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How Risk Averse Farmers On Sensitive Environmental Land Respond To Dedicated Energy Crop

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HOW RISK AVERSE FARMERS ON SENSITIVE ENVIRONMENTAL LAND RESPOND TO DEDICATED ENERGY CROP

by

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A Research Paper
Submitted in Partial Fulfillment of the Requirements for the
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RESEARCH PAPER APPROVAL

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LAND RESPOND TO DEDICATED ENERGY CROP

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in the field of Agribusiness Economics

Approved by:

Silvia Secchi - Professor

Graduate School
Southern Illinois University Carbondale
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AN ABSTRACT OF THE RESEARCH PAPER OF

Kent Rupp, for the Master of Science degree in Agribusiness Economics, presented on November 04, 2011 at Southern Illinois University Carbondale.

TITLE: HOW RISK AVERSE FARMERS ON SENSITIVE ENVIRONMENTAL LAND RESPOND TO DEDICATED ENERGY CROP

MAJOR PROFESSOR: Dr Silvia Secchi

This study will analyze farmers and landowners of the Clear Creek Watershed in Iowa. Their willingness to accept switchgrass will be collected by a 2010 Clear Creek Land Use survey administered to the local area watershed farmers and landowners. The literature review of this will look at the current ethanol industry in Iowa, the Clear Creek Watershed's environmental health, and some of the willingness to accept factors (of biomass production) for farmers and landowners. A multiple regression was conducted on three possible predictors of the willingness to accept payment levels. Overall, the predictor values of age, education level, and farm size had a weak goodness of fit to the willingness to accept of switchgrass.

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INTRODUCTION

Agriculture has been a large and extremely important industry in the Midwestern United States for centuries. In the Midwest, the state of Iowa has led the way in peak agricultural output when compared to the other Midwestern states. Iowa currently leads the nation in corn production--producing 2.4 billion bushels per year. This figure correlates to a yielding average of approximately 182 bushels per acre (Iowa Corn Promotion Board/Iowa Corn Growers Association, 2011). With corn prices trending upward, repeated corn production in land use management is prevalent among many farmers nationwide.

Conscious management decisions are further supported by strong ethanol policies that are present in Iowa. There are currently 40 ethanol plants in use (with more coming online) within Iowa (Iowa Corn Promotion Board/Iowa Corn Growers Association, 2011) (see Figure 1). Iowa also leads the nation in overall ethanol production, contributing around 30% of the nation's total amount. The annual ethanol production is 3.5 billion gallons and will continue to grow if more plants go online (Iowa Renewable Fuels Association, 2011). To feed this growing renewable energy industry, land managers and farmers are consecutively planting corn in their annual rotations. This land use is a form of highly intensive farm production.

Environmental concerns over the continued use of elevated agricultural fertilizers and chemicals have grown as continuous crops (in this

case corn as it is used to produce ethanol for fuel) are planted. Areas like watersheds, wetlands, lakes, streams, and marginal (environmentally sensitive) lands have resulted in negative health effects due to extensive agricultural production. Changing land use over time has directly impacted these sensitive and important areas. The Clear Creek Watershed is an area located in Johnson and Iowa Counties, Iowa. This area has exhibited environmental degradation over time. This Iowa state watershed is comprised of approximately 66,000 acres, around 50% is planted in corn and soybeans annually (Clear Creek Watershed Project, 2010).

Modern agriculture has dominated the landscape in this watershed. Increased demand for ethanol from corn production has taken a toll on the overall health of this area, due to the increase of leeched agricultural chemicals and farm soil sediment washing away from field water run-off. The draining of these components leads to an increase in sediment and nitrogen concentrations in the Clear Creek water stream. *Clear Creek was once known for its pristine waters. However, over time, Clear Creek has worn down. No longer does the creek flow with the beauty that it once did. Excess sediment, nutrients and bacteria are threatening Clear Creek. Sediment from the watershed runs off the fields, delivering thousands of tons of sediment from sheet and rill erosion to the creek annually* (Clear Creek Watershed Project, 2010, para. 3,4).

This important watershed provides many positive attributes like aesthetic beauty, diverse habitat domain, and a point source of clean water for many communities and a major university. Watershed recovery and health plays

a critical role in the environmental arena. Local landowners and farmers are paramount influences in its upkeep and maintenance, and every attempt to achieve positive environmental health is vital for many reasons, both environmentally and socially. Can energy crops be utilized in environmentally sensitive lands in order to reverse environmental degradation while supplying renewable energy sources such as cellulosic ethanol?

In this research paper, I will discuss three subtopics related to the Clear Creek Watershed in Iowa. The first issue is the current environmental health "snap-shot" of the Clear Creek Watershed District in Iowa. The second issue is the ethanol presence in Iowa (that has supported continuous corn rotations) and its negative environmental impacts. Lastly, through survey feedback and quantitative research, I will analyze farmers' willingness-to-accept behavior in land use changes. The underlying research question will ultimately be; how will risk averse farmers in environmentally sensitive lands of the Clear Creek Watershed District, Iowa, respond to switchgrass production as a means to improve environmental health while providing a renewable energy crop? The answers to this research question will be influenced by landowners and farmers comprising the Clear Creek Watershed. Their responses to a 2010 Watershed Survey will help to expose the rationale of acceptance behavior concerning new land use changes and technologies. The careful and tedious construction of a master Access database will be built to encapsulate all of the survey (397) responses. A master database will enable the timely construction of question specific questions (from the survey) to be queried and further analyzed (through

a basic descriptive statistics background overview, and a specific multiple variable regression) for informative information of farmers' perceptions. The areas of interest could include (but is not limited to) the gender breakdown of the responses, age of the respondents, education level, and overall farm size in total acreage owned. These responses could then be extrapolated for researching farmers and landowners nationwide with regard to environmental policies and renewable energy acceptance.

REVIEW OF LITERATURE

The Clear Creek Watershed area was once known for clear water and healthy environmental status. Studies have been performed to measure the impact of environmental and agricultural influences on the Clear Creek area. There has been considerable landscape change in the Clear Creek area between the mid-1800's and today. "From 1840 until approximately 1900, the mosaic of prairie, forests, and wetlands that had made up the native vegetation in the watershed was rapidly converted by settlers into fields, pastures, farms, and home sites. During this time period, forest cover declined within the watershed by approximately 44%" (Clear Creek Fact Sheet, 2006). Using data from the Clear Creek Watershed 2010 Agricultural Land Survey, we will describe and examine the Clear Creek Watershed and its environment and factors in the attitudes of local farmers toward sustaining it. This survey was administered to over 900 local farmers and land owners that impact the Clear Creek directly. These owners and farmers utilize the lands that directly surround the Clear Creek and impact the creek's health.

A) Basic Facts

The Clear Creek Watershed is located in Johnson and Iowa counties in south eastern Iowa. The creek itself has been placed on Iowa's impaired waters list. "The water body is then placed on the '303(d)' list, commonly known as the 'impared waters list.' This is named after section 303(d) of the federal Clean Water Act. It means that the stream or lake needs a water quality improvement plan written. Each lake and stretch of stream or river in Iowa

is designated for a specific use, like for contact recreation such as swimming or fishing, for drinking water, or for maintaining a healthy population of fish and other aquatic life. If the water quality in the stream or lake does not allow it to meet its designated use, it does not meet Iowa's water quality standards and is considered "impared" (Iowa DNR, 2011).

The Clear Creek covers 66,142 acres. The breakdown of the land use is included in figure number four (table 1).

Table 1

CLEAR CREEK LAND USE BREAKDOWN	
	%
Corn	27.81
Soybeans	22.83
Ungrazed Grass	22.79
Deciduous Forest	7.83
CRP Grassland	5.24
Roads	3.31
Grazed Grass	3.26
Alfalfa	2.84
Commercial/Industrial	1.64
Residential	1.17
Barren	0.35
Wetland	0.25
Other Row-crops	0.24
wetland Forest	0.15
Coniferous forest	0.13
Water	0.07

(Clear Creek Watershed Project, 2010)

The amount of excess sediment washed into the Clear Creek is contributing negatively to its productivity. Adding such a high amount of extra sediment will make the land less fertile and productive over time. For example, "In May 2004, more than 239,000 tons of soil washed into Clear Creek equaling

16,000 dump truck loads of soil" (Clear Creek Watershed Project, 2010). In addition, the nutrients in the soil are threatening Clear Creek. Nitrogen and phosphorus are found in manure and chemical fertilizers. "Nutrients like this can cloud water, create low oxygen and high ammonia levels, lead to poor aquatic life diversity, and even speed up the natural aging process of the Creek" (Clear Creek Watershed Project, 2010).

Bacteria from fecal contamination is another concern for those near Clear Creek. The two largest sources of fecal contamination are failing septic systems and livestock (Clear Creek Watershed Project, 2010). Local towns such as Tiffin and Coralville have access to the streams. There is concern about E Coli bacteria in North Branch, a tributary to the Clear Creek.

B) Ethanol/Environment

Ethanol is a corn-based alcohol. It is added to fuel as a gasoline alternative. The positive side of ethanol is that it is a more cleanly burning material than gasoline. The negative side of ethanol is it is a less efficient type of fuel than regular gasoline. The typical fuel to ethanol additive ratio is E85. In this fuel mixture, 85% of the fuel is ethanol and the remaining 15% is gasoline. The three types of ethanol production are created by dry milling, wet milling, and cellulosic ethanol from biomass. The method most commonly used is the dry milling for North American automotive usage. "Cellulosic biomass production is still being researched, but it is expected to be the most energy efficient and cost efficient method if it reaches mass production" (Ethanol Creation, 2011).

Ethanol production in Iowa is increasing steadily. According to a 2001 study, "Recent price signals for ethanol capacity expansion have been very strong. At average margins and costs for the 2000/2001 agricultural marketing year, the payback period for an ethanol plant investment is easily less than two years. Investors should bear in mind, however, that the processing margin in a competitive market returns to the level that can be secured in investments elsewhere in the economy. Five-year, ten-year, and fifteen-year payback periods will return when the market catches up to the new ethanol demand" (Otto & Gallagher, 2001). These statements show that early predictions regarding future ethanol production were that returns would be strong, and incentives were there. At that time, there were less than half the number of production ethanol plants there are today. In 2001, the level of ethanol consumption in Iowa was 405 million gallons. In 2010, Iowa produced 3.5 billion gallons. These production reports show an upward trend in corn demand and ethanol usage over time (Otto & Gallagher, 2001; IFRA, 2011). With the proper price on corn and ethanol subsidies, it stands to reason that ethanol production will only increase.

Due to increasing corn prices, a trend we are seeing in the Midwest--and Iowa in particular--land use is favoring repeated corn plantings instead of crop rotation (such as corn and soybeans in yearly rotations). The major reason for this change is the increase in corn prices and upward demand of ethanol from corn.

A study performed in 2010 in Iowa "looked at the land use impact of the biofuels expansion on both the intensive and extensive margin, and its

environmental consequences" (Secchi et al., 2010). The present land changes in Iowa are the reason Iowa has become a leading biofuel producer. Two types of land were studied: land that is currently cropped and land currently out of agricultural production (CRP or "Conservation Reserve Production" land)(Secchi et al., 2010). Fertilizer application rates, production budgets, and soil models were all used in the study. The results of the study show that "for the most productive land it becomes increasingly profitable to move towards more corn production as corn prices increase" (Secchi et al., 2010).

Environmental concerns weigh heavily on decisions for land usage. "Flooding, upland soil and stream band erosion, sedimentation, and contamination of water from agricultural chemicals are critical environmental, social, and economic problems in Illinois and other states of the U. S. and throughout the world (Borah & Bera, 2003). Corn places stress on the land on which it is planted. It is a very rigorous and intense crop to produce. "Corn production uses more herbicides and insecticides than any other crop produced in the U.S., thereby causing more water pollution than any other production crop" (Pimentel & Patzek, 2005). The increasing ethanol production, in turn, increases air and water pollution (air pollution from fossil fuel and ethanol burning). Factors such as these support the conclusion "the U.S. corn production system is not environmentally sustainable now or in the future, unless major changes are made in the cultivation" (Pimentel & Patzek, 2005) of corn.

C) What Can Be Done To Help?

In Clear Creek, landowners will need to employ conservation practices in order to return the watershed to desirable status. The combination of appropriate environmentally favorable attitudes will be needed to reclaim the pristine waters and diverse habitat that the watershed can once again achieve. There are many ways to achieve this goal. There are many ways to enhance Clear Creek by employing conservation practices in the area. Examples are: no-till practices, land use alternatives, livestock management, grade stabilization structures, wetlands, buffers/filters, nutrient management (Clear Creek Watershed Project, 2010).

- One way is to increase water quality by increasing the amount of forest cover in the Clear Creek area. The area's forest cover has nearly doubles in the last century. "The remnant natural areas may contain critical components of biodiversity today" (Clear Creek Watershed: 150 Years of Landscape Change, 2006).

- No-till practices can be used to protect the soil against erosion. After the crop is harvested, the remnants are left to cover the ground. Nutrients are held in the soil by the materials left on top of them.

- The access of livestock to streams (banks) can be limited. Moving the livestock to new grazing spots will help as well.

- Grass buffers can protect the soil (from water/wind runoff).

- Grass waterways and gullies can be used to slow down erosion.

- Nutrient management is vital to the health of the soil and water in the Clear Creek area. By being conservative with use of fertilizers (and other

agricultural chemicals), cost is reduced for farmers as well.

- Alternative land uses could help solve problems in the area as well. The planting of switchgrass as an alternative to corn could possibly stabilize the health of the district as well as provide income for farmers as cellulosic ethanol is becoming viable. "Switchgrass is a high yielding (about 13.5-17.9 Mg Ha^{-1} or 6-8 short tons ac^{-1} in the Southeastern U.S.), warm season perennial grass that can grow to more than 2.75 m in height and be supported by a vigorous root system extending to depths of up to 3 m. As a natural component of the tall-grass prairie that covered most of the Great Plains and much of the southern United States, Switchgrass is well-adapted to grow in a large portion of the United States with low fertilizer applications and high resistance to naturally occurring pests and diseases" (Jensen et al., 2007 p. 773).

In addition, switchgrass has many potential economic benefits. "The large-scale production of switchgrass could also promote economic growth in rural areas, increase returns to agricultural producers, and decrease farm expenditures" (Jensen et al., 2007).

D) Willingness To Accept

Bearing in mind the previously mentioned benefits of planting switchgrass, the next portion of the paper will discuss the attitudes of farmers toward planting switchgrass (for both economic gain and environmental benefits through conservation).

Farmers' knowledge about the switchgrass crop is a key component of determining their willingness to grow (accept) it. For example, "farmer awareness or perception of soil problems is frequently found to positively correlate with the adoption of soil conservation practices" (Knowler & Bradshaw, 2006). Switchgrass production can be seen as a conservational approach to agriculture.

Improving or enhancing regional environmental quality is attractive to farmers because of the win-win benefits for all (if good economically and environmentally). Increased biofuel production is another example of a win-win benefit. "Increased biofuel production depends on technological advancement, expanded infrastructure, facilitory policy, and market accessibility, but it is also heavily reliant on farmers' farm-level decisions" (Tyndall et al., 2010). These decisions will on the management side of production agriculture as different equipment and planting knowledge and skills will shape the effective transition to a long term switchgrass production. Many prior work indicate that overall farmer knowledge will be a key to switchgrass acceptance and success.

With any change, there is risk involved. Farm size plays into a farmer's willingness to try planting switchgrass. "The marginal risk effects of modern variable inputs are shown to be crucial in determining tendencies for adoption intensities by farm size" (Just & Zilberman, 1983).

The economic risk for farmers will need to be offset by subsidies whenever possible. Most farmers are unwilling to assume the risk involved without this cushion. "These subsidies would have to be directly targeted at

biomass production rather that ethanol production or biofuel production because new ethanol production subsidies would simply increase the demand for corn, not switchgrass, despite the potentially significant environmental advantages of expanded switchgrass production" (Babcock et al., 2007 p. 9). This is in contrast to earlier economic studies that support the idea that switchgrass could be an important and competitive factor in production agriculture (important due to its positive environmental impact and its carbon sequestration effect throughout the United States) (McLaughlin et al., 2002).

Although farmers and producers ultimately fall into one category of risk management, risk adverse, the three areas of risk management are covered next. The risk-averse producer will want to continue to manage their respective operation by lowering their overall risk in terms of present and future production and growth. The start-up and utilization of a perennial wild grass such as switchgrass will be meet with early skepticism. New equipment (technology), harvest schedule change, transportation and storage problems will need to be created, improved, and utilized smartly over time. The other two types of producers will possibly be candidates for switchgrass agriculture. The risk neutral producer will look for subsidies that will offset any potential (early) economic loss, the risk factor is not a final decision point in the acceptance of a new technology (switchgrass). The risk taker will see that a new and growing renewable energy source market is worth the participation. The early higher risks are not meet with such criticism and possible subsidies are worth the initial endeavor. The above is background information to show the true spectrum of the behaviors of people

who own land and farm could behave. However, it is stressed that all farmers will

always be risk adverse as they all will want to operate by reducing risk and

maximizing profit.

VISITING CLEAR CREEK, SUMMER 2010

Over the winter of 2009-2010, the Clear Creek Watershed survey was sent out to 991 landowners. Over the summer of 2010, 397 were collected and added into an Access Database that will allow the use of simple and cross queries that the completed surveys will represent.

On June 7th and 8th, the initial 246 surveys were scrutinized with Caroline and Dr. Secchi. This meeting allowed us to accurately interpret the surveys and to develop an Access Database that would better fit the survey responses.

Over the duration of the summer, I supervised the database completion as well as executing the quality checks and clean-up of the Master Access Database. Each survey entered contained 62 main questions (with many main questions containing multiple sub-questions); thus, accuracy of the data entrance was very important. The first round of the surveys (246 total surveys) were completed before the 4th of July. Then a trip to Iowa City, Iowa was organized in order to return the original 246 surveys and to collect the second round of surveys--135 total in the second batch. This trip was taken over the time frame of July 21st through the 23rd.

We had free time to fully explore the Clear Creek Watershed and its surrounding rural area. We spent hours driving and walking around random spots in order to interpret how the landscape of farming and livestock attributes will affect the watershed. I noticed that while driving around the countryside and

paying close attention to actual farm setups, the farmers behaviors supported not only a need for grain farming that utilized the landscape, but the farmers also incorporated livestock production into the managing of the landscape. Perhaps this one-two approach to land use and capital investment would ultimately help farmers profit maximize. A good example of this was the dominating presence of fence rows that encapsulated large tracts of lands--i.e. fields and pasture lands. It was amazing to see that fences around fields was a common theme as opposed to Central Illinois in which fences are mostly utilized for land space dedicated to (year around) livestock production (such as large pastures--the largest fields in Central Illinois do not support fencing). This capital investment of fence rows seem to support livestock placement after harvest--a good way for farmers to feed livestock on land that is not being produced in grains--like over winter periods. While also driving in this area, alfalfa is more common than wheat which surprised me a bit. This, too, is an indication that the presence of livestock in the Clear Creek Watershed should be considered when environmental impact is being scrutinized, because livestock is prevalent here.

RESEARCH QUESTION

The health of the Clear Creek Watershed in Iowa has been degraded overtime due to the influence of urban expansion and production agriculture. Landscape changes to the surrounding area of the creek will need to incorporate a conservational type of soil and land management in order to reclaim the once pristine nature of the Clear Creek. Based off of survey feedback and economic data, will the farmers and land owners of the Clear Creek area accept incorporating such practices (or technologies) in order to stop environmental degradation? More specifically: are the farmers willing to accept producing switchgrass in order to help improve the Clear Creek Watershed environment? Survey feedback and economic analysis will show if the farmers are willing to plant switchgrass in order to produce a renewable biofuel source and help the Clear Creek Watershed area. The variables of age, education level, and farm size will be the factors that will be tested (in terms of their influence) on the willingness to accept switchgrass production. This analysis will be very site sensitive as it will incorporate only the land area specific to the Clear Creek.

DATA AND METHODS

A 2010 agricultural land survey was sent out to the during the winter of 2009/2010. The total number of mailed surveys was 991 and the survey consisted of 62 question (with many that had multiple sub questions). Over the course of many months, the total completed and returned surveys reached 397. This gave us a survey response rate of ~41% which is a standard response rate in many surveys. The format of the survey was 13 pages with a final page for comments. Questions were placed into sub categories that would be used to help shape farmers and landowners overall background. The breakdown is listed below:

- Personal Information
- Watershed Conservation
- Information Sources
- Farm Characteristics
- On Farm Conservation Practices
- Growing Crops For Biofuels

The categories listed above will contribute to a general background of descriptive statistics that will cover some attributes of the survey takers. Gender, age, and other variables (independent) will be analyzed further in order to breakdown into groups (for further descriptive and regression statistics analysis) the varying characteristics of farmers from this survey (of the 397 total surveys received, there are 170 farmers who answered "Yes" to question 3 of the survey, question 3 asked "Do you consider yourself a farmer?" yes or no). The

"growing crops for biofuels" had sub categories that consist of the harvesting process of biomass, the marketing process, costs and benefits of biomass production, available equipment, and biomass production/environmental issues. This particular area will be used in order to access and analyze the economic portion of the farmers willingness to accept switchgrass production through a multiple regression (supplied by the use of the master Access database).

A) Background Survey Statistics

The background descriptive statistics from the survey will encompass two areas or themes. The first theme will look at the gender (Q3) of all of the 170 farmers of the survey. The second theme will look into the three independent variables that will also be further scrutinized by a multiple regression. The three variables are age, education level, and the farm size of the 170 farmers. Also noted, the term willingness to accept (WA) will always be gauged by farmers who answered the WA questions with a positive (0>) dollar amount. This premise will be consistent thought out the methods and data.

The breakdown for the willingness to accept (WA) corn stover (alone in query from the survey) and switchgrass (alone in query from the survey) and the willingness to accept corn stover (CS) and switchgrass (SG) (both questions queried from the survey and analyzed together) were constructed from the survey data collected and located in the Access database. The three queries (from above) were queried from the data and individually exported to Excel spreadsheet file. The three Access query sequences are listed below, starting with the Gender query for corn stover:

- Q2 Gender

- Q3 Farmer (Yes or No)

- Q48 Willingness to Accept (WA) and Not Willingness to Accept (NWA)

    The switchgrass query is:

- Q2 Gender

- Q3 Farmer (Yes or No)

- Q56 Willingness to Accept (WA) and Not Willingness to Accept (NWA)

    The corn stover and switchgrass query is:

- Q2 Gender

- Q3 Farmer (Yes or No)

- Q48 Willingness to Accept (WA) and Not Willingness to Accept (NWA)

- Q56 Willingness to Accept (WA) and Not Willingness to Accept (NWA)

    i)   This query will only include farmers WA both CS and SG

        The three individual queries were transferred to an Excel file and the data responses were cleaned up. Missing responses and data gaps were deleted from the three queries so that consistent and full data statistical analysis would be accurate across the board of question/responses.

        The first two individual queries are analyzed first using descriptive statistics. Looking at the willingness to accept corn stover (WA CS) by itself and the willingness to accept switchgrass (WA SG) by itself in the mean standard yielded a double-effect in that for both female and male farmers, a higher profit was needed for the WA of switchgrass over the WA corn stover. The average WA for both male and female producers was about twice as high for switchgrass

over corn stover. This doubling shows that there is a higher need for profit in switchgrass over the corn stover profit. Also comparing males to females, on average the means of the WA for females in regards to CS and SG is higher than the male farmers' WA of CS and SG (take into account that CS and SG are both individual queries). A quick look at the WA tables show that the WA profit level for CS is generally half of SG profit levels, and female (farmers) tend to maintain higher WA levels (in needed profit margins) over male (farmers) WA (again this if for CS and SG individual queries). The above analysis and figures are representative of doing individual queries for corn stover and switchgrass. See tables 2-5.

Table 2

Female WA Corn Stover	Q48
Mean	142.188
Standard Error	59.657
Median	50
Mode	50
Standard Deviation	238.628
Sample Variance	56943.2
Kurtosis	12.9664
Skewness	3.4896
Range	980
Minimum	20
Maximum	1000
Sum	2275
Count	16

Table 3

Male WA Corn Stover	Q48
Mean	100.046
Standard Error	12.5487
Median	60
Mode	50
Standard Deviation	83.2388
Sample Variance	6928.7
Kurtosis	2.80377
Skewness	1.54717
Range	390
Minimum	10
Maximum	400
Sum	4402
Count	44

Table 4

WA Female Switchgrass	Q56
Mean	251.563
Standard Error	57.2125
Median	200
Mode	100
Standard Deviation	228.85
Sample Variance	52372.4
Kurtosis	7.98525
Skewness	2.60131
Range	950
Minimum	50
Maximum	1000
Sum	4025
Count	16

Table 5

WA Male Switchgrass	Q56
Mean	207.692
Standard Error	17.2462
Median	200
Mode	200
Standard Deviation	107.702
Sample Variance	11599.8
Kurtosis	0.13886
Skewness	0.75814
Range	450
Minimum	50
Maximum	500
Sum	8100
Count	39

Tables 2-5 also show other interesting figures in that mode is roughly a double-effect from CS to SG for the tables and the sum (total) exhibits the rough double effect as well. The total number of farmers that expressed a positive dollar amount of the WA of CS and SG for female was 16 (farmers) for each, and the total number of farmers that expressed a positive dollar amount of the WA of CS for males was 44 (farmers) and the male WA for SG was 39 (farmers). The male farmers had a higher WA level (in numbers) than the female farmers (for SG query and CS query).

The final individual query was selecting farmers who were willing to accept (WA) CS and SG together (these farmers supplied a WA to CS and SG by survey response, as opposed to the first two queries that looked at all of the farmers who were WA CS and SG individually). This query will focus in on a smaller amount of farmers (in both females and males), however, this will be a gauge in the mind set of farmers who would accept more than one type of

renewable biofuel sources. The analysis of the descriptive statistics shows similar patterns to the first two individual queries (from the figures in Tables 1-4). The mean WA of females is generally higher for CS/SG than the males WA. The rough double-effect that the WA of SG over CS WA for females and males is also present. The total number of farmers that expressed a positive dollar amount of the WA of females for both CS/SG was 11 (farmers), while the male farmers was almost triple at 31 (farmers) males had a WA both CS/SG. In all of the gender analysis, male responses had higher numbers, but females needed a higher profit level. See Tables 6-9.

Table 6

WA Female	Q48
Mean	164.546
Standard Error	86.4383
Median	50
Mode	50
Standard Deviation	286.683
Sample Variance	82187.3
Kurtosis	9.10447
Skewness	2.95555
Range	980
Minimum	20
Maximum	1000
Sum	1810
Count	11

Table 7

WA Female	Q56
Mean	259.091
Standard Error	77.6994
Median	200
Mode	250
Standard Deviation	257.7
Sample Variance	66409.1
Kurtosis	8.50004
Skewness	2.77017
Range	950
Minimum	50
Maximum	1000
Sum	2850
Count	11

Table 8

WA Male	Q48
Mean	99.2581
Standard Error	16.0942
Median	60
Mode	50
Standard Deviation	89.6088
Sample Variance	8029.73
Kurtosis	3.32581
Skewness	1.75246
Range	390
Minimum	10
Maximum	400
Sum	3077
Count	31

Table 9

WA Male	Q56
Mean	193.71
Standard Error	17.2536
Median	180
Mode	200
Standard Deviation	96.0639
Sample Variance	9228.28
Kurtosis	0.12992
Skewness	0.80261
Range	350
Minimum	50
Maximum	400
Sum	6005
Count	31

The second theme will delve into the descriptive statistical analysis of the three individual variables (later used in the regression analysis) of age, education level, and farm size. The Age (Q1) only included answers above 0 for the construction of all three stats tables. The Education Level (Q4) was based on a education level scale of 1-6. Only answers of 1 through 6 was accepted for the construction of the stats tables. Below is the classification of the Education Levels:

Education Level Number Classification:

1   Some High School or Less

2   High School Diploma (include GED)

3   Vocational or Technical Diploma/Certificate

4   Some College but no Bachelor's Degree

5   B.A., B.S., or Equivalent

6   Graduate Degree, Master's, Ph.D., M.D., etc.

The Farm Size (Q18a) only included farm ownership of above 0 for the

stats tables. These independent variables (above) were exported to Excel and

the descriptive statistics for each set of queries (3 tables) were conducted using

the above criteria and utilizing Excel functions. All three tables showcase

differences between the WA farmers in each scenario (query) to the NWA

farmers. Further inspection and analysis of the descriptive statistics can compare

and contrast the three groups of farmers in regards to biofuel collection. The

queries of the WA CS, WA SG, and the WA CS/SG will incorporate the three

independent variables (X) that will be utilized in the final regression of the

research paper. The variables of age, education level, and farm size (measured

in acres) will be analyzed from the above thee queries that were ran in the

master Access database. All of the three queries will be broken down into the

WA, and the NWA categories, and be further analyzed.

First is the corn stover query (CS is individually targeted):

- Q1 Age

- Q3 Farmer (Only Yes, 170 total yes farmers)

- Q4 Education Level

- Q18a Farm Size

- Q48 Willingness to Accept (**WA**) **and** Not Willing to Accept (**NWA**)

The age of the CS WA and NWA yielded 57 farmers who were WA

, and 108 farmers who were NWA. The Clear Creek survey data showed that the

mean, median, and mode of the NWA was higher and that the WA CS farmers

were typically younger farmers. The education level variable for the CS query showed that the median value for education was some college for the WA farmers, as opposed to high school graduates for the NWA. The mode for this query, however, showed that both WA and NWA were educated at the high school diploma level. There might be a weaker argument that the WA farmers had obtained a higher level of education, but based on the mode, high school graduates were the most common education level of both WA and NWA producers. In the education levels across the board, WA farmers were 61, while the NWA farmers accounted for 108 farmers. Again, NWA farmers were higher in numbers than the WA farmers. The farm size variable ended up with 53 WA farmers as opposed to 87 NWA farmers (this was the smallest gap of the three variables). The mean, median, and mode for the WA farmers was higher than the NWA farmers. This suggests that larger farms (in acreage owned) are more willing to accept corn stover harvesting for renewable energy production (see Table 11in appendix).

The switchgrass query is the second query (SG is individually selected):

- Q1 Age
- Q3 Farmer (Only Yes, 170 total yes farmers)
- Q4 Education Level
- Q18a Farm Size
- Q56 Willingness to Accept (**WA**) **and** Not Willing to Accept (**NWA**)

The next query for SG yielded similar results as the CS query. The age variable showed that the mean, median, and mode for the NWA farmers was higher than the WA farmers. This variable had 53 WA farmers, while the NWA farmers were 112 overall. The education level based on the mode, concluded that there is no education level difference between the WA farmers and the NWA farmers. Across the board, high school diploma was the highest occurring education level for WA and NWA farmers. The WA farmers was 56 while the NWA farmers were 113 for the education level variable. the final variable, farm size, yielded 49 WA farmers as opposed to 91 NWA farmers. These higher differences for the NWA farmers over the WA farmers (in comparing the numbers) is the same across the board, just like the CS query resulted in. The mean status (in acreage size) for the WA farmers is higher than the NWA farmers. This suggests that larger farms (in acreage ownership) would be more likely to WA SG over the smaller farms (in size comparison)(see Table 12 in appendix).

The CS and SG query (both CS and SG are selected):

- Q1 Age

- Q3 Farmer (Only Yes, 170 total yes farmers)

- Q4 Education Level

- Q18a Farm Size

- Q48 Willingness to Accept (**WA**) **and** Not Willing to Accept (**NWA**)

- Q56 Willingness to Accept (**WA**) **and** Not Willing to Accept (**NWA**)

i) This query will only include farmers who accepted both Stover and Switchgrass

ii) For the Not Willing to Accept, both Stover AND Switchgrass were not accepted

iii) The total WA + NWA was 139 farmers

The last query contained both CS and SG together. The same WA and NWA breakdown into two categories will be analyzed, based off of the same three variables. The age variable showed that again, younger farmers based off of the median age were more WA over the older NWA farmers. The WA (those farmers who had a positive dollar amount for the willingness to accept) of farmers was 40 (farmers) as opposed to the higher total of 95 (those farmers who had a positive dollar amount for the willingness to accept) NWA farmers. The education level shows that the consistent high school diploma level is a commonplace theme for the categories of WA and NWA based off of the mode (the high school education level is consistent throughout the entire study). The education level shows that there are 43 WA farmers and 95 NWA farmers. The final variable, farm size, had 37 WA farmers and 75 NWA farmers (which for all three queries, WA numbers were lower than the NWA farmers in total numbers). The mean, median, and mode was higher for the WA farmers across the board. This result shows that perhaps the largest farms are more WA biofuel production than the smaller farms (see Table 13 in appendix).

B) Regression Statistics

To answer the research question listed above, a simple multiple regression will be set up and utilized for the statistical analysis of the interested survey depended variable, which is the farmers' willingness to accept switchgrass (measure in term of dollar value). This multiple regression model taken from the survey is: WILLINGNESS-TO-ACCEPT SWITCHGRASS= β_0 + β_1AGE + β_2EDUCATIONLEVEL + β_3FARMSIZE+noise

Where:

- WILLINGNESS-TO-ACCEPT SWITCHGRASS is question #56 of the Clear Creek Watershed 2010 Agricultural Land Survey

- β_1AGE is question #1 of the Clear Creek Watershed 2010 Agricultural Land Survey

- β_2EDUCATIONLEVEL is question #4 of the Clear Creek Watershed 2010 Agricultural Land Survey

- β_3FARMSIZE is question # 18a of the Clear Creek Watershed 2010 Agricultural Land Survey

The initial surveys (397 received) were entered into a Master Access Database that was created in the summer of 2010. This database allowed for running effective searches (queries) and finding multiple survey answers that could be used to analyze any aspect of the 62 questions that were present in the survey. The question that narrowed down our economic approach to accepting switchgrass was always question #3, which established if the survey taker was a farmer (Do you consider yourself a farmer, yes or no). Only "farmers" were used in the final research question since they would be truly beholden to

the upkeep and care of the land (in many survey cases, farmers were usually the true landowners as well).

The breakdown of the regression is the willingness to accept switchgrass (What is the minimum net profit per acre you would need to get in order to consider growing switchgrass) is the dependent (Y) variable. The independent (X) variables that could impact the Y variable are: Age (What is your current age), Education Level (What is the highest grade or level of education that you have completed), and Farm Size (Total number of acres you owned in 2009). The final query of "farmers" who answered the willingness to accept switchgrass (#56>0) were narrowed down to a sample size of 35 (n=35). The queried questions were cleaned up by deleting any survey answer that was 0 or -99 (which is a blank-unanswered question), by each Y and X variable. This lead to 35 final observations from the all of the received (397) surveys.

RESULTS

The overall goodness of fit measure (Regression Statistics) for this regression is weak, the Multiple R value is low at 0.227, and the R square is 0.051. Looking at the ANOVA, none of the X variables (the predictor variables) are significant at the 0.05 alpha level (see Table 10 in appendix). The closest variable to the 0.05 alpha level was the Education Level, but education level still had a high 0.34 P value (which rendered it not significant). The education level (X independent variable) has a negative relationship with the willingness to accept level. If willingness to accept goes up (in $), education level will fall. However, all three predictors had little effect on the dollar amounts collected from question #56 (the goodness of fit was weak). The regression of the willingness to accept switchgrass was not strongly impacted or effected by the influences of the farmers' age, education level, or farm size.

The survey response rate could have impacted the overall weakness of the predictor values as only 35 (n=35) out of the returned and completed 397 Clear Creek surveys were used in this study (35 answered all of the queried questions that allowed for a uniform regression). This accounted for only 8.82% of the received 397 completed surveys. Overall, this equates to only 3.53% response rate of the 991 total surveys that were sent out to all of the Clear Creek Watershed farmers and/or landowners that surround the watershed. A low response rate for this specific question could greatly alter or under-represent the true sentiment of the farmers and landowners of the Clear Creek.

DISCUSSION

A focused look at the regression lead to a quick 'knee-jerk' reaction that a week overall relationship of the independent variables connection to the dependent variable. This regression showed that the willingness to accept switchgrass was impacted little by age, education, and farm size. However, to counter-balance this narrowly focused and highly selective regression, the broad descriptive statistics (the background statistics in the data section) of the 170 farmers' biofuels behaviors paints a different (willingness to accept both corn stover and switchgrass biofuels) picture. This descriptive analysis has themes that can lead the direction of biofuel acceptance. There are other works that sought out insight for the same or similar willingness to accept biofuel feedstock (like corn stover or switchgrass) that can used to fundamentally move this discussion forward in a productive manner.

Jensen, et al. showed that a large survey (3000+ responses of Tennessee farmers) yielded a 30% acceptance for the switchgrass production as a means to improve the environment and provide biofuel production (if it is profitable). This specific survey collected evidence that farmers are aware of biomass production and emission control in terms and the positive effects biomass production could have (switchgrass is not well known in the farming community). The problem with switchgrass for Jensen, et al. and the survey concluded that "technical assistance" will be a driving force for helping switchgrass production (example: proper market infrastructures). Jensen also concluded that such factors as net farm income producers would set aside a

small amount of land for switchgrass, and off-farm income earners would also convert land to switchgrass production. A negative relationship of farm size and acceptance exists within their survey (as opposed to this research regression which showed a weak correlation of farm size to switchgrass production). However, the descriptive statistics concluded that larger farms (in acreage ownership) were more willing to accept biomass production over smaller farms. The other influences of the Jensen, et al. survey on willingness to accept were marketing development, contracts use, harvest limitations and CRP. Influences that were not an issue (to the farmers in terms of acceptance) were, subsidization and government payments (Jensen).

Other works like Tyndall, et al. had a different approach to biomass acceptance focused on Iowa farmers and the harvesting of corn stover for ethanol production. They concluded similar results (studies site a low acceptance of biomass harvesting) to switchgrass acceptance and the Jensen study. A 17% acceptance rate was concluded in their paper (for harvesting corn stover). This study found that perhaps younger farmers too would be more willing to accept biomass production, and larger farmers were more accepting of biomass harvesting. These two factors were mirrored by the survey feedback of the Clear Creek Watershed Survey. Tyndall, et al. listed a few points that outline what impact farmers and also could help improve the current biomass to energy scene:

- Farmer education programs about biomass production
- Farmer participation in ownership of a local biorefiney (owning shares)

- Evolving policy on risk management
- U. S. farm bill can expand/promote biofuel usage.

These recommendations showcase their specific study of the Iowa farmers in regards to harvesting corn stover for ethanol production (Tyndall).

My opinion in the willingness to accept switchgrass is that in the short run, factors like machinery cost and lack of knowledge will thwart off any initial interest, but these factors can possibly be developed for the long run. Switchgrass has been a presence in the Midwest for quite some time, but several issues that will need costly (start up and maintenance) implementation will make planting switchgrass slow (in acreage conversion for biofuel). Farmers understanding and utilization of a perennial (vice annually planted and harvested crop like corn) grass is a long term investment. A stand of switchgrass converted in acreage will need to be devoted for many years to fully utilized biomass production and collection (for renewable energy reasons). The collection, storage and transportation to a local refinery in true cost will add to the renewable energy (biomass) debate, and I feel that many producers will have a wide range of early on concern for its long term purpose and prosperity. The study by Babcock, et al. stated a relevant concern as "few farmers will choose to change to switchgrass without new subsidies". Babcock goes on to say "these subsidies would have to be directly targeted at biomass production rather than ethanol production because new ethanol production subsidies would simply increase the demand for corn, not switchgrass". This subsidy policy would need to define precisely what types of land (farm land included) are eligible for assistance. The Clear Creek

Watershed would be a great example of how sensitive land will need to be further scrutinized in terms of a properly placed subsidy payment system (an expensive subsidy system could narrow its policy implementation and reach to only environmentally sensitive land, this could lower over subsidization of taking good cropland out of food production).

The entire study area of the acceptance and utilization of biomass for renewable energy source will continue to grow over time. More research will need to be conducted and change over time as the needs and education of the farmers and landowners will progress and change over time.

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APPENDICES

APPENDIX

The data for this regression was collected and queried in Access

Database. These variables (X and Y) were then copied and placed in Excel so a

regression could be run. Of all of the queried willingness to accept answers

(Q56), only 35 answered all of the queried questions (Age, Education Level,

Farm Size, and Willingness-To-Accept). These 35 will make up the sample size

of this study (n=35).

Table 10
SUMMARY
OUTPUT

Regression Statistics	
Multiple R	0.227225
R Square	0.051631
Adjusted R Square	-0.04015
Standard Error	163.762
Observations	35

ANOVA

	df	SS	MS	F	Significance F
Regression	3	45260.92	15086.97	0.562569	0.643757
Residual	31	831357.7	26817.99		
Total	34	876618.6			

	Coefficients	Standard Error	t Stat	P-value
Intercept	250.1984	151.6545	1.649792	0.109083
Age	0.34657	2.288968	0.151409	0.880634
Education Level	-19.3218	19.74231	-0.9787	0.335305
Farm Size	0.022675	0.043068	0.52649	0.602295

Figure 1 U.S. Ethanol Plants

http://www.esri.com/
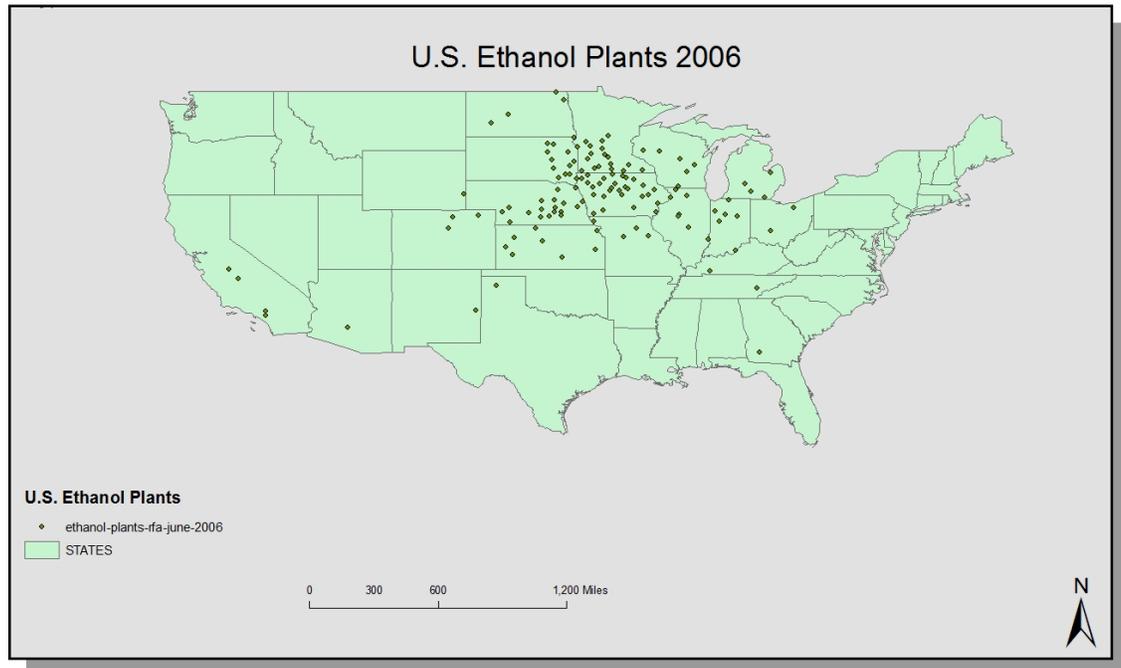
Map made by Kent Rupp 2011. GIS Data taken from 2006 ESRI

This map was made using ArcMap Software and GIS Data. It shows that

the ethanol industry is heavily found in Iowa

Table 11 Corn stover WA and NWA Descriptive Statistics

Descriptive Statistics	Age		Education		Farm Size	
	WA	NWA	WA	NWA	WA	NWA
Mean	57.5088	65.2407	3.62295	2.93519	412.717	184.402
Standard Error	1.81992	1.34579	0.19158	0.14002	82.6286	15.3349
Median	58	67	4	2	180	160
Mode	63	79	2	2	120	80
Standard Deviation	13.7401	13.9859	1.49626	1.45508	601.545	143.035
Sample Variance	188.79	195.605	2.2388	2.11726	361857	20458.9
Kurtosis	-0.674	0.61236	-1.455	-0.6011	8.71425	1.26472
Skewness	-0.2279	-0.6631	0.21715	0.78223	2.88012	1.14951
Range	56	71	4	5	2984	695
Minimum	27	25	2	1	16	5
Maximum	83	96	6	6	3000	700
Sum	3278	7046	221	317	21874	16043
Count	57	108	61	108	53	87

Table 12 Switchgrass WA and NWA Descriptive Statistics

Descriptive Statistics	Age		Education		Farm Size	
	WA	NWA	WA	NWA	WA	NWA
Mean	54.7358	66.2768	3.75	2.90265	384.714	209.516
Standard Error	1.91153	1.23203	0.19281	0.13711	89.354	17.5987
Median	55	68	4	2	145	170
Mode	63	66	2	2	120	80
Standard Deviation	13.9162	13.0385	1.44285	1.45752	625.478	167.88
Sample Variance	193.66	170.004	2.08182	2.12437	391223	28183.9
Kurtosis	-0.7824	0.83259	-1.4135	-0.4951	8.49042	1.8172
Skewness	-0.1589	-0.6315	0.08003	0.85891	2.90497	1.37398
Range	57	71	4	5	2985	795
Minimum	26	25	2	1	15	5
Maximum	83	96	6	6	3000	800
Sum	2901	7423	210	328	18851	19066
Count	53	112	56	113	49	91

Table 13 Both CS and SG WA and NWA Descriptive Statistics

Descriptive Statistics	Age		Education		Farm Size	
	WA	NWA	WA	NWA	WA	NWA
Mean	56.65	67.4842	3.74419	2.82105	467.649	193.267
Standard Error	2.17961	1.29153	0.21845	0.14508	114.842	16.6816
Median	57	69	4	2	180	170
Mode	63	79	2	2	120	80
Standard Deviation	13.7851	12.5883	1.4325	1.41406	698.555	144.467
Sample Variance	190.028	158.465	2.05205	1.99955	487979	20870.6
Kurtosis	-1.1021	0.94327	-1.4068	-0.3114	5.75189	1.29367
Skewness	-0.098	-0.64	0.06679	0.90107	2.4677	1.14632
Range	49	71	4	5	2984	695
Minimum	34	25	2	1	16	5
Maximum	83	96	6	6	3000	700
Sum	2266	6411	161	268	17303	14495
Count	40	95	43	95	37	75

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