EASTERN KENTUCKY FARMER’S WILLINGNESS TO GROW BIOMASS
FOR ENERGY PRODUCTION

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by
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Accepted by the faculty of the College of Science and Technology, Morehead State University, in partial fulfillment of the requirements for the Master of Science degree.

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May 3, 2013

Date
It is clear that agricultural producers across America and especially Kentucky are going to have to change farming practices to meet 21st Century needs. By 2025, Kentucky’s goal is to derive 12 percent of its motor fuels demand of 775 million gallons per year from biofuels. This represents approximately 20 percent of Kentucky’s current fuel needs (Beshear, 2008). However, one area that has potential to expand in the Appalachian region of Kentucky and the surrounding states is the production of biomass. Biomass has numerous potential uses in the bioenergy area for the production of ethanol or as a heat source.

There are hurdles impeding the further development of biomass production in Kentucky. The most significant hurdle being the lack of infrastructure needed to
transport and process biomass. This problem is currently being addressed through a number of avenues both governmental and private. The primary focus of this paper is assessing the understanding of agricultural producers of biomass production, processing, and willingness to produce biomass. A survey was created to ascertain the willingness of Kentucky farmers to diversify their crop production to include biomass products to counteract the decline of fossil fuels. One key question asks are you willing to produce biomass and the rest are demographic questions and questions meant to elicit their knowledge and interest in biomass and bioenergy production.

Preliminary data used to determine the number of producers in the 48 counties east of I-75 was collected from the 2007 Census of Agriculture. In Kentucky, there are approximately 55,500 farms that are 50 acres or larger. Approximately 16,500 of these farms are located in the 48 counties east of I-75. With the help of Kentucky office of National Agricultural Statistics Service a stratified random sample of these 16,500 was selected. The total sample size surveyed was 1,000.

Of the 1,000 producers surveyed 226 were returned with usable data gained from 198 of said responses from 42 of the 48 counties. There was 19.8 percent return rate with the usable responses. Responses indicate the average number of years owning agricultural land in Kentucky is 29.98 years. Eighty of the responses indicate that the producers would be willing to grow biomass for energy. Of the respondents 165 were male and 28 stated being female.
Under the current market conditions only 80 of the 198 (39.4 percent) are willing to produce biomass for the production of bioenergy. A number of reasons exist to explain why operators would select to participate in biomass production. These reasons include wishing to diversify their farm portfolio and bringing fallow land back into production or utilizing under-performing land. It is important to understand the reasons why operators make this choice as environmental regulations continue to constrain fossil fuels and renewable energies grow in the market share of the United States energy portfolio.

For the development of a sustainable bioenergy energy economy in Kentucky, a baseline of producers’ knowledge of bioenergy crops and concerns must be established. Without an understanding of the producers’ current knowledge base, potential bioenergy producers, extension educators, rural development specialists, and other stakeholders will not know where to focus efforts to foster the development of these industries. Furthermore, many of the producers in this region of the state are older, potentially increasing the difficulty of developing a bioenergy economy for this region.

Accepted by: [Signature]

[Name], Chair
I would like to dedicate this thesis to Fritz and Audeen Pace Jacobs. They have instilled in me the value of learning and that learning is a continuous process beginning at birth and ending only in death. This road to educational fruition must be garnered from the knowledge of one’s heritage. One must understand and appreciate one’s origin before successfully establishing a route to a gratifying educational future.
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Introduction

“Good farmers, who take seriously their duties as stewards of creation and of their land’s inheritors, contribute to the welfare of society in more ways than society usually acknowledges, or even knows. These farmers produce valuable goods, of course; but they also conserve soil, they conserve water, they conserve wildlife, they conserve open space, they conserve scenery.” – Wendell Berry from Connecting Strategies to Better Kentucky’s Agricultural Economy and Rural Communities, by Kentucky Agricultural Council Task Force on the Future of Agriculture (2012).

History does repeat itself even in the usage of biomass as a fuel source as slated in the Centre for Energy Biomass Timeline (Centre for Energy, 2012). Henry Ford in the 1880’s used ethanol as the fuel source for the quardicycle and in 1908 when he designed the Model T he built an ethanol fermentation plant in Atchison, Kansas, to manufacture ethanol for motor fuel. In the 1930’s in the United States Midwest there were 2,000 service stations selling gasohol which was ethanol made from corn (Centre for Energy, 2012). After World War II low priced petroleum products became the fuel of choice and the ethanol industry shut down in the United States. Some forty years later renewed interest in ethanol and other biomass concepts returned to the forefront in the 1970’s with the oil embargo (Centre for Energy, 2012). Biomass is any organic matter, especially plant matter that can be converted to fuel and is therefore regarded as a potential energy source. Biopower, more
commonly referred to as biomass power, is the use of biomass to generate electricity. There are seven major types of biomass power systems which are direct-fired, cofiring, gasification, anaerobic digestion, pyrolysis, small modular, and cellulosic ethanol.

Fast-forward 34 years and biofuels has become a significant part of the United States fuel portfolio. The U.S. Energy Independence and Security Act (EISA) of 2007 mandates that 36 billion gallons per year of biofuels be produced in the United States by 2022, with 21 billion gallons coming from feedstocks other than corn. In order for this directive to be ascertained, new concepts, ideas, and products in agriculture will be required. History has shown that agriculture is still the linchpin of all the societies of the world and the farmer will continue to be the steward of the land. The farmers represent two percent of the population and are responsible for producing a sustainable amount of food to feed the masses. Now the seed sowers, the cultivators, and the harvesters are facing another quest. Their new charge will be to assume the new agriculture role as an energy provider if this mandate is to be achieved. The purpose of this study is to survey randomly selected farmers within a 48 county region in Eastern Kentucky who have access to approximately 16,529 acres. Plants and organic waste of all types have the ability of being processed to produce heat, power, and fuel. Crops produce biomass residue, which is presently left in the field which provides little food or direct monetary value other than providing organic matter and fertilizer for the
field. There is a tradeoff with each producer deciding if it benefits them to remove the residue.

According to the Department for Energy Development and Independence (DEDI) (2008), Kentucky farmers could produce over 2.3 million dry tons of agricultural biomass residue annually, with 3.6 million dry tons of dedicated energy crops being produced at $40 per ton. It is estimated that the Conservation Reserve Program (CRP) land could produce 1.8 million dry tons of switchgrass, 1.4 million dry tons of willow and hybrid poplar, and 2.3 tons of other hay crops. Corn stover and wheat straw could supply 1.5 million tons of residue yielding 121 million gallons of ethanol per year. Kentucky has over 12 million acres of forestland, of which private individuals own 78 percent. An estimated 9.18 million
dry tons of woody biomass would be available for use from harvest, milling and urban residues (Kentucky Department for Energy Development and Independence (DEDI), 2008).

In 2009 Kentucky Governor Steven Beshear set up a task force on Biomass and Biofuel Development in Kentucky to determine a strategic action plan to develop a biomass and biofuel industry in Kentucky. With the limited quantity of other alternative energy sources (i.e. solar, hydro and wind), within the survey region cofiring or burning biomass and coal would be the primary source of alternative energy (Executive Task Force on Biomass and Biofuels Development in Kentucky, 2009).

The task force found that:

1. Current biomass production capabilities are estimated at 12-15 million tons per year with minimal land use changes. Approximately 30% of this volume is expected from forestry and woody biomass production, 30% from energy crop production, 20% from waste forest products and 20% from agricultural waste (Executive Task Force on Biomass and Biofuels Development in Kentucky, 2009).

2. Potential Biomass production capabilities by 2025 are estimated at 25 million tons per year, but could involve land use changes of approximately 2 million acres, or 15% of Kentucky’s farmland. Approximately 20% of this volume is expected from forestry and
woody biomass production, 60% from energy crop production, 10% from waste forest products and 10% from agricultural waste (Executive Task Force on Biomass and Biofuels Development in Kentucky, 2009).

3. To minimize land use changes, advances in biotechnology must occur that improve biomass adaptability so that marginal and reclaimed lands become productive, and that increase current biomass yields on all lands (Executive Task Force on Biomass and Biofuels Development in Kentucky, 2009).

4. Kentucky currently has no standards for biomass sustainability, resulting in diverse opinions of sustainability definitions. Actions on sustainability standards at the federal level may pre-empt Kentucky’s interests, however, the Commonwealth should develop its own standards and become active in the federal process (Executive Task Force on Biomass and Biofuels Development in Kentucky, 2009).

5. The Task Force concludes that 25 million tons of biomass per year, produced within a sustainable environment defined by the Commonwealth with land use changes involving 15% of Kentucky’s farmland, is feasible by 2025 if improvements in yield and adaptability are realized (Executive Task Force on Biomass and Biofuels Development in Kentucky, 2009).
Kentucky has the opportunity to become a player in the biomass biofuels scenario, but will need to fill the knowledge gaps for its future producers. According to Meyer (2008) Kentucky is a late bloomer due to the lack of large amounts of corn and the physical lay of the land not being suitable for first generation biofuel crops (Meyer, 2008). Second generation feedstocks are still in their infantile experimental stages. The Center for Renewable and Alternative Fuel Technologies (CRAFT) Study (Goff, et. al, 2011) which surveyed farmers in 38 Central Kentucky counties and the Smith Study conducted with East Kentucky Power Cooperative, with producers in eight counties in Northeastern Kentucky this infancy is depicted (Smith, 2006).

A Kentucky biofuels program will provide shifts toward renewable energy and opportunities for farmers to diversify their operations and bring idle land back into production. Farm practices will have an impact on the economic viability and commercial development of next-generation bioenergy. Whether it be switchgrass, sweet sorghum or camelina, each crop according to Karst (2010) will have its own set of opportunities, challenges, and gaps in knowledge (Karst, 2010). Farmers are a cautious breed who are not going commit to a new crop until they have answers that fill the knowledge gaps.

Hipple and Duffy (2012) research indicates that Southern Iowa switchgrass producers were a skeptical group with a wait and see attitude. Here are some of the knowledge gap concerns of their research participants.

Potential adopters need to know actual or anticipated:
• Cost per acre
• Labor involved
• Equipment requirements
• Other capital requirements
• Fertilizer needs
• Land best suited for production
• Expected return on investment
• Market identification and stability
• Cost-benefit comparison between switchgrass, conventional row crops, and other alternatives (Hipple & Duffy, 2012).

Gibeault (2010) provides a summation finding that the biomass energy knowledge gaps are a hurdle that must be overcome if there is to be adequate understanding (Gibeault, 2010).

The purpose of this research is to survey 1,000 farmers in the 48 county survey region to ascertain their willingness to diversify their crop production to include biomass products to supplement fossil fuels.
Table One: USDA NASS, 2007 Kentucky Agricultural Census

<table>
<thead>
<tr>
<th>Item</th>
<th>Kentucky</th>
<th>Survey Area (48 Counties)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm Numbers (Total 50+ acres), 2007</td>
<td>55,446</td>
<td>16,529</td>
</tr>
<tr>
<td>Land in farms in acres (Total 50+ acres), 2007</td>
<td>13,291,605</td>
<td>3,727,589</td>
</tr>
<tr>
<td>Average size of farm in acres, 2007</td>
<td>164</td>
<td>153</td>
</tr>
<tr>
<td>Total cropland in acres, 2007</td>
<td>7,278,098</td>
<td>20,434</td>
</tr>
<tr>
<td>Average Producer Age (years)</td>
<td>59.9</td>
<td>55.75</td>
</tr>
</tbody>
</table>
The shaded area indicates the 48 county survey area East of and bisected by Interstate 75.
### Table Two: Counties in Survey Area

<table>
<thead>
<tr>
<th>Bath</th>
<th>Bell</th>
<th>Bourbon</th>
<th>Boyd</th>
<th>Bracken</th>
<th>Breathitt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campbell</td>
<td>Carter</td>
<td>Clark</td>
<td>Clay</td>
<td>Elliott</td>
<td>Estill</td>
</tr>
<tr>
<td>Fayette</td>
<td>Fleming</td>
<td>Floyd</td>
<td>Grant</td>
<td>Greenup</td>
<td>Harlan</td>
</tr>
<tr>
<td>Harrison</td>
<td>Jackson</td>
<td>Johnson</td>
<td>Kenton</td>
<td>Knott</td>
<td>Knox</td>
</tr>
<tr>
<td>Laurel</td>
<td>Lawrence</td>
<td>Lee</td>
<td>Letcher</td>
<td>Lewis</td>
<td>Madison</td>
</tr>
<tr>
<td>Magoffin</td>
<td>Martin</td>
<td>Mason</td>
<td>Menifee</td>
<td>Montgomery</td>
<td>Morgan</td>
</tr>
<tr>
<td>Nicholas</td>
<td>Owsley</td>
<td>Pendleton</td>
<td>Perry</td>
<td>Pike</td>
<td>Powell</td>
</tr>
<tr>
<td>Robertson</td>
<td>Rockcastle</td>
<td>Rowan</td>
<td>Scott</td>
<td>Whitley</td>
<td>Wolfe</td>
</tr>
</tbody>
</table>
Literature Review

What is Biomass, Biopower Systems, and Biofuels?

Biopower, or biomass power, is electricity that is derived from biomass origins. The seven major power systems that use biomass are direct-fired, cofiring, gasification, anaerobic digestion, pyrolysis, small modular, and cellulosic ethanol.

Direct fired systems burn biomass feedstock such as Miscanthus and Switchgrass to directly produce steam. The steam then spins a turbine which is connected to a generator that employs the momentum of the spinning turbine to produce electricity. Most biomass power plants use this system. In some instances the steam from the power plants is used in manufacturing processes and to heat buildings (National Renewable Energy Laboratory and the Department of Energy, 2011).

Cofiring of biomass refers to the use of biomass feedstock as a supplemental energy source in high efficiency boilers. This works on the same premise as the direct firing system but the biomass is not the primary fuel source. In most cofiring power plants the main fuel source is coal (National Renewable Energy Laboratory and the Department of Energy, 2011). Biomass is burned with the coal to significantly reduce emissions, especially sulfur dioxide (SO₂) (National Renewable Energy Laboratory and the Department of Energy, 2011).

A gasification system uses an environment comprised of high temperatures and low oxygen which turns the biomass into a gas, which is a mixture comprised
mostly of hydrogen (H), carbon monoxide (CO), and methane (CH₄). Then the gas powers a gas turbine, which resembles a jet engine, to generate electricity (National Renewable Energy Laboratory and the Department of Energy, 2011).

The production of methane gas from decaying biomass can be used as an energy source. This is done by the drilling of wells into the landfill which allows the methane to escape. After which pipes are placed in the wells to direct the methane to a central distribution point where it is first filtered and cleaned to remove any impurities, from here it is piped to a boiler where it is burned in much the same way as the gasification system. Methane is also produced from biomass in a process called anaerobic digestion. Anaerobic digestion involves the use of bacteria to decompose organic matter in an oxygen free environment (National Renewable Energy Laboratory and the Department of Energy, 2011).

Methane has the ability to be used as a source of energy in several ways. The vast majority of facilities use it to generate steam in boilers to produce electricity. There are two new ways to use methane, which are microturbines and fuel cells. Microturbines have the capabilities of generating 25 to 500 kilowatts of power (National Renewable Energy Laboratory and the Department of Energy, 2011). Such turbines might be placed where space limitations exist, due to their being approximately the size of a refrigerator. Methane could be used as a feedstock in a fuel cell, and become in essence a battery without the need to be recharged. A fuel
cell has the capability of producing electrical power given there is fuel (National Renewable Energy Laboratory and the Department of Energy, 2011).

East Kentucky Power Cooperative became the first power company in Kentucky to generate its own power from methane gas from landfills (East Kentucky Power Cooperative, 2011). East Kentucky Power began the endeavor in 2003, with one plant trapping methane from decaying plants and other organic matter placed in landfills. Of the six plants that East Kentucky Power Cooperative operates, four are located in the 48 county survey region. These include the Laurel Ridge, Green Valley, Pendleton, and Mason Landfill Gas Plants (Kentucky's Touchstone Energy Cooperatives, 2012).

Liquid fuels are also produced from biomass through a process called pyrolysis. This occurs when the biomass is heated in an oxygen deprived system. Following this process the biomass turns into a liquid called pyrolysis oil or bio-oil, like petroleum they may be burned to produce electricity. The major issues with this process are the high water content, the high oxygen content, and high viscosity. These are issues due to their potential of harming the systems using the oil. Depending on the pyrolysis conditions the crude bio-oil can contain up to 30 percent water, diesel has a water content of 0.05 percent (Leahy, 2009).

A small, modular system has the ability to generate up to 5 megawatts of electricity. It is designed for use at the small town level or consumer level. This system may be used for example by a farmer using livestock waste to generate
electricity for their individual farm (National Renewable Energy Laboratory and the Department of Energy, 2011).

Cellulosic ethanol is ethanol derived from cellulose or the structural fibers of plant. The sources from which these are derived consist of grain straw, stalks, grasses and quick growing trees such as poplar and willow. This form of ethanol production is efficient in the sense it uses feedstock that would otherwise be considered trash (Goble & Goble, 2012).

Also, there are three specific categories in which biofuels may be placed:

1. First-generation fuels are made mainly from victuals primarily sugars and starches, which are used to produce ethanol.

2. Second-generation fuels are made from non-edible plant materials such as corn stover and soybean hulls, wood and wood residues, plus other plant wastes.

3. Third-generation fuels are made from algae and other microbes. The oil is removed and the remaining biomass is dried and burned as a fuel or fed as a livestock feed (Chevron, 2011).

The Federal Government is attempting to start a cellulosic drop-in fuel industry which does not include ethanol, which means using plants other than corn. The product of this can be used as a substitute for gasoline without changing how the engines are designed or constructed. The Federal Government is offering grants to aid in this endeavor (Skeeles, 2010). In accordance with the widely accepted
definition, a drop-in fuel is any renewable fuel that may be blended with conventional petroleum commodities, and be used in the current petroleum infrastructure (Weaver, 2012).

The United States Military is the world's largest fuel-burning entity. Not only Americans, but people around the world view foreign oil dependence as a serious concern. Reliance on foreign oil makes strange bedfellows from a security standpoint for it places the military and the public in a financially vulnerable place, due to the fluctuation in the per-barrel cost. The Pentagon struggles to identify the true cost of its 300,000 barrel per day consumption to supply units deployed to Iraq and Afghanistan (Chambers & Yetive, 2011).

When the Department of Defense's (DOD) fuel use is divided the Air Force represents 53 percent of the total DOD usage, the Department of the Navy including the Marine Corps totals 28 percent, while the Department of the Army equals 18 percent (Schwartz, et al, 2012).

The United States Navy has a mandate that calls for a fifty percent reduction by 2020 in petroleum (Vasden, 2011). The United States Air Force has a mandate which calls for a fifty percent reduction by 2016 (Vasden, 2011). Reaching these goals should be our nation's top priority. Vasden (2011) states that in order for our freedom to be maintained and our children to have a sustainable future, we must get our military, and eventually the entire country, to a self-sufficient petroleum level.
According to Bill Vasdan, Chairman of the Florida Feedstock Growers Association, the following three problems need to be studied, if producers are to be attracted:

**Problem One:** New facilities have large startup costs and are not easily financed. Loan guarantee programs only work if there is a lender to fund the guaranteed loans.

**Problem Two:** Most facilities take up to two years to permit and 12 to 18 months to build. If a facility is the first of its kind then it’s safe to assume the owners will want to run and prove it before building a dozen more.

**Problem Three:** Feedstock supply issues have crippled the largest biodiesel facilities, and the food-for-fuel debate over corn ethanol has had a tremendous ripple effect on biofuels as a whole (Vasden, 2011).

*Camelina sativa* is a member of the mustard family, a distant relative to canola, and a new player on the biofuels scene. Camelina plants are heavily branched, growing from one to three feet tall producing seed pods containing many small, oily seeds. Being a short season, fast growing crop, it can be used in a similar way to winter wheat in Central and Eastern Kentucky. Farmers in the Northern Great Plains typically plant camelina in early spring and harvest the crop in mid-summer around July. Camelina can be fall seeded in an attempt to get the crop start even earlier, thus giving a greater chance to sequential crop which is similar to crop rotation but allows two or more crops in the same year (Sustainable Oils, 2009). The seeds are easily crushed with oil being used for biodiesel or aviation biofuel that
performs similar to fuels from other sources but Camelina can be more efficient (Sustainable Oils, 2009). The remaining meal is a protein-rich feed source for cattle, poultry or swine (Sustainable Oils, 2009). Sustainable Oils has led an industry coalition that has secured approvals for feeding Camelina in rations for broilers, laying chickens, feedlot beef cattle and swine, and is working to secure camelina meal approvals for all animal uses (Sustainable Oils, 2009).

Vasden (2011) sees part of the key to camelina production to be found on America’s family farms where rural residents grew up with old-fashioned values and where patriotism still thrives. If the Feedstock Association provides support and encouragement the farms will provide the needed camelina (Vasden, 2011).

What is Going on in the Nation

U.S. Energy Secretary Steven Chu recently announced that the Department of Energy has finalized a $105 million loan guarantee to support the development of one of the country’s first commercial-scale cellulosic ethanol plants. Project Liberty is sponsored by POET LLC. of Sioux Falls, South Dakota and will be built in Emmetsburg, Iowa. It will be built next to POET’s existing grain ethanol plant, in Emmetsburg. The new plant will share roads, land, and other infrastructure. The cellulosic plant will produce biogas as a co-product, enough to completely power itself and eliminate the majority of the natural gas required to operate the adjacent grain ethanol plant (Broin, 2011).
Project Liberty's innovative process uses enzymes to convert cellulose from corncobs, leaves and husks into ethanol. POET plans to integrate all the company's 27 plants for a total annual capacity of one billion gallons. Financing has been a key hurdle to getting the first commercial scale cellulosic ethanol plant operating. If the plant has funding and planning then researchers, engineers and farmers will show tangible results (Cellulosic Biorefineries U.S. Department of Energy Finalizes Loan Guarantees, 2011).

Incorporated in the Energy Independence and Security Act of 2007 is a renewable fuels standard (RFS) that requires a seven-fold increase in domestic biofuel production by 2022. The production and use of ethanol in 2006 was approximately five billion gallons. This reduced the need for foreign oil by 170 million barrels, which in return is nearly what the United States buys from OPEC (Organization of the Petroleum Exporting Countries) in one month. Biofuels are currently available to reduce greenhouse gas (GHG) emissions 18-29 percent. GHG emissions were reduced by more than eight million tons in 2007 with the use of biofuels, which is equivalent to removing 1.2 million vehicles from American roads (Information, 2011).

According to Harden (2012), Assistant Inspector General for the United States Department of Agriculture the Biomass Crop Assistance Program (BCAP) was created by the 2008 Farm Bill. It provided matching funds to the owners of renewable biomass as an encouragement tool for the collection, harvesting, storage,
and transportation (CHST) of these materials to conversion sites. At these facilities
the materials would be converted into heat, power, bio-based products, or advanced
biofuels. Ultimately in 2009 as initiative incentives decreased the United States’
reliance on foreign oil, the United States Department of Agriculture (USDA)
expedited BCAP’s implementation. The USDA assigned the duty for dispensing the
matching funds for the CHST Program to the Farm Service Agency. By October
2010, the USDA found that $30 million of incentive payment money had been issued
(United States Department of Agriculture Office of Inspector General, 2012).

The crop producers that have obtained a spot within the BCAP are eligible
for reimbursement for the cost of the establishment of a bioenergy crop up to 75
percent of said cost. Said producers acquire annual payments for up to five years on
non-woody herbaceous crops, be they annual or perennial, and up to 15 years for
annual and perennial woody crops. Under the enhanced stewardship and
conservation measures of the BCAP contracts, the biomass must be collected and
harvested according to an approved conservation, forest stewardship, or other
approved plans in order to protect soil and water quality while preserving the
productivity of the land. No native sods may be converted under said contracts. The
collection, harvesting and transport needs to follow invasive plant species protections
(Farm Service Agency, 2011).

Davis (2007) stated that the U.S. Environmental Protection Agency (EPA)
has established a national Renewable Fuel Standard program (RFS). The RFS
program is designed to encourage the blending of renewable fuels into our nation’s motor vehicle fuel. The law set a modified standard of nine billion gallons in 2008 and up to 36 billion gallons in 2022. By 2022, 21 billion gallons are to come from cellulosic ethanol, and 16 billion gallons are to come from corn based ethanol (Davis, 2009). Twenty-one states have ethanol plants with Kentucky’s being located in Hopkinsville. Kentucky currently has 25 E-85 fuel stations. E-85 fuels consist of 85 percent ethanol and 15 percent petroleum based gasoline. Most of which are located along I-64 and I-75 in the Central and Western part of the state. The cities that have a public E-85 station in the survey region are: Covington, Erlanger, Latonia, Lexington, Newport, and Richmond (E85 Gas Stations in Kentucky, 2012).

In response to the volatile corn market, cellulosic materials have received a lot of attention recently. Depending on the prevailing price for switchgrass, if Kentucky shifted five percent of its pasture and 10 percent of its hay ground, approximately 550,000 acres would be available. At a yield of seven tons per acre, Kentucky could produce as much as 1,925 tons annually (Executive Task Force on Biomass and Biofuels Development in Kentucky, 2009).

Slightly less energy efficient than switchgrass, wood may be used for ethanol production. With additional funding aimed at non-food options by 2012 wood will be an important player in the forest areas of Eastern Kentucky (Davis, 2009). Wood is less efficient due to the higher lignin content. This requires extra enzymes similar to those in the digestive tract of termites to degrade the lignin into starches and glucose.
Duckweed and algae may be the newest sources for ethanol production since duckweed may be harvested almost daily from the scum on ponds and will produce four times the amount of ethanol per acre of corn (Davis, 2009). Kentucky farmers must see the need for crop changes and how it will benefit them on the individual level before they will be willing to take on new production ventures (Davis, 2009).

**Perspectives from Other States**

Altman, Bergtold, Sanders, & Johnson (2011) surveyed the middle of Missouri and Southern Illinois. Previous studies had focused on physical characteristics; processing technologies, environmental consequences, and potential volume of biomass. The bottom line of any commercialization is whether the process is economically feasible. The purpose of their research was to investigate the impact of price variability and producer characteristics on agricultural producer’s willingness to supply biomass (wheat straw, corn stover and hay) to emerging renewable energy industries (Altman, et.al. 2011).

The Missouri Department of Natural Resources (2011) is navigating the quest for individuals who can work as a group and who are out of the box thinkers with a willingness to take on plans and move in new directions. The Hampton family owned feedlot began exploring renewable energy ideas four years ago. The Hampton Feedlot project created a greater willingness for the family to participate because the
project received a grant and loan guarantee from the USDA, as well as tax credits from other agencies for current and future project plans for providing electricity (Gibson, 2011). Missouri was the first state approved by the United States Department of Agriculture to qualify as recipients of the initiative incentive matching payment fund for the collection of, harvesting, storing, and transportation (CHST) of biomass. Missouri received less than $1 million in CHST matching payments for the fiscal years of 2009 and 2010 (United States Department of Agriculture Office of Inspector General, 2012). It is important to provide money for incentives for biogas projects, for many must strive to meet the 15 percent of the 2021 renewable energy standard (Gibson, 2011).

Jensen, Clark, Ellis, English, Menard, Walsh, and Torre (2007) conducted a survey of Tennessee farmers to analyze their willingness to supply switchgrass to an emerging energy market. The majority of farmers who responded had not heard of growing switchgrass for energy. Of the respondents half were unsure about whether they would be willing to grow switchgrass. A two limit Tobit model was used to ascertain the effects of various farm and producer characteristics on the share of farmland they would be willing to convert. The higher the net farm income per hectare had a negative influence on the share, reflecting the opportunity cost of converting land. Younger farmers with higher levels of educational attainment and off-farm incomes were willing to convert a higher share of farmland. The size of the farm and use of leased land had a negative influence on willingness to convert to

22
switchgrass. Even though erosion issues had no bearing on influence, however providing wildlife habitat did (Jensen, et al., 2007).

Cope, McLafferty and Rhoads (2011) mailed 400 surveys to rural residents in Central Illinois to gauge the farmers' knowledge and attitudes toward perennial energy grasses primarily switchgrass and miscanthus. The surveyors found that 75 percent of the responders were fifty years old or greater. They also state that the respondents had little to no knowledge of energy grass cultivation. Given their limited knowledge the respondents saw a benefit to the cultivation of such grasses for soil stability (Cope, et al., 2011).

A survey conducted by Fewell, Bergtold, and Williams (2011) in Kansas, shows contract attributes that positively affect farmers' decisions include net returns, biorefinery harvest options, insurance availability, and seed cost-sharing. Contract length negatively affects farmers' decisions, most opt for shorter-term contracts. Farmers have a low chance of adopting switchgrass for a biofuel feedstock, mainly due to the long-term nature of growing switchgrass and it not being competitive enough of crops at this time (Fewell, et al, 2011).

**What the State of Kentucky is doing in Regards to Biomass**

The state of Kentucky serves as a role model for its people. Since the state's fleet has grown to over 1,100 vehicles the state's motor pool offers ethanol blended gasoline storing 10,000 gallons of E10 and 5,000 gallons of E85 on site.: Green Earth
Biofuel of Kentucky located in Irvine, Kentucky demonstrates the feasibility of using locally grown biomass as the main ingredient for heterotrophic algae to produce algal oil that can be refined to renewable diesel for use in military vehicles used by the Kentucky National Guard and LexTran city buses. Green Earth Biofuel of Kentucky will continue to produce its renewable diesel fuel from soybean oil. Its present capability is to produce 25 million gallons per year with expansion to 75 million per year (Green Earth Biofuel of Kentucky, Inc., 2010).

Griffin Industries is based out of Cold Springs, Kentucky with a biodiesel facility in Butler, Kentucky that began producing commercial biodiesel in the 1990’s before the Department of Energy even considered biodiesel as an alternative fuel. In December of 2010, Griffin Industries Inc. was procured by Darling International Inc. located in Irving, Texas (Business Courier, 2011).

Griffin Industries uses animal fats, recycled greases, and soybean oil to produce their Bio G 3000 Premium Biodiesel (Griffin Industries, 2010). This product is environmentally friendly, meaning it is biodegradable and produces less air pollution than conventional diesel (Griffin Industries, 2010). Bio G-3000 can be used in place of diesel fuel without engine modification or performance reduction and is the fastest growing domestic alternative fuel. This biodiesel facility is the oldest continuously run producing flexibly feed stock biodiesel plant in the United States (Griffin Industries, 2010). Rendering facilities like Griffin divert animal fats,
greases, and used cooking oil from building up in landfills and from being dumped in environmentally unsound ways.

A novel program, From French Fries to Fuel takes the used cooking oil from the dining halls at the University of Louisville to produce an alternative fuel source to help operate a campus shuttle bus at the Belknap campus (Hughes, 2012). The first shuttle runs have been based on about a 5 percent biodiesel mixture with the capabilities of an adjusted blend increase to 10 and 20 percent. The oil drained from the food fryers is filtered and loaded into a laboratory processing tank for three days of chemical cleaning, processing and settling between steps (Hughes, 2012).

The Louisville Biodiesel Cooperative grew from the altruistic need to inform and educate the citizens about petroleum diesel’s economic and health concerns in Metro Louisville. To reach this goal the cooperative has a network to gather used cooking oil from large commercial and non-profit kitchens in order to convert it into biodiesel for local use. It is a conservative estimate that the restaurant kitchens in Louisville use 10 million gallons of cooking oil per year (Louisville Biodiesel Cooperative, 2011.). Biodiesel is the only direct one for one petroleum diesel fuel replacement to significantly reduce pollution, improve environmental health and exceed petroleum diesel fuel quality rating citone by 30-60 percent (Louisville Biodiesel Cooperative, 2011).

In August 2009, The Kentucky Clean Fuels Coalition received $12.8 million in stimulus funding for the placement of diesel hybrid school buses to be used in
Kentucky school districts. Kentucky has the largest hybrid-electric school bus fleet in the nation with 160 school buses on the road (Kentucky Clean Fuel Coalition, 2012). The Kentucky Department of Education administers the funding which is available to any of the 174 public school districts in the state. Thirty one districts applied for the funding for the buses that are constructed by Thomas Built and International and are equipped with an Eaton hybrid system (Kentucky Clean Fuel Coalition, 2012). Louisville has 125 hybrid electric school buses in its fleet which is the largest grouping in the nation (Kentucky Clean Fuel Coalition, 2012). Pike County has the largest fleet in Eastern Kentucky (Kentucky Clean Fuel Coalition, 2012). Their 32 buses have averaged 12.63 miles/gallon and they are doubling their fuel efficiency through driver education and route placement. Through August 2011, nearly 380,000 miles were logged by the 210 buses with an average fuel efficiency of 9.65 miles per gallon which equates to three miles per gallon higher than the baseline (Kentucky Clean Fuel Coalition, 2011).

There are twelve of the thirty-one school districts in the 48 county survey region that are participating in Kentucky’s hybrid electric bus program. The list includes Bath County (3), Breathitt County (12), Campbell County (1), Corbin Independent (1), Covington Independent (1), Harlan Independent (1), Kenton County (5), Madison County (6), Martin County (1), Montgomery County (1), Pike County (32), and Whitley County (1) (Kentucky Clean Fuel Coalition, 2011).
In April 2012, during National Park Week Mammoth Cave National Park became the first national park in the nation to use alternative fuels and technologies in all their vehicles and equipment. Melissa Howell of the Kentucky Clean Fuels Coalition aided in the Park’s purchase of four propane Bluebird buses for visitor transportation, two propane F-150 pick-up trucks and three low speed electric vehicles (Kentucky Clean Fuel Coalition, 2011).

The park has also been using biodiesel to power their river ferry. According to a personal interview with Steve Kovar the maintenance supervisor conducted in August of 2012, the filters on the equipment using biodiesel have to be changed more often than with the conventional petroleum diesel. The park has ceased using biodiesel in the back-up generators. This stoppage is due to the biodiesel compromising the fuel lines and internal mechanisms of the pumps (Kovar, 2012).

All the ranger vehicles are flex-fuel meaning they operate on both E-85 and conventional gasoline. Operating these vehicles on days where temperatures are above 92 degrees Fahrenheit with strictly E-85 fuel has presented difficulty with starting of the vehicles, according to Kovar (2012). He also stated, that there is a significant difference in milage between E-85 and gasoline (nine plus miles per gallon lower with the E-85) (Kovar, 2012).

In a four year study 2007-2011 the University of Kentucky College of Agriculture has worked with a group of 20 Northeastern Kentucky producers on a switchgrass pilot project. Each producer was selected by the local county agriculture
and natural resources extension agents based on their interest and agricultural background knowledge and machinery resources. These 20 producers' farmed 5 acre test plots of switchgrass that were located within 60 miles of Maysville, Kentucky. This study was designed to help farmers evaluate options for planting, growing, harvesting, transporting, and processing the switchgrass (Greenwell, et al., 2012).

According to the Center for Renewable and Alternative Fuel Technologies (CRAFT) located at Eastern Kentucky University, a 35 county survey on Central Kentucky Producers Opinion on Switchgrass Production for Energy was conducted from April 21-May 13 2011. The 35 county study was within a fifty mile radius of Winchester, Kentucky, the potential home for a biofuels facility. Surveys were mailed to 1,025 Kentucky producers randomly selected by the Kentucky NASS Field Office. Of the 180 surveys returned data from which 168 surveys were used. Of those 168 surveys, 58 percent replied that they were not familiar with switchgrass as an energy crop. It was found that when asked if they would consider growing switchgrass 24 percent stated they would consider it, 34 percent were not sure, and 42 percent were a definite no. The major contributors towards the acceptance of growing switchgrass are total farm acreage and total gross farm income. For switchgrass to be grown on local farms, educational outreach programs will need to be developed for farmers to close the knowledge gaps (Goff, et al., 2011).

According to the surveys and reports reviewed, responses indicate that for the correct price and with the correct infrastructure farmers will be willing to produce
biomass for the production of energy. The price where you start to see a significant increase in production is $50-$55 per dry ton. Kentucky is currently lacking the infrastructure needed and which must be corrected before significant commercial production of energy crops can begin (National Agricultural Statistics Service, 2008).
Data and Methodology

Preliminary data used to determine the number of producers in the 48 counties east of I-75 was collected from the 2007 Census of Agriculture released by the National Agricultural Statistics Service (NASS). In Kentucky, there are approximately 55,500 farms of 50 acres or larger (National Agricultural Statistics Service, 2008). Approximately 16,500 of these farms are located in the 48 counties east of I-75 (National Agricultural Statistics Service, 2008). The average farm size for the survey area is 153 acres, with an average approximant age of 56 years for the producers (National Agricultural Statistics Service, 2008). With the help of Kentucky office of National Agricultural Statistics Service a random sample of 1,000 producers were selected from these 16,500.

These 1,000 producers were then sent a letter explaining the purpose of the study and how the survey will be anonymous. The first letter and survey were sent with the letter, both were sent on 10/4/2012. On 11/15/2012, a follow-up letter and a second survey were sent to producers who had not responded. See appendices for further information on what was included in the letters and the survey.

The survey is analyzed using qualitative choice models. Qualitative choice models are appropriate when trying to determine the characteristics of an individual that influence their decisions. Furthermore, probit models are a type of qualitative choice model based on utility theory, or rational choice prospective on behavior (McFadden, 1973). Producers maximize their expected utility of profits, which are
subject to constraints imposed by the characteristics of their marketing and production environment. This is true as it relates to producers determining their preferences for bioenergy production; a probit model is a logical choice for modeling producer decisions (Goodwin, 1993). Probit models are used to predict certain statistical outcomes.

For the purposes of this research project a probit model is used even though it is numerically more complicated. Today’s computing power of computers allows for the easy estimation of these models. The primary question this model will be used to analyze is “Would you participate in a biomass and bioenergy market?” Specifically, this research seeks to determine what factor(s) influence a producer’s decision to participate or not.

The reduced form equation for this question is given by

\[ P_i = f(X_i, \gamma_i, \theta_i). \]

Where \( P_i \) is defined as the probability that \( \text{Operator}_i \) is willing to produce biomass for a bioenergy. \( X_i \) is defined as traits of the operator including age, gender, experience, percent of land owned, and education level. \( \gamma_i \) is defined as the type of farm based on their operation type. \( \theta_i \) is defined as all other variables.

The literature indicates there are a number of factors that influence an operator’s decision to participate in a biomass market. These include market availability, growing season, perennial versus annual crop, equipment needs and costs. Studies including the Fewell (2011) and the CRAFT (2011) found that these...
factors impact the probability of them producing biomass. Lack of knowledge on the subject and lack of market potential are the main issues that negatively impact the probability of producers to switch to biomass production.

They also found that total farm size and total gross income along with a higher education level increased the probability of them to produce biomass. We expect our study to find similar results.
Results

Of the 1,000 producers surveyed usable data was gained from 198 of the 226 total responses, from 42 of the 48 counties. The 28 without usable data were not counted due to the producer answering no to the first question asking if they owned agricultural land in Kentucky or were returned totally blank. There was a 19.8 percent return rate with the usable responses. General statistics from the survey revealed that the average number of years owning agricultural land in Kentucky is 30 years. Eighty of the responses indicate that the producers would be willing to grow biomass for energy. Of the 198 respondents 165 were male and 28 stated being female, 182 Caucasians, 5 Native Americans, 1 African American, and 6 others. Of the 198 with usable data 196 answered as follows, 11 had little to no high school, 75 had graduated high school, 37 had some college, 38 were college graduates, and 35 had a Master or Doctorate degree. In the charts that follow the amounts are the total number of people that answered the question of the 198 with usable data.

Under the current market conditions only 80 of the 198 (39.4 percent) are willing to produce biomass for the production of bioenergy. A number of reasons exist to explain why operators would select to participate in biomass production. It is important to understand the reasons why operators make this choice as environmental regulations continue to constrain fossil fuels and renewable energies grow in market share of the US energy portfolio.
Understanding factors that influence an operator's willingness to participate in a biomass market is paramount. Companies considering the usage of biomass in their production process need to understand both why producers would consider or not consider the production of biomass. Figures two - nine display operators attitudes towards biomass production and reasons they would or would not consider the production of biomass. Figure Two shows that 109 of the 188 that responded to this question believe that biomass could be a viable energy alternative to fossil fuels. The interesting part about this is that this region has been dominated by coal production but operators in the region believe that biomass could play a role in energy production moving forward.

**Figure Two: Survey Question Seven, “In My Opinion Agricultural Biomass is a Viable Energy Alternative to Fossil Fuels”**
Additionally, in Figure Three operators around the region believe that biomass could supply a portion of energy needs for rural communities. Over 80 percent of the responses to this question are either neutral or supportive of this idea. Given that this region is comprised of rural communities, the development of a biomass industry in this region could provide much needed economic development.

In the last year, the region has seen a significant decline in the number of coal miners with 4,028 losing their jobs in 2012 (Kentucky Department of Energy, 2013). This has had the indirect impact of influencing the tax base of a region that is already distressed.

**Figure Three: Survey Question Twenty-One, “I Would Supply Agricultural Biomass to Bio-refineries Capable of Producing Energy for Rural/Local Needs”**

![Bar chart showing responses to survey question](image)

On a larger scale, 156 of the respondents are either neutral or agree that biomass could supply a portion Kentucky’s energy needs (Figure Four). Kentucky is
predominately a rural state and has long been an energy exporter. The majority of this energy exporting was a result of the state’s coal production. However, given the decline of this industry as a result of increased regulation there may be opportunities for biomass to fill the losses from decreased coal production. Additionally, according to the Executive Taskforce (2009) and the Billion Ton Study (2011) biomass production could be an area Kentucky has an advantage over other states in renewable energy production.

**Figure Four: Survey Question Twenty-Two, “I Would Supply Agricultural Biomass to Bio-refineries Capable of Producing Energy for Our State’s Needs”**

![Graph showing responses to survey question](image)

In the survey questions were also asked to determine what producer perceived as the most appealing and discouraging aspects of growing biomass (Figure Five). According to respondents of the survey the most appealing aspect of growing biomass is to diversify their operation. This was as expected and was a
finding of other similar studies conducted by other states. The second most cited reason to consider biomass production would be to utilize underperforming land or others may refer to this as marginal land. This region of Kentucky is dominated by rolling and rugged terrain that would be considered marginal. Additionally, this area is predominately a cow/calf producing and tobacco growing area. A significant portion of this region is in pasture being utilized by the cattle industry. However, some of this land could be converted to biomass production if it could provide operators with higher net returns than they are currently receiving from the cattle industry. Other appealing aspects of biomass production are fewer inputs, use of existing equipment and less management time.

**Figure Five: Survey Question Five, “Most Appealing Aspect of Growing Biomass”**
Along with trying to identify appealing aspects, the survey also inquired about discouraging aspects. Figure Six shows that market potential is the biggest hurdle to the development of biomass industry in Eastern Kentucky. This response was expected because many of the technologies that would be utilized to convert biomass to different sources of energy are still in the developmental phases. Additionally, potential market size for biomass is unknown and depends on many different factors. The second most discouraging aspect is that it is unknown how much assistance will be needed by producers to learn the new production and marketing skills that will be needed by potential producers of biomass. This could produce a significant learning curve for operators in the area as many rely on auction markets that already exist for the products. Development of skills require training to help close the knowledge gaps.
Figure Six: Survey Question Six, “Most Discouraging Aspect of Growing Biomass”

The survey also inquired about other perceptions of biomass production. Figure Seven shows the results of operator’s beliefs on whether grants should be awarded. Overwhelming the majority 149 operators or 73.74 percent answered neutral or agreed that grants should be awarded for research and development. This indicates that operators in the region believe that this could be an even more viable industry if there were grants available to continue the advancement of the industry. This is due in part to the decline of popularity of the use of fossil fuels in the public eye. Also, in the survey area producers are seeking ways to diversify the operations with the decline of tobacco and many miners being laid off.
Figure Seven: Survey Question Thirty-Four, "Grants Should be Awarded for Research and Development Capable of Advancing Biomass Production Technologies."
Figure Eight: Survey Question Thirty-Three, "Government Incentive Programs Should be Provided to Supplement the Costs of Establishing Biomass Crop Species."

Figure Eight shows the results of what operators believe on whether or not there should be an incentive program to help develop this industry. One hundred and thirty-three people were neutral or agreed that government incentives should be given to supplement establishment costs. Due to the high establishment cost associated with many biomass crops, many of the producers want to see incentives to offset these cost. Additionally, many of these crops are perennial and it may take one, two, or more years before a crop can be harvested.

Currently, the Biomass Crop Assistance Program and some state programs exist to help with this but more may be needed to grow the industry initially.
Figure Nine: Survey Question Thirty-One, "Tax Credits Should be Given to Landowners, Harvesters, and Companies that Utilize Biomass for Energy Production."

Of the 198 surveys with usable data 180 answered this question as follows. Responses indicate that 16 or 8.89 percent strongly disagreed, 21 or 11.67 percent somewhat disagreed, 36 or 20.00 percent were neutral, 67 or 37.22 percent somewhat agreed, while 40 or 22.22 percent strongly agreed. One hundred and seven of those who answered this question agreed that tax credits should be given. The majority agree that tax credits should be given to help offset some of the costs associated with the product. These tax credits could help with the adoption of biomass production. This will be key for the development of a bioenergy economy in Eastern Kentucky.
Table Three shows the descriptive statistics for the data utilized in the probit model. This table shows the expected results for what this region of Kentucky looks like. Over half of the farms in the data set were beef. There is very little grain production and tobacco is still produced in the region. Additionally, the vast majority of the farms are under 200 acres. Lastly, the survey also points out that the majority of the producers in this area have little to no college education.
Table Three: Descriptive Statistics

<table>
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<th>Variable</th>
<th>Description</th>
<th>Obs.</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
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<tr>
<td>Participation</td>
<td>Willingness to grow biomass</td>
<td>225</td>
<td>0.355</td>
<td>0.4797</td>
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<td>Beef</td>
<td>Beef is produced on operation</td>
<td>195</td>
<td>0.533</td>
<td>0.5001</td>
<td>0</td>
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<td>Tobacco</td>
<td>Tobacco is produced on operation</td>
<td>194</td>
<td>0.0277</td>
<td>0.1588</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Soybean</td>
<td>Soybeans is produced on operation</td>
<td>195</td>
<td>0.0256</td>
<td>0.1584</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Hay</td>
<td>Hay is produced on operation</td>
<td>195</td>
<td>0.2615</td>
<td>0.4406</td>
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<td>1</td>
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<tr>
<td>Less200</td>
<td>Less than 200 acres</td>
<td>225</td>
<td>0.7066</td>
<td>0.4563</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Some col</td>
<td>Attended but not graduated College</td>
<td>193</td>
<td>0.1917</td>
<td>0.3946</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Col grad</td>
<td>College Graduate</td>
<td>193</td>
<td>0.1865</td>
<td>0.3905</td>
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<td>1</td>
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<tr>
<td>Less 80</td>
<td>Less than 80K income per year</td>
<td>225</td>
<td>0.2444</td>
<td>0.4307</td>
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<td>1</td>
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<tr>
<td>Total pro</td>
<td>Sum of positive statements about biomass</td>
<td>225</td>
<td>2.24</td>
<td>2.0496</td>
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<tr>
<td>Years</td>
<td>Years in Farming</td>
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<td>24.6488</td>
<td>18.7411</td>
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<td>70</td>
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<tr>
<td>Gender</td>
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<td>0.1458</td>
<td>0.3538</td>
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<td>1</td>
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In addition to the insights provided by the above figures, a probit regression was estimated to further investigate factors that influence operator decisions. The regression results indicate that operations that have tobacco as an enterprise on their operation would be one group of operators that would be willing to participate in a biomass market. This is as expected for this region given that local labor is becoming more difficult to secure. Hay producers would be the next to follow suit since they will already have the harvesting and basic transportation equipment needed. The results show that beef and equine producers in the region are the least likely to convert due to their fields being used as pasture and range land. However, this will change as beef prices change.

Gender also plays a role in this because of the stereotype women typically are more knowledgeable about environmental issues, thus making female operators more inclined to produce biomass. Corn and soybean producers are also less likely to switch to biomass production because of their current commodities having a higher profit margin. Those producers with some college education or a college degree tend to be more inclined to produce biomass with being more informed when it comes to political and environmental policy. However, this will be a major hurdle for the region because many of the operators have little to no college education.

With this region having smaller farms and less educated operators, additional focus will need to be placed on this region to close the knowledge gap.
The findings correspond to the Tennessee survey mentioned earlier, that age and education play a major part in the willingness for the adoption of growing biomass. The younger the individual and the more educated they are increases the likelihood of the inception of biomass into their operations. These studies including the Fewell (2011) and the CRAFT (2011) have found that the lack of knowledge on

<table>
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<th>Coefficient</th>
<th>Predicted Marginal Effects</th>
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<td>Soybean</td>
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<td>Hay</td>
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<td>Some col</td>
<td>0.8298009***</td>
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<td>Col grad</td>
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<tr>
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<td>-0.2191325*</td>
</tr>
</tbody>
</table>

Number of observations: 183
Wald $x^2$: 29.56
Probability $> x^2$: 0.0019
Log pseudo likelihood: -109.4287
Pseudo $R^2$: 0.119

*Significant at 10%  **Significant at 5%  ***Significant at 1%
the subject and lack of market potential are the main issues. The lack of a current infrastructure is causing issues as well.
Conclusions

This research has shown that the education level of the producers will decrease the knowledge gaps and favorable attitude changes are going to have to increase. Producers have to see a need or incentive for change and view these changes as positive factors that will provide them an avenue for economic advancement. Even though this study did not specifically address economic factors it is evident they play a significant role.

A survey of the literature shows that the nation's first biomass rendering plant for biodiesel is in northern Kentucky to a new algae biodiesel facility in the southeastern part of the state. From northeastern Kentucky comes the introduction of landfill methane gas to produce electricity, while other areas in the eastern counties of the survey region are using wood and woody residues along with plants as a source of power. Kentucky may still be in its biomass industry infancy but with increased interest and public demand future research will continue.

This study found that under the current market conditions only 80 of the 198 (39.4 percent) are willing to produce biomass for the production of bioenergy. A number of reasons exist to explain why operators would select to participate in biomass production. These reasons include wishing to diversify their farm portfolio and bringing fallow land back into production or utilizing under-performing land. It is important to understand the reasons why operators make this choice as
environmental regulations continue to constrain fossil fuels and renewable energies grow in the market share of the United States energy portfolio.

Understanding factors that influence an operator’s willingness to participate in a biomass market is paramount. Companies considering the usage of biomass in their production process need to understand both why producers would consider or not consider the production of biomass. Some of these factors include education level, current combined income, and their primary farming enterprise.

Reasons why operators would elect to participate in biomass production

1. Biomass could provide a portion of the energy needs for these rural communities either on an individual farm or small town basis.

2. Job creation is a prominent reason for an increased interest in biomass production.

The production of biomass will influence all economic facets from the preparation of the ground, to the planting, to the transportation of the raw product, to the production process, to the packaging, to the return transportation of the final product to the consumer.

Farmers that are younger along with those that have a higher education level tend to be more accepting and willing switch part of their operation to biomass. Some other factors that indicate willingness to switch include farmers that have a larger disposable income may switch without having to worry as much about taking an economic hit if they fail. Tobacco producers are the most likely producers to take

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on growing biomass for energy due to the decline of the tobacco industry in the state. Hay producers would be the next likely to switch due to already having the necessary machinery needed to harvest and store the biomass when mature. According to responses and producer comments livestock, producers especially equine producers, are some of the least likely to convert land to growing biomass. This is mainly due to land already being tied up in pasture or range land and handling facilities.

According to other respondent comments there were several that stated they would be interested in seeing commercial hemp being brought into the state. Hemp has at least three possible avenues for marketing, including cosmetics, textiles, and biofuels. Other comments include producers wanting little to no government involvement when it comes to funding of biofuels programs.

Overall lack of background knowledge of the producers and the general public in regards to biomass and biofuels is an issue. To reduce these knowledge gaps field days, webinars, and other types of class maybe held. These types of activities may be held at the Universities in the area or the local Extension Offices. The field days may include touring farms that produce biomass and have some harvesting and other production equipment on site. Other possibilities include touring biomass and biofuels refiners. With the classes and webinars there should discussion on what biomass is, costs associated with it, and types of biomass with examples on site.
Limitations of this Study

This study focuses on a small region of Kentucky which makes it difficult to extrapolate to other regions of the state. However, these results would be relevant to other areas of Appalachia. This study does not investigate biomass price which will be a significant factor in whether producers would produce biomass in this region or not.

Future Research

Future research includes asking the question what price processors must pay to entice operators to produce biomass for bioenergy. Also, there is research to be done in conducting a similar study in another state and compare the results and see what can be done in each region to setup a biomass market. Additionally, further research will be conducted to investigate other questions on survey that could provide additional answers to what would be the best methods for educating producers in this region on the potential of biomass production in the region.
References


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https://louisville.edu/speed/spotlights/from-french-fries-to-fuel-researchers-convert.html


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http://ohioagmanager.osu.edu/farm-policy/biomass-for-energy


http://www.susoils.com/camelina/


Appendices

October 2012

Dear Agricultural Producer:

The Department of Agricultural Sciences at Morehead State University is conducting a brief survey of Kentucky farmers east of I-75, in regards to the production of biomass for energy production. Biomass has been identified as a potential bioenergy feedstock with the potential to serve as a source of energy for power plants as well as a feedstock for the biofuels industry.

The purpose of this study is to determine the opinions of agricultural stakeholders within Kentucky on their willingness to grow, knowledge of biomass, and its uses as an energy and biofuel feedstock. The results of this study will be used to inform researchers about the perspectives of local farmers on biomass for bioenergy production. By completing this questionnaire, you will be contributing to the future growth of the local bioenergy economy. Your name was drawn in a random sample of agricultural producers in Kentucky. In order that the results accurately represent all agricultural producers, it is very important that each questionnaire be completed and returned.

Participation in this research study is voluntary and all information you provide will be kept confidential. You may skip any questions you are not comfortable with answering. Your response to the survey will be critical to the success of the study and will only take a few minutes of your time. Survey results will be reported in a summary format, and individual responses will not be identifiable. If you are interested in the results of the study, please check out www.moreheadstate.edu this spring.

Please place the completed questionnaire in the enclosed postage-paid self-addressed return envelope, and drop it in the mail before October 22, 2012.

If you should have any questions, please do not hesitate to contact us at (606) 783-2662 or t.mark@moreheadstate.edu or apjacobs@moreheadstate.edu. Thank you in advance for your assistance with this research effort, and we look forward to receiving your feedback.

Under Title 7 of the U.S. Code and CIPSEA (Public Law 107-347), facts about your operation are kept confidential and used only for statistical purposes in combination with similar reports from other operations. Response is voluntary.

Sincerely,

Dr. Tyler B. Mark  
Assistant Professor Agribusiness  
Department of Agricultural Sciences  
606-783-2628  
t.mark@moreheadstate.edu

Austin P. Jacobs  
Graduate Assistant  
Department of Agriculture Sciences  
606-783-9046  
apjacobs@moreheadstate.edu
November 2012

Dear Agricultural Producer:

In early October, we sent you a questionnaire to help us determine opinions on Biomass production for energy. As of today, we have not received your reply. Your responses are vital to the success of this project, so we have enclosed a second copy of the survey and hope that you will take the time to complete and return it. If you have already returned the first survey, there is no need to complete this one.

The Department of Agricultural Sciences at Morehead State University is conducting a brief survey of Eastern Kentucky farmers in regards to the production of biomass for energy production. Biomass has been identified as a potential bioenergy feedstock with the potential to serve as a source of energy for power plants as well as for the biofuels industry.

The purpose of this study is to determine the opinions of agricultural stakeholders within Eastern Kentucky on their willingness to grow and knowledge of biomass and its uses as an energy and biofuel feedstock. The results of this study will be used to inform researchers about the perspectives of local farmers on biomass for energy production. By completing this questionnaire, you will be contributing to the future growth of the local biofuel economy. Your name was drawn in a random sample of agricultural producers in Kentucky. In order that the results accurately represent all agricultural producers, it is very important that each questionnaire be completed and returned.

Under Title 7 of the U.S. Code and CIPSEA (Public Law 107-347), facts about your operation are kept confidential and used only for statistical purposes in combination with similar reports from other operations. Response is voluntary.

Participation in this research study is voluntary and all information you provide will be kept confidential. You may skip any questions you are not comfortable with answering. Your response to the survey will be critical to the success of the study and will only take a few minutes of your time. Survey results will be reported in a summary format, and individual responses will not be identifiable. If you are interested in the results of the study, please check out www.moreheadstate.edu this fall.

If you should have any questions, please do not hesitate to contact us at (606) 783-2628 or t.mark@moreheadstate.edu or apjacobs@moreheadstate.edu. Thank you in advance for your assistance with this research effort, and we look forward to receiving your feedback.

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Austin P. Jacobs
Graduate Assistant
Department of Agriculture Sciences
606-783-9046
apjacobs@moreheadstate.edu
Eastern Kentucky Producer Willingness to Grow Biomass as an Alternative Energy Source

Dr. Tyler B. Mark
Austin P. Jacobs
Morehead State University
Department of Agricultural Sciences

Under Title 7 of the U.S. Code and CIPSEA (Public Law 107-347), facts about your operation are kept confidential and used only for statistical purposes in combination with similar reports from other operations. Response is

In cooperation with

MOREHEAD STATE UNIVERSITY

NASS
AGRICULTURE COUNTS
Glossary of Terms

1. Biomass - organic matter, especially plant matter that can be converted to fuel and is therefore regarded as a potential energy source.
2. Biofuels - a fuel such as wood or ethanol, derived from biomass.
5. Sweet sorghum bagasse - is the fibrous matter that remains after sorghum stalks are crushed to extract their juice.
6. Miscanthus - any tall perennial bamboo-like grass of the genus Miscanthus, native from southern Africa to SE Asia
7. Sustainable Agriculture - any of a number of environmentally friendly farming methods that preserve an ecological balance by avoiding depletion of natural resources.

Section I: Agricultural Land Ownership/Lease

1. Do you currently own/lease any farmland in Kentucky (Acreage either owned/rented) in Kentucky?
   - Yes
   - No (Please return blank questionnaire in enclosed stamped envelope)

   Acreage Owned =

2. Please choose how much agricultural land you have acquired in the last 10 years. (Please fill in only one)
   - 0 acres
   - 1-9 acres
   - 10-24 acres
   - 25-49 acres
   - 50-99 acres
   - 100-149 acres
   - 150-199 acres
   - 200-299 acres
   - 300+ acres
3. Please choose the primary agricultural crop/livestock under which the majority of your agricultural land holdings fall. (Please fill in only one)

- [ ] Beef
- [ ] Corn
- [ ] Poultry
- [ ] Tobacco
- [ ] Swine
- [ ] Hay
- [ ] Soybean
- [ ] Dairy
- [ ] Other = _________

4. Please choose one ownership category under which the majority of your agricultural land holdings fall. (Please fill in only one)

- [ ] INDIVIDUAL (including joint husband, wife and family ownerships other than family corporations)
- [ ] PARTNERSHIP
- [ ] CORPORATE
- [ ] CLUB OR ASSOCIATION
- [ ] OTHER (please specify) ______________

5. What is the most appealing aspect of growing biomass (Please choose one)?

- [ ] Utilize under-performing land
- [ ] Use of existing equipment
- [ ] Diversify my farm
- [ ] Less crop management time
- [ ] Fewer inputs
- [ ] Other (please describe): __________________

6. What would discourage you the most from growing biomass (Please choose one)?

- [ ] Growing under a contract
- [ ] Changing your current operation
- [ ] Producing a perennial crop
- [ ] Needing assistance
- [ ] Market potential
- [ ] Other (please describe): __________________
## Section II. Biomass Issues

*Please remember these are your opinions and do not require scientific expertise.

1. For each statement below, please indicate your level of agreement or disagreement regarding biomass issues by filling in the single most appropriate answer.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Somewhat Disagree</th>
<th>Neutral</th>
<th>Somewhat Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>In my opinion, agricultural biomass is a viable energy alternative to fossil fuels.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I believe biomass used for energy production can help supplement our state's energy needs.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>In my opinion, economically viable technologies exist for converting biomass to bioenergy.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I believe my state can achieve governmental mandates requiring a percentage of total energy production come from renewable resources.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I believe harvesting agricultural biomass for bioenergy negatively impacts wildlife habitat.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I believe harvesting agricultural biomass for bioenergy negatively impacts air and water quality.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I believe harvesting agricultural biomass for bioenergy negatively impacts soil quality.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I believe harvesting agricultural biomass for bioenergy will reduce growth production on agricultural crops.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I believe agricultural biomass harvesting and collection will not require extra men and equipment.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
I believe agricultural biomass transportation can be done with traditional agricultural equipment.

<table>
<thead>
<tr>
<th>Extremely Negative</th>
<th>Somewhat Negative</th>
<th>Neutral</th>
<th>Somewhat Positive</th>
<th>Extremely Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
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</tr>
</tbody>
</table>

I believe agricultural biomass can be easily stored for long periods using traditional storage methods.

<table>
<thead>
<tr>
<th>Extremely Negative</th>
<th>Somewhat Negative</th>
<th>Neutral</th>
<th>Somewhat Positive</th>
<th>Extremely Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

I believe converting agricultural biomass to bioenergy is a simple process that can be done at most agricultural processing facilities.

<table>
<thead>
<tr>
<th>Extremely Negative</th>
<th>Somewhat Negative</th>
<th>Neutral</th>
<th>Somewhat Positive</th>
<th>Extremely Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

At this point in time, agricultural biomass is currently being utilized in our state for energy production.

<table>
<thead>
<tr>
<th>Extremely Negative</th>
<th>Somewhat Negative</th>
<th>Neutral</th>
<th>Somewhat Positive</th>
<th>Extremely Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

I believe agricultural biomass requires utilizing entire crop (e.g. corn, sweet sorghum) as well as residual feedstock (e.g. corn stover, sweet sorghum bagasse).

<table>
<thead>
<tr>
<th>Extremely Negative</th>
<th>Somewhat Negative</th>
<th>Neutral</th>
<th>Somewhat Positive</th>
<th>Extremely Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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<td>0</td>
</tr>
</tbody>
</table>

I would supply agricultural biomass to bio-refineries capable of producing energy for rural/local needs.

<table>
<thead>
<tr>
<th>Extremely Negative</th>
<th>Somewhat Negative</th>
<th>Neutral</th>
<th>Somewhat Positive</th>
<th>Extremely Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
</tr>
</tbody>
</table>

I would supply agricultural biomass to bio-refineries capable of producing energy for our State's needs.

<table>
<thead>
<tr>
<th>Extremely Negative</th>
<th>Somewhat Negative</th>
<th>Neutral</th>
<th>Somewhat Positive</th>
<th>Extremely Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

I would supply agricultural biomass to bio-refineries capable of producing energy for our Nation's needs.

<table>
<thead>
<tr>
<th>Extremely Negative</th>
<th>Somewhat Negative</th>
<th>Neutral</th>
<th>Somewhat Positive</th>
<th>Extremely Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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<td>0</td>
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<td>0</td>
</tr>
</tbody>
</table>

2. In general, what is your overall opinion of using biomass for bioenergy? (Please fill in only one)

<table>
<thead>
<tr>
<th>Extremely Negative</th>
<th>Somewhat Negative</th>
<th>Neutral</th>
<th>Somewhat Positive</th>
<th>Extremely Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

VII
3. For each statement below, please indicate your level of agreement or disagreement regarding biomass management issues by filling in the single most appropriate answer.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Somewhat Disagree</th>
<th>Neutral</th>
<th>Somewhat Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>In my opinion, the health of my agricultural land can be improved by using biomass for bioenergy.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I believe agricultural biomass is a low value product compared to traditional commodity crops.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I believe biomass harvesting will help diversify the management activities of my agriculture and/or forest land.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

4. For each statement below, please fill in the appropriate response that best describes your current management activities regarding your agricultural land. (N/A means this does not apply to you or you are unaware of the answer)

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you practice sustainable agriculture?</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Would you be willing to participate in management activities specifically geared toward biomass production such as short rotation woody crops (miscanthus, poplar, sweet sorghum, etc.)?</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Section III. Biomass Policy and Market

*Please remember these are your opinions and do not require scientific expertise.

1. For each statement below, please indicate your level of agreement or disagreement regarding biomass policy issues by filling in the single most appropriate answer.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Somewhat Disagree</th>
<th>Neutral</th>
<th>Somewhat Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax credits should be given to landowners, harvesters and companies that utilize biomass intended for energy production.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Government subsidies should be provided, as incentives, to companies for selling biomass residues (e.g. hulls, stover, etc.) from agricultural and mill operations.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Government incentive programs should be provided to supplement the costs of establishing biomass crop species (miscanthus, poplar, willow, sweet sorghum, etc.).</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Grants should be awarded for research and development capable of advancing biomass production technologies.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Secured loans should be provided to develop and construct commercial scale bio-refineries.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

2. For each statement below, please indicate your level of agreement or disagreement regarding biomass policy issues by filling in the single most appropriate answer for each statement.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Somewhat Disagree</th>
<th>Neutral</th>
<th>Somewhat Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>In my opinion, we should use agricultural biomass as feedstock for bioenergy markets.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I believe my community is capable of supplying a biomass to bioenergy market.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
3. Would you participate in a biomass to bioenergy market?
   o NO
   o YES

Section IV. Please Tell Us More About Yourself

*Remember, your responses are completely anonymous. If you feel uncomfortable answering questions in this section, please complete the rest of the survey and return it.

Thank you.

1. What is your age? (Please fill in only one)
   o Under 25  o 35-44  o 55-64
   o 25-34  o 45-54  o 65 and over

2. What is your primary occupation?
   Principal: ______________________  Spouse: ______________________

3. Are you a resident or non-resident agricultural landowner/lesser in Kentucky?
   o RESIDENT  o NON-RESIDENT

4. How long have you owned agricultural land in Kentucky?
   _______ YEARS
5. What is your best estimate of the total combined income of all members of the owner’s household over 14 years of age during the past 12 months? (Please include NET income from businesses, farming, and rentals, money from jobs, pensions, dividends, interest, social security, unemployment, welfare, and workman’s compensation.) **(Please fill in only one)**

- [ ] Less than $20,000
- [ ] $20,000 - $39,999
- [ ] $40,000 - $59,999
- [ ] $60,000 - $79,999
- [ ] $80,000 - $99,999
- [ ] $100,000 - $124,999
- [ ] $125,000 - $150,000
- [ ] Over $150,000

6. What is your gender?

- [ ] MALE
- [ ] FEMALE

7. What is your marital status?

- [ ] Never married
- [ ] Divorced or separated
- [ ] Widow or Widower
- [ ] Married or living with partner

8. What is your level of education? **(Please fill in the highest level reached)**

- [ ] Some high school or less
- [ ] High school graduate
- [ ] Some college
- [ ] College graduate
- [ ] Graduate degree (M.S./Ph.D.)

9. What is your ethnic group?

- [ ] Caucasian
- [ ] Hispanic
- [ ] Asian or Pacific Islander
- [ ] Native American (Indian, Eskimo)
- [ ] African-American
- [ ] Other

10. How many times did you attend extension workshops or experiment station field days in 2012?

- [ ] Never
- [ ] 1-2
- [ ] 2-5
- [ ] 6-10
- [ ] Over 10
- [ ] Other (Please Describe) ___ _
11. Do you currently belong to any of the following types of organizations? (Check all that apply)

- Grower or commodity organizations
- Cooperatives
- Hunting-related organizations
- Farm Bureau
- Environmental organizations

Please feel free to offer additional comments: