers would have an economic incentive to convert their current crops into biofuel feedstock crops. As well, it models at what price points Oklahoma would have the greatest number of gallons of biofuel produced and what percent of crop acres must be converted to produce each level of biofuel gallons. The study did not attempt to model the likelihood or time path of such conversions. A significant investment in infrastructure would also be required before Oklahoma can realize the potential identified in this study.

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Appendix

Corn Crop 5yr. Average Acres and Yield

County	Harvested Acres	Average Yield	Total Yield/County
Adair	0	0.0	0
Alfalfa	460	110.7	50,904
Atoka	0	0.0	0
Beaver	6,780	155.1	1,051,849
Beckham	0	0.0	0
Blaine	180	33.5	6,030
Bryan	2,060	92.1	189,808
Caddo	3,100	102.0	316,262
Canadian	260	62.0	16,120
Carter	0	0.0	0
Cherokee	0	0.0	0
Choctaw	2,620	117.6	308,164
Cimarron	23,700	164.3	3,894,858
Cleveland	760	107.4	81,624
Coal	0	0.0	0
Comanche	2,260	73.0	165,070
Cotton	300	41.3	12,396
Craig	3,100	87.1	269,948
Creek	0	0.0	0
Custer	780	65.0	50,700
Delaware	0	0.0	0
Dewey	380	42.0	15,960
Ellis	1,960	147.3	288,786
Garfield	600	50.6	30,336
Garvin	2,640	105.8	279,312
Grady	2,240	80.6	180,454
Grant	1,480	87.9	130,151
Greer	0	0.0	0
Harmon	560	69.7	39,010
Harper	1,360	140.9	191,624
Haskell	900	94.2	84,798
Hughes	1,280	102.3	130,893
Jackson	0	0.0	0
Jefferson	0	0.0	0

Johnston	0	0.0	0
Kay	7,600	92.6	703,760
Kingfisher	380	78.4	29,792
Kiowa	300	17.3	5,202
Latimer	0	0.0	0
Le Flore	2,540	106.2	269,799
Lincoln	500	73.3	36,640
Logan	220	32.7	7,185
Love	0	0.0	0
Major	2,740	163.1	447,004
Marshall	380	52.0	19,775
Mayes	1,180	79.6	93,928
McClain	1,600	102.6	164,224
McCurtain	9,640	88.4	852,176
McIntosh	300	55.3	16,602
Murray	80	17.5	1,400
Muskogee	7,360	123.9	912,051
Noble	1,320	78.0	102,960
Nowata	1,200	90.7	108,816
Okfuskee	780	86.5	67,501
Oklahoma	980	90.1	88,318
Okmulgee	1,940	86.4	167,616
Osage	100	18.8	1,880
Ottawa	4,060	93.9	381,234
Pawnee	0	0.0	0
Payne	360	70.5	25,380
Pittsburg	460	82.1	37,784
Pontotoc		0.0	
Pottawatomie	1,920	102.1	195,994
Pushmataha	0	0.0	0
Roger Mills	0	0.0	0
Rogers	80	17.5	1,400
Seminole	0	0.0	0
Sequoyah	5,640	111.4	628,296
Stephens	0	0.0	0
Texas	75,200	168.7	12,687,744
Tillman	6,660	60.5	403,063
Tulsa	0	0.0	0
Wagoner	3,920	96.1	376,869
Washington	300	53.1	15,924
Washita	180	37.0	6,660
Woods	0	0.0	0
Woodward	0	0.0	0

Sorghum Crop 5yr. Average Acres and Yield

County	Harvested Acres	Average Yield	Total Yield/County
Adair	0	0	0
Alfalfa	5,760	42.7	245837
Atoka	0	0.0	0
Beaver	22,440	39.1	876506
Beckham	820	35.2	28864
Blaine	2,440	37.6	91842
Bryan	240	14.0	3360
Caddo	5,020	46.1	231623
Canadian	1,700	22.9	38862
Carter	0	0.0	0
Cherokee	0	0.0	0
Choctaw	0	0.0	0
Cimarron	60,000	37.7	2264400
Cleveland	40	11.5	460
Coal	0	0.0	0
Comanche	1,080	30.9	33372
Cotton	580	22.8	13236
Craig	4,780	59.6	284792
Creek	160	13.5	2160
Custer	3,800	38.0	144552
Delaware	560	46.7	26174
Dewey	520	12.8	6635
Ellis	1,860	38.3	71312
Garfield	18,200	46.1	838292
Garvin	480	28.6	13728
Grady	1,040	53.2	55286
Grant	28,700	47.5	1364398
Greer	480	28.3	13603
Harmon	5,320	36.0	191414
Harper	1,700	38.0	64600
Haskel	0	0.0	0
Hughes	160	26.0	4160
Jackson	7,180	40.8	292657
Jefferson	80	13.5	1080
Johnson	0	0.0	0
Kay	30,300	49.7	1505304
Kingfisher	1,160	40.6	47096
Kiowa	3,980	37.3	148534
Latimer	0	0.0	0

Le Flore	60	10.0	600
Lincoln	0	0.0	0
Logan	600	37.0	22200
Love	100	10.0	1000
Major	1,480	37.4	55322
Marshall	180	20.0	3600
Mayes	2,100	58.3	122472
McClain	180	21.4	3852
McCurtain	950	43.5	41325
McIntosh	100	12.0	1200
Murray	0	0.0	0
Muskogee	1,520	53.8	81776
Noble	7,340	39.5	289783
Nowata	800	41.8	33440
Okfuskee	0	0.0	0
Oklahoma	240	21.0	5040
Okmulgee	0	0.0	0
Osage	1,060	50.3	53276
Ottawa	4,820	61.5	296430
Pawnee	900	38.9	34992
Payne	740	33.6	24849
Pittsburg	0	0.0	0
Pontotoc	0	0.0	0
Pottawatomie	280	16.8	4704
Pushmatah	0	0.0	0
Roger Mills	740	23.6	17449
Rogers	620	37.5	23250
Seminole	0	0.0	0
Sequoyah	0	0.0	0
Stephens	320	9.0	2880
Texas	60,600	44.3	2683368
Tillman	4,940	39.6	195822
Tulsa	0	0.0	0
Wagoner	1,200	57.7	69192
Washington	560	27.0	15120
Washita	4,220	32.3	136222
Woods	1,680	38.5	64613
Woodward	740	50.5	37355

Alfalfa Crop 5yr. Average Acres and Yield

County	Harvested Acres	Average Yield	Total Yield/County
Adair	0	0.00	0
Alfalfa	23,000	3.45	79350
Atoka	-	0.00	0
Beaver	4,260	4.08	17381
Beckham	6,320	2.89	18265
Blaine	7,500	2.98	22350
Bryan	940	3.59	3375
Caddo	7,060	3.56	25134
Canadian	16,500	3.70	61050
Carter	-	0.00	0
Cherokee	-	0.00	0
Choctaw	380	1.66	631
Cimarron	-	0.00	0
Cleveland	2,080	3.48	7238
Coal	-	0.00	0
Comanche	8,100	2.85	23085
Cotton	1,180	2.57	3033
Craig	860	2.60	2236
Creek	1,000	2.49	2490
Custer	7,800	3.21	25038
Delaware	480	2.75	1320
Dewey	2,140	3.00	6420
Ellis	-	0.00	0
Garfield	6,340	2.64	16738
Garvin	19,900	3.44	68456
Grady	31,100	3.50	108850
Grant	10,300	2.90	29870
Greer	4,400	3.37	14828
Harmon	6,080	4.20	25536
Harper	3,700	3.74	13838
Haskell	1,280	3.49	4467
Hughes	760	3.15	2394
Jackson	4,100	3.66	15006
Jefferson	-	0.00	0
Johnston	-	0.00	0
Kay	4,740	3.00	14220
Kingfisher	8,660	3.66	31696
Kiowa	7,400	2.81	20794
Latimer	-	0.00	0
Le Flore	1,080	2.83	3056
Lincoln	2,160	3.42	7387

Logan	2,700	3.35	9045
Love	-	0.00	0
Major	5,840	2.86	16702
Marshall	-	0.00	0
Mayes	1,600	3.22	5152
McClain	10,800	4.01	43308
McCurtain	1,100	2.81	3091
McIntosh	-	0.00	0
Murray	2,020	2.85	5757
Muskogee	2,420	3.45	8349
Noble	5,140	2.68	13775
Nowata	2,340	2.64	6178
Okfuskee	420	3.70	1554
Oklahoma	7,100	3.94	27974
Okmulgee	840	3.01	2528
Osage	3,860	2.48	9573
Ottawa	680	2.64	1795
Pawnee	2,860	2.99	8551
Payne	4,140	3.13	12958
Pittsburg	280	1.81	507
Pontotoc	-	0.00	0
Pottawatomie	4,260	3.45	14697
Pushmataha	-	0.00	0
Roger Mills	7,640	3.82	29185
Rogers	-	0.00	0
Seminole	-	0.00	0
Sequoyah	940	2.30	2162
Stephens	-	0.00	0
Texas	8,140	5.58	45421
Tillman	13,080	2.90	37932
Tulsa	-	0.00	0
Wagoner	1,180	3.19	3764
Washington	1,260	2.67	3364
Washita	14,200	3.46	49132
Woods	8,200	3.12	25584
Woodward	3,040	2.87	8725

AOH Crop 5yr. Average Acres and Yield

County	Harvested Acres	Average Yield	Total Yield/County
Adair	0	0.00	0
Alfalfa	9800	1.83	17914
Atoka	0	0.00	0
Beaver	24800	1.42	35216
Beckham	24800	1.42	35216
Blaine	0	0.00	0
Bryan	52840	1.90	100290
Caddo	47100	1.70	80164
Canadian	36000	1.63	58824
Carter	0	0.00	0
Cherokee	0	0.00	0
Choctaw	26740	1.02	27328
Cimarron	6600	0.98	6442
Cleveland	27100	1.68	45420
Coal	0	0.00	0
Comanche	25000	1.52	38050
Cotton	15040	1.56	23402
Craig	69500	1.53	106196
Creek	35880	1.54	55183
Custer	16600	1.61	26660
Delaware	0	0.00	0
Dewey	21400	1.48	31715
Ellis	15200	0.84	12829
Garfield	29400	1.48	43571
Garvin	33800	1.75	59015
Grady	48600	1.81	88063
Grant	14900	1.47	21843
Greer	9900	1.75	17305
Harmon	7600	1.47	11172
Harper	10800	1.51	16351
Haskell	53960	1.90	102416
Hughes	38500	1.74	67144
Jackson	16660	1.68	27955
Jefferson	12900	1.41	18189
Johnston	0	0.00	0
Kay	19400	1.53	29682
Kingfisher	36500	1.58	57816
Kiowa	14700	1.54	22609
Latimer	0	0.00	0
Le Flore	57080	1.65	94296
Lincoln	56820	1.66	94208
Logan	28200	1.52	42864

Love	22900	1.71	39251
Major	22600	1.63	36883
Marshall	0	0.00	0
Mayes	57100	1.77	101295
McClain	33200	1.82	60490
McCurtain	38160	2.09	79602
McIntosh	38200	1.44	55084
Murray	15100	1.78	26938
Muskogee	78500	1.61	126228
Noble	21300	1.52	32376
Nowata	34300	1.42	48843
Okfuskee	20720	1.43	29630
Oklahoma	19100	1.87	35679
Okmulgee	44240	1.57	69280
Osage	45900	1.51	69309
Ottawa	45060	1.83	82550
Pawnee	15340	1.65	25372
Payne	49700	1.55	77234
Pittsburg	32520	1.13	36813
Pontotoc	0	0.00	0
Pottawatomie	38300	1.71	65340
Pushmatatah	0	0.00	0
Roger Mills	17100	1.39	23701
Rogers	50140	1.60	80324
Seminole	0	0.00	0
Sequoyah	31520	1.73	54467
Stephens	0	0.00	0
Texas	18200	1.82	33197
Tillman	14400	1.86	26755
Tulsa	0	0.00	0
Wagoner	41600	1.81	75213
Washington	18760	1.41	26489
Washita	25600	1.58	40499
Woods	17900	1.75	31253
Woodward	22700	1.42	32325

Cotton Crop 5yr. Average Acres and Yield

County	Harvested Acres	Average Yield	Total Yield/County
Alfalfa	1,080	384	414936
Adair	-	-	-
Atoka	-	-	-
Beaver	-	-	-
Beckham	6,040	306	1848240
Blaine	-	-	-
Bryan	-	-	-
Caddo	2,940	477	1401204
Canadian	1,980	396	784080
Carter	-	-	-
Cherokee	-	-	-
Choctaw	-	-	-
Cimarron	-	-	-
Cleveland	-	-	-
Coal	-	-	-
Comanche	2,640	283	746592
Cotton	1,840	239	439392
Craig	-	-	-
Creek	-	-	-
Custer	1,800	383	689400
Delaware	-	-	-
Dewey	-	-	-
Ellis	-	-	-
Garfield	-	-	-
Garvin	220	141	30932
Grady	200	144	28800
Grant	3,660	426	1558428
Greer	4,780	544	2599364
Harmon	20,240	715	14475648
Harper	-	-	-
Haskell	-	-	-
Hughes	-	-	-
Jackson	54,600	912	49773360
Jackson	-	-	-
Jefferson	-	-	-
Johnston	-	-	-
Kay	7,200	357	2568960
Kingfisher	-	-	-
Kiowa	6,780	321	2179092
Latimer	-	-	-
Le Flore	-	-	-

Lincoln	-	-	-
Logan	-	-	-
Love	-	-	-
Major	-	-	-
Marshall	-	-	-
Mayes	-	-	-
McClain	-	-	-
McCurtain	400	179	71760
McIntosh	-	-	-
Murray	-	-	-
Muskogee	-	-	-
Noble	1,000	323	323400
Nowata	-	-	-
Okfuskee	-	-	-
Oklahoma	-	-	-
Okmulgee	-	-	-
Osage	-	-	-
Ottawa	-	-	-
Pawnee	-	-	-
Payne	-	-	-
Pittsburg	-	-	-
Pontotoc	-	-	-
Pottawatomie	-	-	-
Pushmataha	-	-	-
Roger Mills	1,260	321	404712
Rogers	-	-	-
Seminole	-	-	-
Sequoyah	-	-	-
Stephens	-	-	-
Tillman	41,100	391	16061880
Tulsa	-	-	-
Wagoner	-	-	-
Washington	-	-	-
Washita	9,640	330	3177344
Woods	1,100	167	184140
Woodward	-	-	-

Oats Crop 5yr. Average Acres and Yield

County	Harvested Acres	Average Yield	Total Yield/County
Adair	0	0	0
Alfalfa	240	23.0	5520
Atoka	0	0.0	0
Beaver	80	7.5	600
Beckham	140	5.7	801
Blaine	480	30.2	14506
Bryan	340	31.9	10832
Caddo	540	29.3	15844
Canadian	420	36.4	15305
Carter	0	0.0	0
Cherokee	0	0.0	0
Choctaw	0	0.0	0
Cimarron	0	0.0	0
Cleveland	180	18.7	3359
Coal	0	0.0	0
Comanche	340	28.0	9520
Cotton	560	23.8	13339
Craig	520	29.1	15111
Creek	0	0.0	0
Custer	460	41.4	19026
Delaware	0	0.0	0
Dewey	300	17.6	5268
Ellis	300	13.8	4140
Garfield	240	16.8	4037
Garvin	0	0.0	0
Grady	180	14.0	2520
Grant	280	20.5	5740
Greer	180	9.8	1764
Harmon	220	16.9	3722
Harper	0	0.0	0
Haskell	0	0.0	0
Hughes	0	0.0	0
Jackson	280	14.0	3920
Jefferson	420	34.3	14423
Johnston	0	0.0	0
Kay	160	13.0	2080
Kingfisher	880	10.0	8800
Kiowa	840	22.0	18446
Latimer	0	0.0	0
LeFlore	0	0.0	0
Lincoln	60	11.3	680

Logan	320	34.3	10989
Love	140	13.0	1820
Major	620	26.8	16604
Marshall	460	37.0	17020
Mayes	0	0.0	0
McClain	0	0.0	0
McCurtain	0	0.0	0
McIntosh	0	0.0	0
Murray	0	0.0	0
Muskogee	0	0.0	0
Noble	380	25.9	9850
Nowata	500	42.7	21330
Okfuskee	0	0.0	0
Oklahoma	240	28.5	6840
Okmulgee	0	0.0	0
Osage	120	16.0	1920
Ottawa	160	17.5	2800
Pawnee	140	18.3	2568
Payne	0	0.0	0
Pittsburg	0	0.0	0
Pontotoc	0	0.0	0
Pottawatomie	0	0.0	0
Pushmatah	0	0.0	0
Roger Mills	0	0.0	0
Rogers	140	17.8	2498
Seminole	0	0.0	0
Sequoyah	0	0.0	0
Stephens	120	4.5	540
Texas	240	10.5	2525
Tillman	620	33.1	20510
Tulsa	0	0.0	0
Wagoner	300	19.9	5958
Washington	0	0.0	0
Washita	200	16.0	3200
Woods	380	19.6	7448
Woodward	380	30.8	11704

Peanuts Crop 5yr. Average Acres and Yield

County	Harvested Acres	Average Yield	Total Yield/County
Adair	0	0	0
Alfalfa	0	0	0
Atoka	0	0	0
Beaver	0	0	0
Beckham	4960	3205	15896800
Blaine	780	1947	1518660
Bryan	1640	2177	3570280
Caddo	20840	2871	59831640
Canadian	0	0	0
Carter	0	0	0
Cherokee	0	0	0
Choctaw	0	0	0
Cimarron	0	0	0
Cleveland	0	0	0
Coal	0	0	0
Comanche	440	94	41360
Cotton	120	100	12000
Craig	0	0	0
Creek	0	0	0
Custer	1120	2674	2994880
Delaware	0	0	0
Dewey	0	0	0
Ellis	0	0	0
Garfield	0	0	0
Garvin	340	902	306680
Grady	1080	2371	2560680
Grant	0	0	0
Greer	3120	2381	7428720
Harmon	2500	2798	6995000
Harper	0	0	0
Haskell	0	0	0
Hughes	1020	692	705840
Jackson	1400	2531	3543400
Jefferson	0	0	0
Johnston	0	0	0
Kay	0	0	0
Kingfisher	0	0	0
Kiowa	860	2050	1763000
Latimer	0	0	0
Le Flore	0	0	0
Lincoln	0	0	0

Logan	0	0	0
Love	1340	2590	3470600
Major	0	0	0
Marshall	520	869	451880
Mayes	0	0	0
McClain	360	780	280800
McCurtain	0	0	0
McIntosh	0	0	0
Murray	0	0	0
Muskogee	0	0	0
Noble	0	0	0
Nowata	0	0	0
Okfuskee	220	378	83160
Oklahoma	0	0	0
Okmulgee	120	107	12840
Osage	0	0	0
Ottawa	0	0	0
Pawnee	0	0	0
Payne	0	0	0
Pittsburg	180	738	132840
Pontotoc	0	0	0
Pottawatomie	280	676	189280
Pushmataha	0	0	0
Roger Mills	0	0	0
Rogers	0	0	0
Seminole	0	0	0
Sequoyah	0	0	0
Stephens	440	993	436920
Texas	0	0	0
Tillman	4860	2167	10531620
Tulsa	0	0	0
Wagoner	0	0	0
Washington	0	0	0
Washita	1800	2865	5157000
Woods	0	0	0
Woodward	0	0	0

Rye Crop 5yr. Average Acres and Yield

County	Harvested Acres	Average Yield	Total Yield/County
Adair	0	0	0
Alfalfa	19.7	2,800	55272
Atoka	0.0	0	0
Beaver	7.3	180	1321
Beckham	21.6	7,240	156529
Blaine	17.8	4,220	74947
Bryan	5.0	80	400
Caddo	23.0	2,940	67561
Canadian	23.1	1,120	25827
Carter	7.6	200	1520
Cherokee	0.0	0	0
Choctaw	8.5	160	1360
Cimarron	3.3	160	522
Cleveland	0.0	0	0
Coal	0.0	0	0
Comanche	10.3	260	2668
Cotton	4.7	60	280
Craig	0.0	0	0
Creek	0.0	0	0
Custer	6.8	400	2720
Delaware	0.0	0	0
Dewey	13.7	600	8244
Ellis	20.4	720	14702
Garfield	16.1	1,160	18699
Garvin	16.1	520	8351
Grady	21.3	440	9390
Grant	11.5	300	3450
Greer	18.3	1,240	22742
Harmon	5.2	180	936
Harper	16.5	880	14485
Haskell	0.0	0	0
Hughes	3.7	120	439
Jackson	21.9	1,160	25450
Jefferson	15.7	1,000	15660
Johnston	0.0	0	0
Kay	0.0	0	0
Kingfisher	23.5	21,900	515526
Kiowa	3.2	100	320
Latimer	0.0	0	0
Le Flore	0.0	0	0
Lincoln	0.0	0	0

Logan	21.1	3,600	75888
Love	15.6	2,720	42541
Major	19.1	7,600	144856
Marshall	11.2	220	2464
Mayes	0.0	0	0
McClain	11.0	320	3520
McCurtain	7.3	140	1028
McIntosh	0.0	0	0
Murray	4.0	120	480
Muskogee	0.0	0	0
Noble	0.0	0	0
Nowata	0.0	0	0
Okfuskee	0.0	0	0
Oklahoma	3.0	60	180
Okmulgee	0.0	0	0
Osage	9.7	140	1352
Ottawa	0.0	0	0
Pawnee	0.0	0	0
Payne	21.7	860	18628
Pittsburg	0.0	0	0
Pontotoc	0.0	0	0
Pottawatomie	19.1	320	6099
Pushmatatah	0.0	0	0
Roger Mills	14.0	1,280	17920
Rogers	0.0	0	0
Seminole	0.0	0	0
Sequoyah	0.0	0	0
Stephens	7.0	160	1120
Texas	3.3	120	401
Tillman	0.0	0	0
Tulsa	0.0	0	0
Wagoner	0.0	0	0
Washington	0.0	0	0
Washita	18.7	2,000	37480
Woods	18.1	800	14448
Woodward	15.5	1,380	21335

Soybeans Crop 5yr. Average Acres and Yield

County	Harvested Acres	Average Yield	Total Yield/County
Adair	0	0	0
Alfalfa	1,460	37.1	54166
Atoka	0	0.0	0
Beaver	720	36.6	26376
Beckham	0	0.0	0
Blaine	0	0.0	0
Bryan	3,320	42.6	141432
Caddo	4,280	45.4	194169
Canadian	3,000	38.7	116100
Carter	0	0.0	0
Cherokee	0	0.0	0
Choctaw	3,960	45.4	179916
Cimarron	480	12.3	5904
Cleveland	300	21.7	6500
Coal	0	0.0	0
Comanche	200	11.3	2253
Cotton	920	26.8	24656
Craig	10,520	32.5	341900
Creek	0	0.0	0
Custer	760	56.4	42839
Delaware	0	0.0	0
Dewey	280	36.9	10332
Ellis	80	6.7	533
Garfield	2,980	35.1	104598
Garvin	6,280	40.0	251409
Grady	1,540	46.1	70943
Grant	11,540	35.2	405823
Greer	0	0.0	0
Harmon	0	0.0	0
Harper	120	6.1	732
Haskell	1,040	29.5	30715
Hughes	1,380	36.0	49680
Jackson	0	0.0	0
Jefferson	0	0.0	0
Johnston	0	0.0	0
Kay	29,500	37.5	1106250
Kingfisher	1,160	46.0	53399
Kiowa	0	0.0	0
Latimer	0	0.0	0
Le Flore	14,780	39.6	584795
Lincoln	700	38.3	26787

Logan	0	0.0	0
Love	0	0.0	0
Major	640	48.4	30997
Marshall	80	8.3	667
Mayes	4,680	29.2	136656
McClain	4,280	41.5	177763
McCurtain	6,740	39.5	266455
McIntosh	660	21.6	14256
Murray	0	0.0	0
Muskogee	17,680	40.7	720165
Noble	8,880	35.0	311096
Nowata	3,040	35.6	108224
Okfuskee	660	36.4	24024
Oklahoma	1,400	47.7	66827
Okmulgee	3,800	28.4	107793
Osage	0	0.0	0
Ottawa	21,460	36.6	784721
Pawnee	0	0.0	0
Payne	740	26.6	19709
Pittsburg	60	5.6	334
Pontotoc	0	0.0	0
Pottawatomie	3,320	45.3	150396
Pushmatatah	0	0.0	0
Roger Mills	0	0.0	0
Rogers	0	0.0	0
Seminole	0	0.0	0
Sequoyah	8,080	47.8	385955
Stephens	0	0.0	0
Texas	4,140	55.2	228528
Tillman	1,880	35.5	66677
Tulsa	0	0.0	0
Wagoner	35,300	40.0	1410823
Washington	9,080	35.1	319011
Washita	740	59.9	44301
Woods	0	0.0	0
Woodward	0	0.0	0

Wheat Crop 5yr. Average Acres and Yield

County	Harvested Acres	Average Yield	Total Yield/County
Adair	180	20.0	3600
Alfalfa	231,000	38.1	8801100
Atoka	280	16.8	4698
Beaver	94,000	25.6	2406400
Beckham	48,000	28.7	1375680
Blaine	136,000	32.1	4368320
Bryan	6,900	33.7	232392
Caddo	152,000	35.7	5432480
Canadian	151,000	36.9	5571900
Carter	1,540	29.2	44968
Cherokee	200	27.7	5532
Choctaw	1,550	36.8	56978
Cimarron	106,000	28.7	3044320
Cleveland	5,100	31.7	161670
Coal	240	25.3	6072
Comanche	40,600	30.9	1254540
Cotton	76,000	30.7	2331680
Craig	10,400	37.6	391248
Creek	1,840	35.4	65062
Custer	161,000	34.2	5506200
Delaware	2,360	38.5	90907
Dewey	107,000	32.2	3443260
Ellis	44,600	25.1	1118568
Garfield	283,000	36.4	10306860
Garvin	6,400	37.9	242560
Grady	56,600	35.4	2001376
Grant	308,000	35.8	11038720
Greer	72,000	27.7	1991520
Harmon	32,600	27.6	899760
Harper	58,400	27.3	1596656
Haskell	520	25.8	13416
Hughes	2,140	37.8	80892
Jackson	148,000	30.7	4537680
Jefferson	10,200	32.9	335784
Johnston	1,260	31.5	39690
Kay	187,000	36.3	6791840
Kingfisher	178,000	35.4	6304760
Kiowa	208,000	32.7	6805760
Latimer	0	0.0	0
Le Flore	4,900	35.7	175126
Lincoln	2,900	39.3	114028

Logan	54,000	33.5	1809000
Love	4,140	32.5	134467
Major	97,000	31.3	3032220
Marshall	1,280	23.4	29978
Mayes	6,500	36.8	239070
McClain	10,200	33.3	340068
McCurtain	3,100	35.1	108686
McIntosh	900	40.8	36756
Murray	1,020	31.0	31661
Muskogee	7,300	38.4	280320
Noble	124,000	33.3	4134160
Nowata	3,640	30.0	109346
Okfuskee	1,200	29.7	35664
Oklahoma	11,900	34.1	406028
Okmulgee	3,800	41.2	156560
Osage	15,800	34.6	546364
Ottawa	25,000	42.1	1052000
Pawnee	9,900	34.9	345510
Payne	11,200	32.0	358624
Pittsburg	820	36.2	29651
Pontotoc	500	27.1	13540
Pottawatomie	8,800	38.7	340208
Pushmatah	0	0.0	0
Roger Mills	34,000	28.3	963560
Rogers	7,500	32.0	240000
Seminole	1,260	31.4	39514
Sequoyah	2,700	39.9	107838
Stephens	9,700	30.8	299148
Texas	173,000	36.7	6342180
Tillman	126,000	31.0	3908520
Tulsa	2,400	34.8	83520
Wagoner	14,200	38.6	548688
Washington	8,300	33.9	281370
Washita	185,000	33.1	6123500
Woods	162,000	34.9	5660280
Woodward	68,000	29.9	2034560

VITA

Holly Ruth Bunt

Candidate for the Degree of

Master of Science

Thesis: MODELING POTENTIAL CROP LAND SHIFTS INTO BIOFUEL PRODUCTION FOR THE STATE OF OKLAHOMA

Major Field: Agriculture Economics

Biographical:

Personal Data: Born in Red Bluff, California, on January 31, 1985, the daughter of Bub and Shellie Ragan.

Education: Graduated from Red Bluff Union High School, Red Bluff, California in June 2003; received Bachelor of Science degree in Agriculture Economics with a focus in finance from California State University, Fresno. Completed the requirements for the Master of Science in Agriculture Economics at Oklahoma State University, Stillwater, Oklahoma in May, 2008.

Experience: Raised on a small farm in Red Bluff, California where I produced sheep, hogs and cattle; employed by California State University, Fresno in the student bookstore and as an assistant to the professor head of the beef cattle operation, 2003 to 2006; and employed by Oklahoma State University, Stillwater as a graduate research assistant, 2006 to present.

Professional Memberships: California Young Cattleman's Association, Delta Zeta Sorority, FFA, 4-H and student government.

Name: Holly Ruth Bunt Date of Degree: May, 2008

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: MODELING POTENIAL CROP LAND SHIFTS INTO BIOFUEL PRODUCTION FOR THE STATE OF OKLAHOMA

Pages in Study: 66 Candidate for the Degree of Master of Science

Major Field: Agriculture Economics

Scope and Method of Study: The purpose of this study is to determine the amount and regional distribution of biofuel feedstock crops that are currently produced in Oklahoma and to model the potential cropland changes for increased biofuel feedstock production. The study considers potential production of both biodiesel feedstocks (soybeans and winter canola), and grain based ethanol feedstocks (corn, grain sorghum, and hulless barley). The additional possibility of cellulosic based ethanol feedstocks such as corn stover, wheat straw or switchgrass are considered in a second scenario. The potential land conversion into biofuel feedstocks are modeled over a wide range of biofuel price levels. This provides a projection of the price response of land conversion. It should be emphasized that all land in farms is currently in use. It should be realized that a biofuels industry would bid resources from current use with possible negative impacts on some agriculture sectors.

Findings and Conclusions: The results show that if cellulosic-based ethanol is commercialized, then an overwhelming amount of ethanol can be produced when only 49.52% of total crop acres are converted to switchgrass or hulless barley with a biofuel price of \$2.50/gallon. If the situation arises where cellulosic-based ethanol is not able to be commercially produced then the next best use of 48.40% of crop land in Oklahoma would be to produce grain-based ethanol from corn and sorghum, while converting all other crops into one of the two previously stated crops.

While this study has a number of limitations it does provide an important first step in identifying and quantifying Oklahoma's potential in the biofuel industry. Biofuel production could provide the incentives for substantial cropping shifts, largely at the expense of hay and wheat production, which is Oklahoma's largest crop. This study projected when producers would have an economic incentive to convert their current crops into biofuel feedstock crops. As well, it models at what price points Oklahoma would have the greatest number of gallons of biofuel produced and what percent of crop acres must be converted to produce each level of biofuel gallons. The study did not attempt to model the likelihood or time path of such conversions. A significant investment in infrastructure would also be required before Oklahoma can realize the potential identified in this study.

ADVISER'S APPROVAL: Dr. Phil Kenkel