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Small and medium enterprise agricultural producers and forest landowners attitudes and perceptions towards new bio-based paths to prosperity: a pilot study in Louisiana and Mississippi

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SMALL AND MEDIUM ENTERPRISE AGRICULTURAL PRODUCERS AND FOREST LANDOWNERS ATTITUDES AND PERCEPTIONS TOWARDS NEW BIO-BASED PATHS TO PROSPERITY:
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Abstract

Energy producers, developers, legislators, policy makers, and the public are searching for alternative energy sources to alleviate energy demands and dependency on fossil fuels. Of the renewable energy sources, biomass from forestry, crop, and animal residues offer a clean and sustainable solution to help mitigate climate issues and stabilize energy needs. However, most of forests and farms in the U.S. are privately owned by either individuals or families. It is important to understand forest landowners', agricultural producers', and poultry producers' attitudes and perceptions towards management activities intended for producing bio-based products. Three surveys were conducted tailored for each group. We surveyed 3,500 small to medium forest landowners in Southwest Louisiana, 2,964 small to medium agricultural producers in the Delta region of Louisiana and Mississippi, and 846 poultry producers within the U.S.

Results from all three surveys suggest respondents were positive about utilizing biomass for bioenergy. Results from all three surveys suggests a large portion of the antagonistic or neutral attitudes respondents had towards bio-based issues are due, in part, to lack of information or knowledge on the subject. Also, the majority believed that viable technologies exist for converting biomass to bioenergy. However, most believed it is a low-value product compared to traditional products.

Just over half of both the forestry and agricultural producer survey respondents said they would participate in management activities specifically geared for biomass production or participate in biomass markets. Older respondents were more likely to agree that harvesting biomass will negatively impact wildlife habitat, air, water, and soil quality. Also, they had a higher propensity to agree that tax credits, subsidies, and incentive programs should not be

provided for biomass establishment, selling, and utilization. In direct contrast, results suggest that larger landowners and producers were less likely to agree that harvesting biomass will negatively impact wildlife habitat, air, water, and soil quality. Also, they were more likely to agree tax credits, subsidies, and incentive programs should be provided for biomass establishment, selling, and utilization. As for poultry producers, results indicated that the majority would participate in the sale of poultry litter biomass and biomass markets. Also, poultry producers appeared to have a higher level of familiarity towards biomass concepts and issues when compared to forest landowners and agricultural producers.

Chapter 1. Introduction

Prior to the industrial revolution of the U.S., biomass in the form of wood, crop residues, and animal manure satisfied nearly all of man's energy production needs. The environmental movement of the 1960's spurred the creation of several policies intended to reform emission and pollution practices of the industrial sector in order to provide the nation a cleaner environment. Persistent concerns of society continuing to become more highly mechanized and dependent on fossil fuels created an interest in bio-based projects.

Biomass essentially began to be examined in the 1970's as a solution to the energy crisis resulting from heavy regulations and predicted shortages within the fossil fuel industry. However, the discovery of fossil fuel reserves followed by a deregulation of the oil industry led to an era of cheap energy. More recently, occurrences such as a global recession along with instability within oil-rich countries, among other factors, inflated energy prices to unprecedented levels.

Concurrent with increased energy prices is a revitalization of environmental awareness. The 21st century is the beginning of a period with increasing requirements for holistic approaches land stewardship supported by science-based methods to help solve environmental issues. Issues fueling these requirements are soil, water, and air quality to name a few. Added to environmental concerns is increasing demand for energy.

Increases in population, survival rates, and technological advancements are just a few of the social issues augmenting stress to the energy predicament. Many energy producers, developers, legislators, academia, policy makers, and the public are searching for alternative energy sources to alleviate the energy demand and dependency on fossil fuels. These interested parties view renewable energy sources as clean and sustainable solutions. Of the renewable

energy sources, biomass feedstock from forestry, agricultural, and livestock industries offer potential to help mitigate environmental issues and stabilize energy needs.

Recently, several innovations and technology advancements have come from the biomass industry. Advancements within the industry are primarily focused on the areas of harvesting and collection, storage, pretreatment, and conversion of biomass to bio-based products. The preprocessing and pretreatment of biomass also increases the potential gain of biomass to bioenergy efficiency (Meza et al. 2008; Jackson et al. 2010; Zhu and Pan 2010). Once treated, biomass resources can be converted to energy using a variety of processes to generate electricity, fuel vehicles, residential and commercial heating, as well as provide process heat for industrial facilities. With advancements in biomass technologies in place, energy producers seek sustainable supplies of biomass feedstock to ensure long-term success. Such feedstocks can come from the forestry and agricultural communities.

Projections show that U.S. energy consumption is increasing and will continue to increase, with bio-based products gaining attention to supplement this growing demand for energy (Komiyama et al. 2001). Innovations within the biomass industry are aiding the development of bio-based facilities throughout the U.S. For example, many facilities are capable of utilizing multiple feedstocks to create energy from either direct firing or co-firing processes. The continued development of bio-based products and facilities may help to establish several market opportunities for forest landowners, farmers, and poultry producers by providing feedstock in the form of post-harvest residues and dedicated energy crops including trees, crop residues, and animal wastes.

If the success of the biomass industry occurs, the diverse markets that emerge will secure the demand for a sustainable supply of biomass feedstock. Augmenting fundamental markets are

policy initiatives in the form of mandates, incentives, and tax provisions. Government agencies in partnership with industry and academia will likely be focused on achieving goals requiring specific amounts of renewable fuels be produced by future deadlines. Any increases in demand for a sustainable supply of biomass feedstock will challenge forest landowners and farmers to adopt innovative practices. They may be asked or forced into participating in government programs that support bio-based production. Understanding forest and agricultural producers' knowledge and attitudes towards biomass technologies and initiatives can help energy producers and policy makers develop programs tailored for these important groups.

The long-term success of bio-based facilities and markets is dependent in part on the level of commitment of feedstock from forest landowners and farmers. Forest, crop, and animal residues present considerable potential as a biomass feedstock. They are renewable, sustainable, locally available, and often considered carbon-neutral when compared to fossil fuels (Hoogwijk 2003;Mathews 2008).

Forest feedstock differs from crop and animal residues in many ways. Forestlands of the U.S. covers over a third of the total land base (Perlack et al. 2005). Nearly all biomass feedstock used for energy production today comes from wood wastes and residues (Parikka 2004). The forest sector offers a variety of feedstock types ranging from in-woods, pre-merchantable roundwood or harvest residues to sawmill residues such as bark and sawdust.

Ownership of forests within the U.S. varies by regions. Over 70 percent of the forests in the West are publicly owned (Oswalt et al. 2009). Individuals or families own the largest percentage of the forests in the Northeastern and Southeastern U.S. (Oswalt et al. 2009). They own 58 percent of forests in the U.S. North and 60 percent in the U.S. South (Oswalt et al. 2009).

Although a large part (24 percent) of the eight percent of total biomass energy production comes from wood, the development and expansion of a biomass industry in the U.S. will require the use of bioenergy crops and agricultural residues (Walsh 2003;U.S.E.I.A. 2009). One report suggests crop residues have the largest readily available source for biomass production (Millbrandt 2005). Nearly all (98 percent) agricultural land in the U.S. is owned by families or individuals (U.S.D.A. 2010).

In addition to forest and agricultural residues, animal wastes are receiving attention as a viable biomass feedstock; especially poultry litter. The poultry industry is one of the fastest growing sectors in the livestock industry in the U.S. (U.S.D.A. 2010). Similar to agricultural producers, the overwhelming majority of poultry producers are individual and families (U.S.D.A. 2010).

Despite some differences, several characteristics persist among forest landowners, agricultural producers, and poultry producers. All three groups share socio-demographic characteristics such as age, income, and education levels. Also, the majority of these forest landowners, agricultural producers, and poultry producers are individual and families (Oswalt et al. 2009; U.S.D.A. 2010). Above all, the decisions of these landowners and producers impact sustainability of harvest yields, rural economies, future policies, and health of ecosystems.

Collectively, a limited amount of research has been conducted that covers forest landowners, agricultural producers, and poultry producers pertaining to biomass. It is important that managers and owners of bio-based facilities have a priori knowledge of the availability of current and future biomass feedstock. Since demand for feedstock likely will be supplied by forest landowners, agricultural and poultry producers, knowledge of their management activities and production levels is considered necessary. Also, little is known about the thoughts and

knowledge of landowners and producers towards bio-based opportunities. It is equally important that state and local representatives along with other lawmakers have insight into their attitudes and perceptions towards bio-based activities so the objectives of future policies meet their intentions from a supply standpoint. Finally, it is important that potential biomass producers understand the landscape so they can make decisions based on involvement.

1.1 Summary

Society has and will continue to use bio-based resources to produce energy and fuel. Biomass is gaining momentum as feedstock for bio-based products to help lower carbon emissions and alleviate dependency on fossil fuels. Recent advancements in bio-based technology coupled with increasing demands for energy have spurred the development of bio-based facilities. However, the long term success of bio-based facilities and their subsequent markets will depend heavily on the availability of feedstock. Forest and crop residues as well as animal wastes (e.g. poultry litter) offer great potential as biomass feedstocks capable of supporting such entities.

Several concerns arise when considering the future of bio-based markets. Even though forest landowners, agricultural producers, and poultry producers have a potential abundance of feedstock availability, little is known about the extent to which they are willing to participate in the supply of feedstock to bio-based markets. Their knowledge concerning the perceptions of utilizing biomass for bioenergy is fundamental to help bridge the gap between producers and suppliers. A better understanding of their activity levels and their perceptions towards bio-based activities will help in identifying alternative business practices. In turn, this should help diversify their portfolios and create revenue streams by properly marketing bio-based products.

Since the future of bio-based facilities and subsequent markets are partly dependent on a sustainable supply of biomass feedstock, major suppliers, such as forest landowners, agricultural producers, and poultry producers, must be studied extensively. This study provides the necessary information regarding the attitudes and perceptions of these three important groups towards bio-based opportunities and their emerging markets.

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Chapter 2. Research Overview: The History, Current Development, and Future Outlook of Bio-based Supply and Demand for Energy

2.1 History of Biomass for Energy

2.1.1 History of Wood Biomass for Energy

Where great civilizations have evolved, wood has been universally present and utilized. Primitive uses for wood included tools, weapons, shelter, and an energy source. As societies have advanced, so has their use of wood. Besides cooking, heating, weaponry, and furniture making, Americans began to develop advanced applications for wood in industrial settings. Developments in industrial construction led to the building of water mills, wind mills, machinery frames, and mechanized machinery such as axles and gears (Stuart and Grace 2009). As an energy source wood was, and still is, being used in direct combustion devices such as fireplaces, woodstoves, and industrial boiler systems (Hewett et al. 1981).

Wood as an energy source played an integral role in the development of the U.S. Wood-fired steam engines provided power to factories, locomotives, and riverboats forging the U.S. towards an industrial revolution (Green 2006). As late as 1850, ninety percent of the energy use in the U.S. came from wood consumption; which began to decline in 1870 and peaked again in 1933 due to the depression (Clawson 1979). Nonetheless, by 1885 coal supplied about as much energy as wood (Green 2006). The immediate abundance of coal coupled with the supply of electricity to urban and rural areas led to a constant decline in wood as an energy source lasting until the 1960’s (Green 2006).

Starting in the 1960’s, wood energy use gradually began to increase due to changes in social, political, and technological trends (Clawson 1979). During the 1970’s, strict regulations

discouraging open burning and landfill disposal of industrial residues, rising petroleum costs, and growth in the forest products industry revived wood as an energy source (Hewett et al. 1981).

2.1.2 History of Agricultural Biomass for Energy

Agriculture has played an important role in the development of societies. The 1850's marked the beginning of industrial agricultural in the U.S. similar to present day agriculture with the use of machinery and monocropping (Landenberger 2005). Changes in technology over the past 100 years have played a major role in the amount of harvested cropland, amount of agricultural labor, and agricultural production in the U.S. (Sundig, 2000).

Agricultural production has been a major force for growth in U.S. agriculture (Fuglie 2007). Although agriculture continues to grow in the U.S., most research on biomass as an energy source, until recently, was primarily on wood biomass (Bain 1993). With agricultural productivity on the rise, cellulosic biomass from agricultural feedstock has great potential to displace future gasoline production (Fuglie 2010; Kim and Dale 2004).

Advancements in plant breeding have resulted in increased yields and quality (Dimitri et al. 2005). Thus, cellulosic biomass sources offer immense potential as feedstock for future biofuel production (Westscott 2007; Powlson et al. 2005). However, corn was the primary feedstock for the approximately five billion gallons of ethanol produced in 2006 in the U.S. (Westscott 2007). Due to the negative aspects of using food crops for bio-based products, extensive research has been performed on dedicated energy crops (Powlson et al. 2005; Walsh et al. 2003; Monique et al. 2003). These sources of cellulosic biomass include a genetically diverse range of herbaceous crops and primarily tall grasses (Monique et al. 2003). Both herbaceous

crops and tall grasses (e.g. *Miscanthus floridulus* and *Panicum virgatum*) can be planted, managed, and harvested using existing agricultural equipment (Walsh et al. 2003).

2.1.3 History of Poultry Litter Biomass for Energy

Animal manure has been used as an energy source for years. Recently, large confinement systems have been developed for livestock on smaller acreage (Jongbloed and Lenis 1998). The change in structure, genetic improvements, animal health, and increased demand from consumers has led to increased production (Jongbloed and Lenis 1998;Naylor et al. 2005). In the U.S., most of the livestock production growth is occurring within these industrial systems (Naylor et al. 2005). For example, the U.S. produces more poultry meat than any other country which produces millions of tons of poultry litter annually (Livingston 2004; Perera et al. 2010).

The increased litter production has led to the realization that suitable land for receiving litter is finite. Coupled with this, environmental and health issues are causing concerns of using litter as a long-term fertilizer and feedstock (Kelleher et al. 2002; Siefert et al. 2004; Whitely et al. 2006). One of the leading alternatives from an environmental and economic standpoint is using poultry litter for energy production (Kelleher et al. 2002; Paudel et al. 2010; Perera et al. 2010; Whitely et al. 2006).

2.2 Emergence of Biomass as a Feedstock for Energy

During the 1970's, strict regulations discouraging open burning and landfill disposal of industrial residues, rising petroleum costs, and growth in the forest products industry revived biomass as an energy source (Hewett et al. 1981). Following this period, biomass received increased attention as a viable supplemental energy source from forestry, agricultural, and animal residues. Biomass energy comes from biological resources such as agricultural crop residues,

fuelwood, charcoal, animal and municipal wastes, or other biofuels derived from plant material. Technological advancements were made in biomass energy conversion processes such as direct combustion, gasification, and bio-fuels (Hewett et al. 1981). Despite the biomass renaissance of this era, biomass energy consumption was 1.4 to1.7 quadrillion BTU's[1], or a modest two percent of the nation's energy needs (OTA 1980).

In recent years, policy makers, legislators, developers, and energy producers have been searching for less expensive, more reliable, and renewable domestic energy sources. Hydro-electric, geothermal, wind, solar, and biomass energy are the most common forms of renewable energy sources that are being used to alleviate our dependency on fossil fuels. Biomass is an attractive choice because it is cost efficient, clean, and the only current renewable source of liquid transportation fuel (Perlack et al. 2005; U.S.D.O.E. 2010; U.S.D.A. 2009). Currently in the U.S., biomass provides about seven percent of the total energy consumption supplying 7.3 quads BTU (EIA 2009).

The 21st century has begun as a period of increasing demand for holistic approaches to land stewardship supported by science-based methods to help solve our need for energy. In recognition of our growing dependence of fossil fuels, congress has already enacted legislation to increase our supply of alternative fuels. The U.S. Department of Energy (DOE), in partnership with other government agencies, industry, and academia, is focused on obtaining a goal of 36 billion gallons of renewable fuels by 2022 as required by the Renewable Fuel Standard (RFS) under the Energy Independence and Security Act of 2007 (EPA 2010).

[1] One quadrillion BTU is equal to 1055 x 10^{15} Joules or approximately 2.93 x 10^{11} kilowatts per hour.

2.3 Advancements in Cellulosic Biomass Technologies

The utilization of biomass could help provide the nation a clean, cost-efficient, renewable energy source. Over the past decade extensive research was conducted to help advance the biomass to bioenergy technologies. Areas of interest include storage, preprocessing, pretreatment, and conversion. Understanding the current state of technologies concerning biomass should help guide decision makers in establishing costs and production levels needed for the development of bio-based markets.

2.3.1 Storage

The versatility of biomass as a renewable energy source is that it can be burned directly to supply heat and power or can be converted to biofuels for transportation utilization. In comparison to other renewable energy sources, it is reliable and may be stored for future use. Storage of biomass is a key part of the logistical procedures relative to creating bioenergy. Also, a constant demand from biomass facilities paired with its seasonal availability due to weather conditions and growing seasons make storage necessary (Rentizelas et al. 2009).

Storage options for supplying biomass facilities include on-field storage, intermediate storage, and on-site facility storage (Rentizelas et al. 2009). On-field storage is both convenient and economical but can lead to degradation, material lost, and other risks. Lack of control over weather and moisture content can cause spore and fungus fermentation, degradation due to infections, fermentation and material loss and chemical breakdown which may lead to internal combustion (Rentizelas et al. 2009). Currently, on-site facility storage is the only viable means of accelerating the drying process, thus reducing the problems of quality degradation, fire damage, or formation of toxic microbes (Rentizelas et al. 2009).

2.3.2 Preprocessing and Pretreatment

Biomass refinement is often necessary to increase the potential gain of biomass-to-energy efficiency. Manipulation of its properties such as moisture content, bulk density, size, and chemical composition can be achieved through both chemical and physical processes (Zhu and Pan 2010). Physical biomass to energy processes, or preprocessing, includes chipping, grinding, milling, drying, pelletizing, briquetting, and charcoal production. Some of these methods may be used in conjunction with biochemical activities, but most are utilized in thermochemical reactions. Chemical pretreatment of feedstock has been considered necessary to remove biomass recalcitrance for microbial and enzymatic processing during cellulosic ethanol production (Zhu and Pan 2010).

Reducing moisture content affects the efficiency of thermal processes like combustion, gasification, and pyrolysis (Jackson et al. 2010). High moisture contents can reduce the net heat available during combustion by twenty percent. Therefore, reducing moisture content to consistently low levels (e.g. bone dry material) can increase the efficiency of combustion (Jackson et al. 2010). Two common methods of drying cellulosic biomass include direct heat and indirect heat drying.

Since most biomass is almost entirely composed of cellulose, oxygen, water, and trace amounts of minerals, combustion produces a combination of oxygen and carbon to form carbon dioxide and oxygen with hydrogen to form water vapor as well as energy in the form of more heat and light (Jackson et al. 2010). Refineries can utilize flue gases, or heat, produced from combustion of particles in boilers to directly reduce the moisture content. Although different types of dryers (flash, cascade, and rotary) are available for such purpose, rotary dryers have low cost of maintenance and consume fifteen percent and thirty percent less specific energy than the

flash and cascade types (Meza et al. 2008). For direct heating, rotary drum dryers are also the most common and flexible. Rotary drum come in pneumatic and trommell types that are adaptable to options of feeders, biomass particle sizes, and heat flow direction (co-current or counter-current). Although direct heat drying systems produce volatile organic compounds during combustion, thermal oxidizers are used to facilitate emissions controls (Jackson et al. 2010).

Charcoaling is an older physical biomass to bioenergy process that was used variously throughout history. During the charcoal process, biomass is burned at high temperatures with little to no oxygen. Intense heat creates a chemical reaction which releases water and other organic compounds. The temperature reaches a level where it is carbonized and chemical reactions are absent (over 662°F; 350°C) (Jackson et al. 2010). Once any tar is removed, the charcoal goes through a cooling process. The charcoal is then crushed with additives such as starch in order to form briquettes.

Chemical pretreatment processes differ from depending on the feedstock. Besides physical differences, woody biomass residues have higher lignin content than agricultural crop residues making the material more recalcitrant to microbial and enzymatic actions (Zhu and Pan 2010). Chemical pretreatment of lignocellulosic biomass is the process of using chemicals to remove or modify lignin, cellulose and hemicelluloses, and other compounds (Kumar et al. 2008). Lignin makes up twenty to thirty percent of cellulosic biomass and promotes blockage to enzymatic saccharification by retarding cellulose hydrolysis through physical blockage and unproductive absorption of enzymes (Zhu and Pan 2010). Achieving the goal of pretreating biomass to remove lignin and other compounds increases hydrolysis of sugar yields to nearly

ninety percent of theoretical yields in comparison to twenty percent of non-pretreated biomass (Jackson et al. 2010).

2.3.3 Biomass Conversion to Energy

Biomass resources can be converted to energy using a variety of processes in order to meet the need of generating electricity, fueling vehicles, residential and commercial heating, and providing process heat for industrial facilities. Although conversion technologies of biomass are extensive and numerous, most of the methods mentioned are geared toward uses in advanced bio-facilities and are flexible in that they can also be used in other agricultural applications. Biomass conversion technologies can be broadly divided into two categories: thermochemical processes and biochemical processes.

Direct combustion of biomass is one of the most common and oldest processes used today. The process of direct combustion combines air with fuel to produce heat, water, carbon dioxide, ash, and trace compounds. For residential purposes, energy can be created using direct combustion in stoves and small scale furnaces. Direct firing at an industrial level uses furnaces or boilers to produce process heat, electricity, or both in a combined heat and power (CHP) system.

Some of the most common biomass combustion boiler designs are pile burners, stoker-fired furnaces (fixed bed furnaces), suspension-fired furnaces (pulverized fuel systems), and fluidized bed furnaces (Saidur et al. 2011). Pile burners and stoker-fired furnaces require less capital investment than other combustion technologies; however, they have less efficiency gains (Jackson et al. 2010). Suspension-fired furnaces achieve high efficiency utilizing technology common to the coal industry for coal-fired furnaces. Fluidized bed furnaces are new to boiler

technologies that have an ability to handle a wider variety of fuels and moisture content as well as having the highest thermal conversion efficiencies due to more complete combustion when compared to other boiler technologies (Saidur et al. 2011). Potentially, CHP systems have a wide range of small and large scale applications combined with higher efficiencies rendering lower emissions than systems producing separate heat and power.

In gasification, biomass is heated in a high temperature environment with steam, air, and oxygen until volatile gases are released (Combs 2008). The gaseous mixture of hydrogen, carbon monoxide, carbon dioxide, and other compounds can be mixed with oxygen and burned to produce steam to operate a turbine and generate electricity. Alternatively, the gases can be cooled, filtered, purified, and stored as a synthesis gas, or syngas, to be used as fuel for internal combustion engines, gas turbines, etc. A major cost associated with gasification is tar removal and/or clean up (Jackson et al. 2010). However, another gasification process using supercritical water (high temperature steam conditions) offers low levels of char formation and the ability to use high moisture feedstock (Jackson et al. 2010).

Pyrolysis is the gasification of biomass in the absence of oxygen and converts wood biomass to a mixture of solid, liquid, and gas (Saidur et al. 2011). The advantages of pyrolysis include a flexible process of converting solid biomass into an easily stored and transportable fuel, which can be successfully used for the production of heat, power, and chemicals. Slow pyrolysis (e.g. charcoal production) converts feedstock using relatively low temperature levels and long reaction times, whereas fast pyrolysis produces small molecules by converting feedstock at high temperature levels (Jackson et al. 2010). The process transforms the biomass into pyrolysis oil (or bio-oil) or syngas without creating ash or energy directly.

Torrefaction is a form of mild pyrolysis that pre-treats wood biomass at relatively low temperatures of 200-300°C in the absence of oxygen (Bergman and Kiel 2005). Gasification of wood biomass is comparatively low at less than 700°C due to high oxygen to carbon (O/C) ration of the fuel and moisture content leading to thermodynamic losses (Prins et al. 2006). As a pretreatment to gasification, torrefaction produces a solid material with high energy efficiencies, lower MC, lower O/C ratio, and is hydrophobic in nature (Jackson et al. 2010). Also, it improves the properties of biomass enabling more efficient co-firing at bio-facilities (Bergman and Kiel 2005).

Biochemical conversion is a chemical decomposition of biomass' cell wall using cellulase enzymes or acids in order to extract sugars for conversion to ethanol (U.S.D.O.E. 2008). Specifically, lignocellulosic hydrolysis is a process of utilizing cellulase enzymes to produce sugar. After the hydrolysis stage, fermenting organisms (e.g. yeast) are added to the mixture inside the fermentor to convert sugars to alcohol and carbon dioxide (Jackson et al. 2010; U.S.D.O.E. 2008).

2.4 Conclusions

Early settlement of the U.S. was dependent upon renewable natural resources to fuel their energy needs. Recent advancements in technology shifted the nation's energy usage to primarily fossil fuels. Since the 1960's, the environmental movement gradually increased interest in alternative energy sources. Also, the demand for energy is increasing engendering an inherent demand for renewable energy resources. Advancements in bio-based technology should help foster emerging bio-based markets.

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Chapter 3. Louisiana Forest Landowners' Attitudes and Perceptions towards Participating in New Bio-based Business Opportunities

3.1 Introduction

Cellulosic biomass from forest industry residues is the leading source of renewable natural energy (Jackson et al. 2010). It has several advantages such as lowering carbon dioxide emissions and stabilizing energy dependence. Louisiana is an area rich in biomass resources with over half the state covered in forests (U.S.F.S. 2005). However, most of these forests are privately owned by either industrial or non-industrial landowners (LSUAgCenter 2009). The decisions of these landowners could affect key issues such as the environment, sustainability, and supply. It is important to understand landowner's knowledge of key biomass issues and concepts as well as their willingness to participate in bio-based activities.

3.2 Problem Statement

National concerns about issues such as fossil fuel supplies and climate change have stimulated interest in renewable energy sources among energy producers, developers, legislators, and policy makers. Hydro-electric, geo thermal, wind, solar, and biomass energy are the most common forms of renewable energy sources that are being used to replace dependency on fossil fuels. The current global energy consumption is estimated to be 8,000 MTOE (Million Tons of Oil Equivalent) per annum. Projections have shown energy consumption will increase to higher than 15,000 MTOE by 2050 (Komiyama et al. 2001). Bio-based renewable energy, such as bioenergy from cellulosic biomass, could provide us with opportunities to help stabilize our energy use.

Louisiana, the study region, is rich in cellulosic biomass resources readily available for bioenergy production from the forestry industry. In Louisiana, experts have estimated

approximately 4,289 million KWh, or 15.43 gigajoules of energy can potentially be produced from woody biomass residue (de Hoop 2006). Knowing the amount of available cellulosic biomass available should help advance the development of a bio-based market.

The U.S. South[2] is an area rich in natural resources. Of the 200 million acres of timberlands in the South, approximately 90 percent (181 million acres) are privately owned either by forest industry or non-industrial private forest landowners (NIPF). NIPF landowners account for the greatest share of timberlands with 4.9 million landowners owning 71 percent of the forestland in the South (Conner 2002) while NIPF landowners account for about 62 percent of the forest land ownership in Louisiana (LSUAgCenter 2009).

With respect towards bio-based paths to prosperity, attitudes and perceptions among private forest landowners are important to consider because they are the ones ultimately making management decisions for their land (Conner 2002). These management decisions by landowners could affect sustainability of harvest yields, state and local economies, future policies, and health of forest ecosystems. It is critical for lawmakers, energy producers, and developers to interpret the willingness of forest landowners to participate in the biomass market so as not to overestimate the supply of biomass.

3.3 Literature Review

3.3.1 Availability of Forestry-Based Biomass Resources

U.S. forests are expanding with an annual net forest biomass increase of 3 percent (Kizhakkepurakkal 2008). With a national growth to removal ratio of 1.72 and a decrease of

[2] Southern states refers to Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas and Virginia.

timber product output of nine percent since 1996, indications show that forests are not being over-harvested or pushed to their productive limits (Jackson et al. 2010). This creates new opportunities for the forest products industry, especially in bioenergy sectors. One study shows that American forests are able to sustainably produce 368 million dry tons of wood for energy generation per year; this figure is an underestimation as it excludes the wood used for pulp/paper, low-value solid products, or wood from fast-growing trees on nonagricultural lands (Richter et al. 2009). In a recent study by Jackson et al. (2010), they estimate 142 million dry tons of wood residues are currently used by the forest industry. This leaves a reported 137 million dry tons of woody biomass potentially available for energy production.

Of the nearly 2,263 million acres of land in the United States, approximately 33 percent, or 749 million acres, are forestlands (Perlack et al. 2005). About two-thirds of this, or 504 million acres, are classified as timberland capable of growing annual wood yields of 20 cubic feet. Of all the forestland regions, the U.S. South has the highest forestland partly due to its sub-tropical and temperate climate, the steady supply of rainfall, and availing topography.

The U.S. South is the “wood basket of the nation.” The total forestland in the U.S. South is 200 million acres, which is 40 percent of the 504 million acres of forestland nation-wide (Smith 2009). As mentioned earlier, the majority of southern timberlands are privately owned. Of these Southern states, Louisiana is rich in renewable natural resources available for bioenergy production from the forestry industry (de Hoop 2006). The intention of this survey is to develop protocols and processes for the study region transferable to other Southern states with similar agricultural and forest resource bases.

Wood residue is an important low-cost source of renewable biomass energy in regions where forest cover forms a major portion of land area (Parikka 2004). Renewable bioenergy

made from woody biomass materials can come from several sources throughout the U.S. Nearly all of biomass fuel used for energy production today comes from wood wastes and residues (Parikka 2004). Wood residues from forest products used for conversion to biomass energy can be broadly categorized into forest residue, residue from forest products industry, and urban wood waste, based on their origin (**Table 1)**.

Table 1: Types of Wood Residues from Different Operations (Source: Parikka, 2004)

Source of Residue	Type of Residue
Forest operations	Branches, needles, leaves, stumps, roots, low-grade and decayed wood, slash, sawdust
Sawmilling and planing	Bark, sawdust, trimmings, split wood, planer shavings
Plywood and composite panel production	Bark, core, sawdust, veneer clippings and waste, panel trim, screening fines, sawdust, sander-dust
Secondary forest products industry	Bark, wood chips, shavings, sawdust, etc.
Urban wood waste	Municipal solid waste, construction and demolition debris, discarded wood products, tree trimmings

Wood residue from forest products industry can be divided into residue from primary and secondary industry, depending on the source of origin. In sawmill and plywood industries, wood residue accounts for approximately 45 to 55 percent of the timber input while sawing and squaring wastes about eight to ten percent and 30 to 50 percent respectively (Parikka 2004). Primary mill residues include wood materials (coarse and fine) and bark generated at manufacturing plants (primary wood-using mills) when round wood products are processed into primary wood products like slabs, edgings, trimmings, sawdust, veneer clippings and cores, and

pulp screenings. Secondary mill residues include wood scraps and sawdust from woodworking shop, furniture factories, wood container and pallet mills, and wholesale lumberyards. These residues are potential biomass fuels that can be used for energy production.

Urban wood residues are an underutilized biomass resource that has a huge potential. Municipal solid waste (MSW) and construction and demolition debris are the two primary sources of urban wood residues. The woody portion of the MSW includes discarded furniture, pallets, packaging materials, lumber scraps, utility tree trimming, and/or private tree companies. The other source of urban wood residues is construction and demolition debris which comes from construction and demolition activity.

Forest residues are logging residues and other removable material remaining after performing silvicultural operations and site conversions. It is estimated that between 30 and 60 tons per acre of biomass are left on the ground following a typical timber harvest. This could be a valuable feedstock for a plant that produces energy (Bogren 2008). Logging residue comprises unused portions of trees cut or felled by logging operations and left in the woods. Other removable materials are the unutilized volume of trees cut or felled during land conversions and silvicultural treatments such as precommercial thinning. Louisiana has high concentrations of forest residues **(Figure 1)**.

The forests of Louisiana cover nearly half of the land area at approximately 13.8 million acres (U.S.F.S. 2005). The diversity and abundance of forests are capable of supporting wildlife habitat, forest harvesting activities, and numerous outdoor recreational activities. The major forest types are oak-gum-cypress, loblolly-shortleaf pine, oak-hickory, oak-pine, and longleaf-slash pine (**Figure 2**).

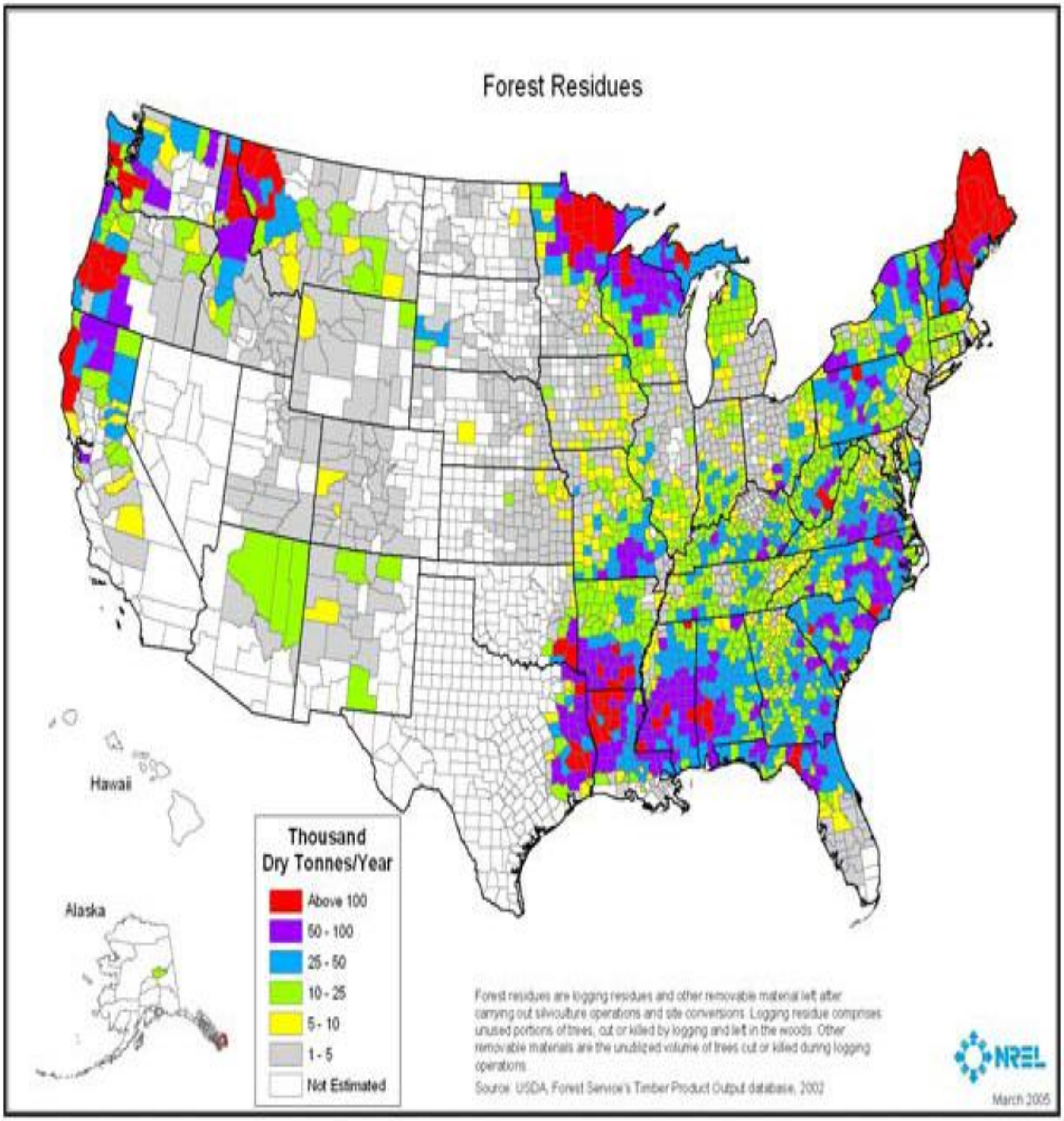

Figure 1: Estimated Forest Residues by County (Source: Milbrandt, 2005)

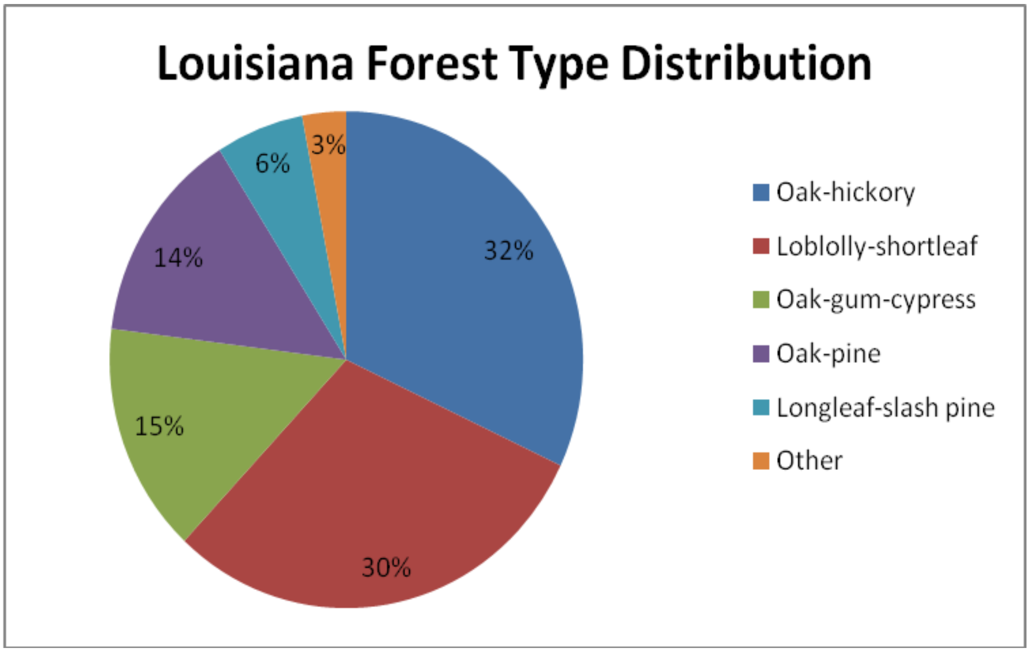

Figure 2: Louisiana's Major Forest Type Distribution (Source: U.S.F.S 2009)

3.3.2 Current State of Technological Advancements in Wood Biomass to Energy

Wood has been utilized as a natural resource for energy production throughout the ages. Several advancements in biomass technology have been made since the environmental awakening that began in the 1960's in the U.S. Current energy and climate issues have further stimulated developments within this area of research. Particular areas of research include harvesting/collection, storage, preprocessing/pretreatment, and conversion. Staying abreast of the advancements in these areas of research helps in better understanding the benefits and limitations of woody biomass.

Currently, many new developments in the area of forest operations technology are being designed to efficiently harvest and collect small wood and understory biomass. In a report by Rummer (2004), studies show that an intermediate processing step to convert the woody biomass residue into bundles or chips can significantly reduce biomass extraction and transportation

costs. Technological advancements allow harvest operators a wide array of equipment configurations to integrate biomass harvesting into traditional operations or perform complete biomass harvesting. Advancements in technology include grapples, shears, skidders, feller-bunchers, and swath cutters designed specifically for biomass harvesting.

In-woods comminution, or densification, of woody biomass residue is a process by which small diameter trees, tops, limbs, or other woody biomass residue is either cut, chopped, grinded, or shredded. Jackson et.al (2010) report that adding a comminuting process to traditional operations can generate extra income and does not significantly reduce existing operations. Also, they reported that when compared to operations that cut, pile, and mulch, in-woods comminution at the time of harvest can reduce costs from $216.76 to $56.76 per acre.

Forest stand improvements, forest health treatments, and short rotation woody crops (SRWC) could provide an important supplemental feedstock of a woody biomass residue. Current biomass harvesters exist that can cut, compact, and bale woody biomass residue up to four inches in diameter and 25 feet tall in plantations and wooded settings. Besides providing woody biomass feedstock, these brush clearing biomass harvesters can help to reduce fire hazards as well as improve and/or restore wildlife habitat and rangeland (Bolding, 2002).

Logistics activities, such as transportation, will play a major role in optimally locating bioenergy facilities (Jackson et al. 2010). Optimization of transportation logistics will vary by region and product. Transportation costs often become a limiting factor and hauling wood biomass beyond a 50-mile radius of the plant may not be economically feasible (Dyken et al. 2010). Some common types of transportation available are trucking, rail, ship, and pipe.

Wood can be harvested throughout the year in most of the contiguous U.S. However, weather conditions and market fluctuations could limit the continuous availability of wood.

Thus, storage of woody biomass will play a key role in the logistics of producing bio-based products. Storage options for supplying biomass facilities include on-field storage, intermediate storage, and on-site facility storage (Rentizelas et al. 2009). Currently, on-site facility storage is the only viable means of accelerating the drying process, thus reducing the problems of quality degradation, fire damage, or formation of toxic microbes (Rentizelas et al. 2009).

Biomass refinement is often considered necessary to increase the potential gain of biomass to bioenergy efficiency. Refinement includes manipulation of its properties through both chemical and physical processes. Physical biomass preprocessing includes chipping, grinding, milling, drying, pelletizing, briquetting, and charcoal production (Jackson et al. 2010). However, chemical pretreatment of woody biomass feedstock has been considered necessary to remove biomass recalcitrance for microbial and enzymatic processing during cellulosic ethanol production (Zhu and Pan 2010). Achieving the goal of pretreating biomass to remove lignin and other compounds increases hydrolysis of sugar yields to nearly 90 percent of theoretical yields in comparison to 20 percent of non-pretreated biomass (Jackson et al. 2010).

Biomass resources can be converted to energy using a variety of processes in order to meet the needs of society. Two broad categories of conversion technologies include thermochemical and biochemical processes. Several advancements have been made in thermochemical processes due to the relatively low costs when compared to biochemical (Jackson et al. 2010). Examples of thermochemical processes include direct combustion (e.g. furnaces, burners, and CHP), gasification, pyrolysis, and torrefaction. Biochemical conversion is a chemical decomposition of biomass' cell wall using cellulase enzymes or acids in order to extract sugars for conversion to ethanol (U.S.D.O.E. 2008).

3.3.3 Benefits of Woody Biomass as an Energy Source

Cellulosic biomass is a form of stored solar energy that can be used to create bio-fuels, burned directly, converted to combustible gases by heating, or converted to a liquid by pyrolysis (Dukes 2003; Perlack et al. 2005). Cellulosic biomass has several economical and environmental advantages over fossil fuel. It is naturally abundant, renewable, and locally available when compared to most fossil fuels.

One of the key factors in the future development of cellulosic biomass for energy will be the costs associated with its production. Incentive programs are available for the public and private sector to help mediate these production costs. Also, wood as a heating source is significantly less expensive when compared to most competing fossil fuels (U.S.F.S. 2004) **(Table 2)**.

Table 2. Example of Annual Home Heating Costs Using Various Fuels[a] (Source: U.S.F.S. 2004)

Fuel	Gross Heating Value[b]	Fuel Required for 1 MM BTU of Usable Heat	Ave Cost/Unit	Total Annual Fuel Cost
Natural gas	1.03 million Btu/1000 ft3	1,220 ft3	$7/1000 ft3	$854
Propane	91,200 Btu/gal	13.86 gal	$1.25/gal	$1,730
Fuel oil #2	138,800 Btu/gal	8.68 gal	$1.40/gal	$1,220
Seasoned firewood	20 million Btu/cord	0.065 cord	$115/cord	$747
Electricity	3,413 Btu/kWh	299 kWh	$0.08/kWh	$2,390
Premium wood pellets	16.4 million Btu/ton	0.073 ton	$120/ton	$882

[a] Based on 100 million Btu of energy for the heating season.

[b] 1000 ft3 ~ 1 million Btu and 1 million Btu = 10 therms.

3.3.4 Limitations of Woody Biomass as an Energy Source

While there is clearly accelerating interest in cellulosic biomass for bioenergy right now, the potential growth for this new industry depends upon sustainable harvest levels, wood fiber prices, and transportation costs. Harvesting, collecting, and transporting cellulosic biomass residues are difficult and expensive, when compared to sawtimber operations, due to its low bulk density and a lack of cost efficient harvesting equipment (Kumar and Flynn 2003; Searcy et al. 2007). Higher transportation costs means cellulosic biomass plants must gather their fuel near plants (Kumar and Flynn 2003; Searcy et al. 2007).

The emerging biomass markets are expected to significantly strengthen the demand for wood fiber in the South. Emerging forest biomass demand will be primarily driven by wood-burning power companies that produce and sell electricity to public utilities as well as an increasing amount of wood pellets that are used domestically and exported to Europe energy markets. Conversion of biomass into cellulosic ethanol for transportation fuel will also impact the structure of the forest sector. According to Forest2Market (2008), U.S. demand for wood fiber from these emerging biomass markets is expected to rise from 2 million tons in 2008 to at least 13.5 million tons in 2020. However, this estimate is conservative and could be higher as more companies move to the sector to build biomass facilities (Forest2Market 2008).

Demand for cellulosic biomass as an energy feedstock could escalate further if a cap-and-trade system for mitigating carbon dioxide is developed in the U.S. Such systems would promote investment by energy companies in biomass-driven power generation in an effort to stay below carbon dioxide emission caps. As of 2010, 19 energy companies were members of the Chicago Climate Exchange voluntary cap-and-trade system in the U.S. (ChicagoClimateExchange 2010) and they were mitigating their emissions in part through

investments in forest establishment on retired agricultural lands and biomass-driven power generation. As of January 2011, the Chicago Climate Exchange voluntary cap-and-trade system in the U.S. is defunct. If a federal cap-and-trade system was to develop in the U.S., it could also increase demand for wood pellets as has occurred in Europe in response to carbon dioxide caps.

This increased demand could raise environmental concerns about the quality and quantity of available biomass feedstock throughout the life of a biorefinery system. Both the quantity and quality of cellulosic biomass available to support the industry on a renewable basis will likely depend on the silvicultural methods and treatments of both private and public forested land. Some consequences of improper silvicultural practices are soil erosion, soil nutrient depletion, failure to regenerate desired species, or significantly reduced forest productivity.

3.3.5 Public Policy Issues Concerning Biomass

Several government policy measures have been enacted to support fossil fuel independence and subsequent bio-based markets. According to the 25 X'25 Vision Statement (2010), U.S. farms, forests, and ranches will provide twenty-five percent of the total energy consumed in the United States by 2025. Congress declared that "it is the goal of the United States that no later than January 1, 2025, the agricultural, forestry and working land of the United States should provide from renewable resources not less than 25% of the total energy consumed in the United States while continuously producing safe, abundant and affordable food, feed and fiber" (25x25 2010)

On May 5, 2009, President Obama issued a presidential directive to the heads of the Department of Energy, Department of Agriculture, and the Environmental Protection Agency to form a working group to aggressively accelerate the investment in and production of biofuels

(U.S.D.A. 2009). Agriculture Secretary Thomas Vilsack will lead an unprecedented interagency effort to increase America's energy independence and spur rural economic development. Financing opportunities from the Food, Conservation, and Energy Act of 2008 were made available before June 5, 2009. These opportunities include: loan guarantees for the development, construction, and retrofitting of commercial scale biorefineries and grants to help pay for the development and construction costs of demonstration-scale biorefineries; expedited funding to encourage biorefineries to replace the use of fossil fuels in plant operations by installing new biomass energy systems or producing new energy from renewable biomass; expedited funding to biofuels producers to encourage production of next-generation biofuels from biomass and other non-corn feedstocks; expansion of Renewable Energy Systems and Energy Efficiency Improvements Program; and guidance and support for collection, harvest, storage, and transportation assistance for eligible materials for use in biomass conversion facilities (U.S.D.A. 2009). Similarly, the 27 Member States of the European Union have set themselves ambitious policy objectives to increase the proportion of renewable energy sources in electricity and heat production, setting a target of twenty-one percent electricity and twenty percent heat from renewable sources in the total energy mix by 2020 (Energy 2009).

3.3.6 Market Development for Biomass

Government support of biomass-based energy during the initial stages of market development should help level the playing field in the heavily subsidized energy sector by financing the growers (farmers) and offering producers incentives, loan guarantees, and market assurances. Specific programs geared towards assisting growers (farmers) are the Woody Biomass Utilization Grants (Woody BUG) and the Biomass Crop Assistance Program (BCAP)

funded by the USDA (Perlack et al. 2005; U.S.D.A. 2010). They aid in the supply of cellulosic biomass to the market by providing grants addressing the national challenge of utilizing low-value forest products and financing to help farmers integrate energy feedstock into existing cropland as well as the transition period. Other incentives of the BCAP include matching funds for the collection, harvesting, storage, and transportation of biomass feedstock (U.S.D.A. 2010).

Unusually low survival rates for first to market businesses deter costly and risky investing attempts to pioneer a new market and offset the pioneer's market share reward (Robinson and Min 2002). The DOE's Loan Guarantee Program attempts to expedite and stabilize utilization projects by providing much needed funding of investment costs. It is intended to encourage early commercial utilization of advanced or new technologies for GHG reduction (or avoidance) energy products.

The Volumetric Ethanol Excise Tax Credit (VEETC) or "blenders' credit", part of the American Jobs Creation Act of 2004, provides an economic incentive (tax credit) to oil companies for blending ethanol with gasoline (Stowers 2009). U.S. ethanol imports are subject to a modest initial tariff and a stiffer secondary tariff is imposed on ethanol imports to offset blenders' credit to any ethanol blended gas made in U.S. Recently, the Renewable Fuel Standard (RFS) as part of the Energy Independence and Security Act of 2007 requires annual production of renewable fuels produced at specific levels at an increasing rate with the final amount set at 21 billion gallons by 2022 (U.S.D.O.E. 2008). Government support in the form of mandates and policy incentives should play a key role in emerging bio-based markets from a demand perspective, thus fostering their success.

3.4 An Overview of Southern Non-Industrial Private Forest Landowners

Forest land ownership in Southern states is dominated by non-industrial private forest (NIPF) landowners, with 4.9 million landowners owning seventy-one percent of the forestland in the South (Birch 1994; Conner 2002). The South accounts for approximately forty percent of the total forest lands in U.S. producing about fifty-five percent of the total U.S annual round wood harvest (Prestemon and Abt 2002). Understanding the characteristics of these producers should have positive economic impacts for individuals, families, and communities within the study region and abroad.

3.4.1 Forest Land Ownership of the U.S. South

Many of the major issues relative to the U.S. South's forestlands intrinsically involve property ownership (Conner 2002). About ninety percent of the timber harvesting activity in the U.S. South comes from non-industrial privately owned forests. NIPF timberland ownership dominates every southern state including Louisiana. NIPF landowners account for about eighty-one percent of the forest land ownership in Louisiana (LSUAgCenter 2009). Of these private landowners, family ownership accounts for four out of every ten acres of forestland in the U.S (Conner 2002).

Trends in NIPF ownership have shown an increase since 1982 on both the corporate and individual level (Conner 2002). Despite total NIPF land ownership increases, the area of individual land ownership has decreased due to fragmentation. According to the U.S.D.A (2010), a large portion of private forestlands are less than a thousand acres. Perera (2008) reported, from the Alabama Forestry Commission website, that the total average of southern

private forest ownership is 38 acres and Louisiana has the largest average landholding at 85 acres.

In addition to the abundant forest resources in the U.S. South, there is a trend towards conversion of farmland to forests in the region. In much of the southeast U.S, contraction of forest acreage is predicted through 2040 due to urban expansion (Prestemon and Abt 2002). The highest increases in forest acreage are predicted for the counties and parishes located along the Lower Mississippi Alluvial Valley (LMAV), with forest acreage estimates increasing up to twenty-seven percent in much of the region through 2040 (Prestemon and Abt 2002). Within the past 25 years, loss of forestland in the LMAV region has nearly halted and restoration of forestland has been a land-use issue (Gardiner and Oliver 2005).

3.4.2 Forest Landowner Characteristics

A large interest within the forest industry sector over the past few decades has revolved around a particular group of forest owners known as NIPF, which is synonymous with the current term family forest owners. Justification of such inquiries deals, in part, with the relative size of the forestland owned by this group. From 1993-2003, this group increased in size by 11 percent and studies indicate this trend to persist (Butler and Leatherberry 2004; Hodgden 2003). Understanding the motivations, characteristics, and attitudes of these individuals should help the forest industry realize the potential markets, such as biomass, within their region.

In a recent study by Hodgden et al. (2003), the number of studies on family forest owners doubled from the years 2000-2003. Also, authors of this study point out that a few similar socio-demographic characteristics endure across a plethora of research. Recent studies show that the majority of the forestland owners were well educated males with an average age greater than 60

years and an income higher than the general public (Butler and Leatherberry 2004; Measells et al. 2005; Perera 2008; Vlosky 2000).

While consistencies appear amongst landowner characteristics, the motivations for ownership and management objectives indicate a range of diversification. The annotated review of research of Hodgden et al. (2003) suggests the same. For some research, atop the list of reasons identified for owning forestland include asset for heirs, part of residence, recreation/personal enjoyment, and aesthetics while timber production remains relatively low (Butler and Leatherberry 2004; Hodgden 2003; Measells et al. 2005). However, studies done in Louisiana indicate timber production to be the main reason for owning forestland (Perera 2008; Vlosky 2000). Recent studies have shown that NIPF landowners have a low knowledge level of biomass harvesting, production, policies, and economics (Almquist, 2006; Oxarart, 2008; Shaw, 2009). Also, the motivations for management objectives and harvest intensities vary amongst determinant factors such as size of ownership, length of ownership, presence of structures, and absenteeism (Perera 2008;Vokoun 2006; Conway et al. 2003; Hodgden et al. 2003).

Limited research covers issues dealing with the attitudes and perceptions of forest landowners towards bio-based opportunities, especially in Louisiana. Also, landowners need the tools necessary to make informed decisions involving integrating science-based cellulosic biomass management activities into existing business plans. The goal of providing unbiased information regarding cellulosic bio-based business opportunities can be realized through research so that forest landowners can provide sustainable cellulosic biomass resources to emerging biomass markets.

3.5 The Study

The purpose of this research was to survey small and medium forest landowners in the U.S. Gulf South, using Louisiana as a pilot state, in order to identify current and potential business positions as well as identify willingness to participate in new cellulosic bio-based business arrangements. Small forest landowners are those having between 10-139 acres and medium landowners as having 140-999 acres. The survey encompassed a five parish region in Southwest Louisiana which has considerable forest resources but a low intensity of forest utilization (**Figure 3**). The study region chosen has characteristics similar to the land base in the Gulf South. Intentions were to develop methods that could be utilized throughout most of the U.S. South.

The survey portion of this research was focused on developing qualitative and quantitative information on the forestry sector. Specifically, the survey was conducted on small to medium size landowners in Louisiana to get their views and opinions on an array of scenarios for different cellulosic bio-based products and business strategies. It was a survey of 3,500 small to medium forest landowners with forest ownership within the focal region chosen by random sample. Information gained from the survey was further analyzed to characterize the populations and regions as well as rating scale data to aid in managerial decision making. This understanding and knowledge ensures landowners have access to all current and emerging markets in order to make informed decisions regarding participation in cellulosic biomass-based business endeavors.

3.5.1 Study Objectives

The specific research objectives of the forest landowner survey in LA are

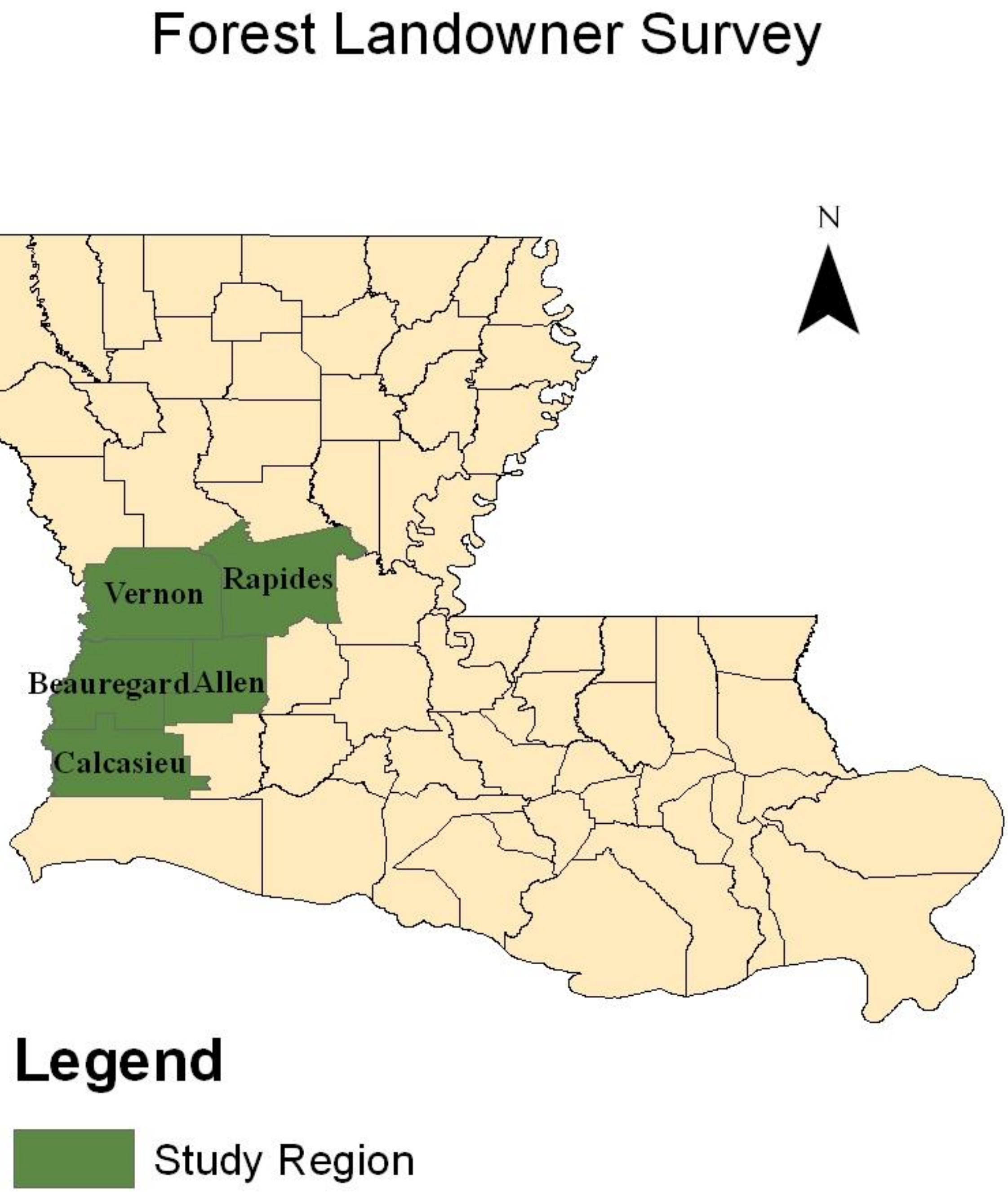

Figure 3. Louisiana Forest Landowner Survey Study Region.

1. To develop a baseline understanding of the role that current forest products play in the supply chains from producers to consumers within the focal region.

2. For existing producers, to identify prerequisites and willingness to shift existing production to potentially higher value bio-based alternatives.

3. For landowners with fallow land or non-productive land, to discern the willingness to plant bio-based forest species dedicated to producing bio-based products.

3.6 Methods

3.6.1 Research Population

This study is part of a larger project designed to identify high potential alternative bio-based revenue and profit streams for small and medium forest landowners, agricultural producers, and poultry producers (SMAPFL) with land holdings in Louisiana and Mississippi. The study area chosen was the Southwest Louisiana region. The Southwest Louisiana region includes Vernon, Rapides, Beauregard, Allen, and Calcasieu parishes. This area was chosen to identify new economic development opportunities for the strong timber resources currently being underutilized. It was also chosen because it is a true representation of the majority of forest land uses in Louisiana as well as in other Gulf Coast states. Non-industrial private forest landowners within this region provide a population that can benefit significantly from diversifying their business portfolios or adopting completely new business practices.

It's important to note that the study group selected is small to medium forest landowners in Louisiana. Specific surveys were designed for the study region. From this Southwest Louisiana region, 3,500 forestland owners were chosen from a random sample. The study samples were obtained from tax roll information provided within Louisiana.

3.6.2 Survey Instrument Design and Measures

The main topics of the survey for forest landowners were covered in four sections. Each of the four sections contained questions involving issues relevant to ownership, biomass knowledge, biomass market and policy implications, and socio-demographics. All surveys contained a cover letter, the survey, and a return envelope. Survey procedures, follow up efforts, and data analysis were conducted in accordance with Tailored Design Method (Dillman 2000). The surveys contained fixed response, scale, and open ended questions to measure the major concepts. The scale questions were based upon Likert scale types (Bruner et al. 2001). The open ended questions were designed to give questionnaires the opportunity to express their opinions not covered in other questions.

3.6.3 Data Analysis

The data from the two mailings were entered into three Microsoft Excel databases. When required, returns were codified according to return responses, request to remove from list, undeliverables, non-applicable, and change of name or address. The categorized data were analyzed using SPSS, SAS, and/or STATA; statistical software commonly used and accepted in human dimension sciences. The majority of the analysis utilized descriptive statistics such as simple frequencies, mean responses, as well as correlation and t-tests.

3.7 Results and Data Analysis

3.7.1 Response Rate and Demographics

Of the 3,500 surveys mailed, 449 were either undeliverable, inappropriate due to respondent being deceased, non-forest landowner, or unwilling to participate in the survey. They

were a total of 162 unusable surveys and 942 usable surveys. The overall adjusted response rate for this survey was 28.2%. Adjusted response rate was calculated as follows.

Adjusted Response Rate = Usable Surveys / [Total Sample – (Undeliverables + Unusables)] %

Non-response bias was assessed between respondents from the first and second mailings. Due to the fact that the respondents from the second mailing required a reminder postcard, they can be perceived as less eager to respond (Adams 1986). The respondents from the second mailing are considered likely to be a fair representation of non-respondents (Armstrong 1977).

To investigate non-response bias, these two groups were compared across all applicable survey questions. T-test statistics were used to compare continuous variables and chi square tests were used to compare categorical data. Approximately ninety-three percent of the questions were not significantly different; therefore the research results can be considered a fair representation of the sample frame.

Over 76 percent of the respondents were male (n=679) and approximately 73 percent were 55 years or older (n=663). The respondents were predominately Caucasian at 95 percent (n=679). Only 4 percent of respondents were in the lowest income category of under $20,000 and the largest percentage, with just over 19 percent, were in the highest category of over $150,000 (n=749). Just over 75 percent of respondents had some college education and over 52 percent earned an undergraduate or graduate degree (MS or PhD) (n=679). Approximately 80 percent of respondents resided in the state of Louisiana where they owned forestland with the rest being absentee owners (n=726).

3.7.2 Ownership Profile

During the last 10 years, about 33 percent of respondents have acquired less than 24 acres, over 30 percent acquired 25 acres or more, and 37 percent acquired none (n=942). Also, 25 percent of respondents sold less than 10 acres of forestland, 15 percent sold 10 acres or more, and 60 percent sold none (n=942). During this time frame, the general tendency of NIPF landowners was to acquire land rather than to dispose or sell their forest lands. Over 63% of the respondents owned less than 80 acres of land (n=798) (**Figure 4**). The overwhelming majority of respondents (85%) chose the individual ownership category which included joint husband, wife, and family ownerships other than family corporations (n=784).

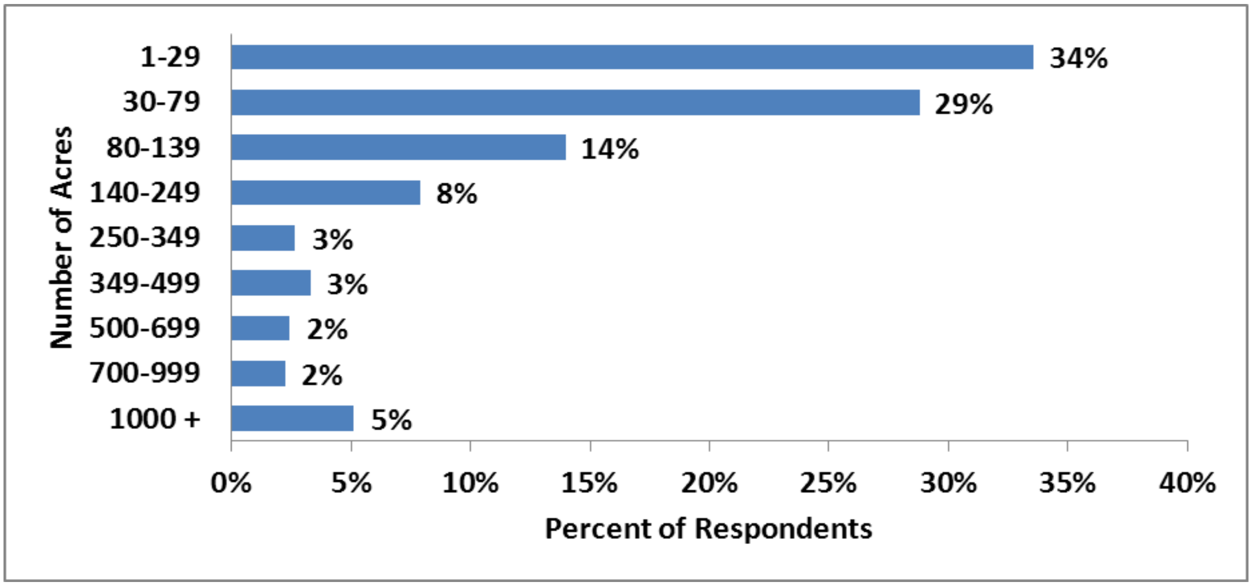

Figure 4. Number of Acres Owned by Percent of Respondents (n=938).

3.7.3 Management Issues

Approximately 66 percent of forest landowners reported they harvested trees from their property during the span of their ownership. The top three products harvested were fuelwood for personal use at 32 percent, pulpwood for sale at 28 percent, and sawlogs for sale at 26 percent

(n=942)(**Figure 5**). Out of 410 respondents, 71 percent planned to harvest trees for their own personal use from their land within ten years or in the distant future. Out of 780 respondents, 89 percent planned to harvest trees for sale from their land within ten years or in the distant future.

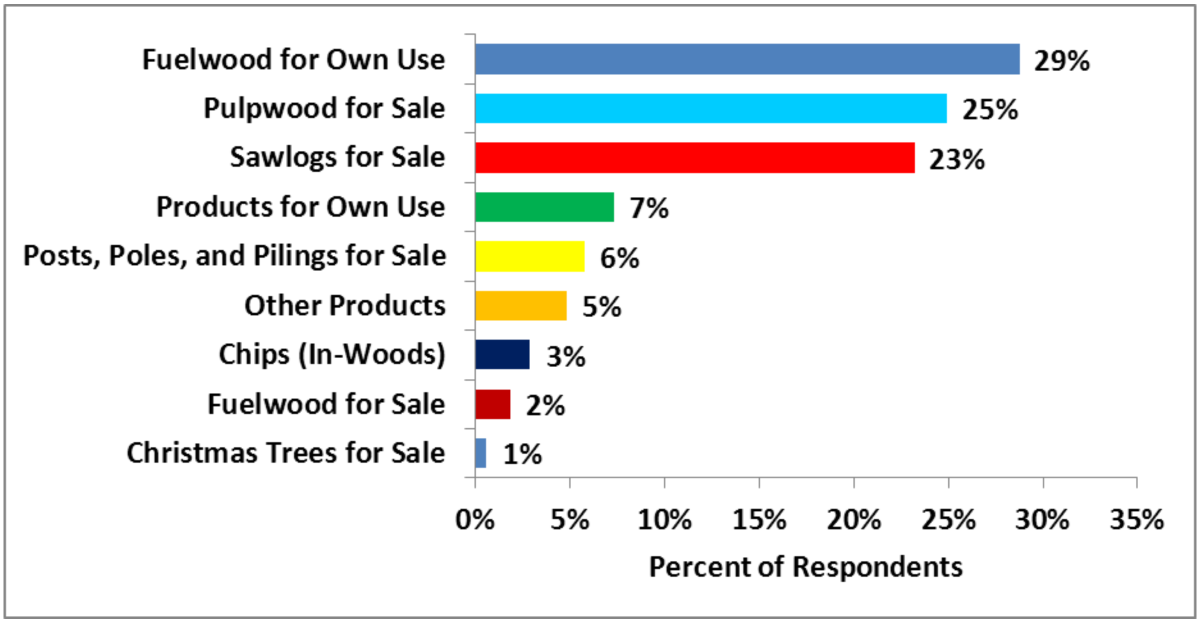

Figure 5. Percent of Respondents Product Utilization from Harvested Trees (n=941).

The majority of respondents (65 percent) did not seek advice or assistance in managing their forestland (n=593). When asked if they had a written forestry management plan, 88 percent said they did not and 12 percent said they did (n=687). A little over 64 percent of those claiming a written forestry plan had someone else prepare the plan. A forester or forestry professional was the highest response given when asked who prepared the plan.

Respondents were asked about their perceptions of current management activities as well as management of biomass for bio-based products. Over 77 percent of respondents believed they practice sustainable forestry (n=895). When asked about specific activities, just over 80 percent did not use herbicide treatments (n=908) and almost 72 percent did not use prescribed burns

(n=910). Over 74 percent of respondents reported that none of their management costs involved burning or removing slash piles or harvesting residues from harvesting activities (n=901). Over 52 percent of respondents agreed that wood biomass harvesting will help diversify the management activities of their timberland while 35 percent were neutral (n=896). Approximately 51 percent of respondents reported they would be willing to participate in managements activities specifically geared toward biomass production (e.g. short rotation woody crops) (n=874). Using the Pearson chi square test, forest type was significantly related to willingness to plant short-rotation woody crops (χ^2=30.257, p=0.000). The different forest types included natural hardwoods, natural pines, mixed hardwoods and pine, planted hardwood, planted pines, and other. The majority of respondents (55 percent) owned mixed hardwoods with the second highest forest type being planted pines at 16 percent (n=941). The willingness of landowners to participate in biomass management activities was rather evenly distributed across all categories except for two in particular. A little more than half of the respondents with natural hardwoods answered "no" as opposed to those answering "yes". In contrast, more than half of the respondents with planted pine answered "yes" as opposed to those answering "no" when asked to participate in biomass management activities. This suggests respondents with planted pines were more likely to participate in management activities.

3.7.4 Biomass Perceptions and the Impetus for Policy and Markets

Questions were asked to interpret landowners' knowledge and perceptions on biomass concepts and utilization (**Table 3**). The majority of respondents (56 percent) agreed that economically viable technologies exist for converting wood biomass to bioenergy. Also, a slightly larger percentage (43 percent) of respondents disagreed that wood biomass

harvesting/collection does not require extra men and equipment. A larger percentage of respondents (47 percent) agreed when asked if wood biomass transportation can be done with traditional logging trucks. Approximately 40 percent of respondents were neutral when asked if the conversion of wood biomass is a simple process that can be done at most pulp/paper or saw mills while more respondents agreed than disagreed with this concept. Approximately 40 percent of respondents were neutral when asked if agricultural biomass requires utilizing entire crop as well as residual feedstock while more respondents agreed than disagreed. Research suggests that harvesting biomass will require extra men, some modified equipment, and will require add-ons to conventional mills or construction of new bio-facilities (Jackson et al. 2010). The high number of neutral responses indicates landowners' uncertainty toward the conversion of wood biomass to bioenergy concepts. Such responses could be considered an indicator of a low-level of familiarity landowners have on the emerging bio-based markets.

A little over 63 percent of respondents had either a somewhat or extremely positive attitudes of using biomass for bioenergy (n=915). Also, 82 percent of respondents agreed that we should use residual wood waste from forest harvesting activities for bioenergy production while 13 percent remained neutral towards the issue (n=900). Almost 50 percent of respondents would supply wood biomass to bio-refineries capable of producing energy for local (n=899) and state's (n=900) needs while only 45 percent would supply wood biomass for our nation's energy needs (n=898). Despite their perceived affinity for utilizing wood residues for bio-based products, only 43 percent of respondents agreed that a bioenergy market will be competitive to conventional energy markets while 38 percent remained neutral (n=903). The mean level of agreement for the statements "Residual wood waste from forest harvesting activities should be used for bioenergy production" and "a bioenergy market will be competitive compared to the

conventional energy market" on a 5 point scale are 4.2 and 3.3 respectively. A paired t-test was used to compare the means of the two groups for equality. The two means differed (t=23.907, p=0.000, n=886) suggesting there is a clear gap between the desire to utilize wood biomass and the viability of bio-based markets.

Table 3. Forest Landowner Knowledge of Key Biomass Concepts.

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
Economically viable technologies exist for converting biomass to bioenergy (n=881).	4%	10%	30%	38%	18%
Agricultural biomass harvesting and collection will not require extra men and equipment (n=902).	13%	30%	32%	18%	6%
Agricultural biomass transportation can be done with traditional agricultural equipment (n=903).	6%	14%	34%	36%	11%
Converting agricultural biomass to bioenergy is a simple process that can be done at most agricultural processing facilities (n=899).	5%	17%	40%	28%	11%
Agricultural biomass requires utilizing entire crop as well as residual feedstock (n=901).	7%	19%	40%	27%	8%

Previous studies indicate that certain socio-demographic characteristics were expected to influence with landowners' knowledge and opinions of biomass issues. Statistical tests were used to determine if the survey responses were significantly different from a mean score of "3" or neutral (**Table 4**). Only the question concerning whether or not subsidies should be provided as an incentive was not significantly different from neutral.

Next, the majority of responses were computed for key biomass issues concerning

environmental and policy issues. As for the environment, a little over 40 percent of respondents

Table 4. Respondent Perceptions of Environment and Market Issues.

Biomass Issues	**mean**	**t-value 1 tailed t-test**	**p-value**
I believe harvesting wood biomass negatively impacts wildlife habitat (n=884)	3.6	8.381	0.000
I believe harvesting wood biomass negatively impacts air and water quality (n=909)	2.8	-4.259	0.000
I believe harvesting wood biomass negatively impacts soil quality (n=908)	2.8	-4.140	0.000
I believe harvesting wood biomass will reduce growth production on standing timber (n=899)	2.6	-11.023	0.000
Tax credits should be given to landowners, harvesters, and companies that utilize biomass for bioenergy (n=904)	3.6	15.576	0.000
Subsidies should be provided as an incentive to companies for selling biomass residues from forestry and mill operations (n=901)	3.1	1.007	0.157
Incentive programs should be provided to supplement the costs of establishing biomass tree crop species (n=901)	3.1	3.074	0.001

agreed that harvesting biomass negatively impacts wildlife habitat (n=912). Almost 40 percent disagreed that harvesting negatively impacts both air and water quality (n=909) and soil quality (n=908) while over 47 percent disagreed that it will reduce growth production on standing timber (n=899). Looking at market and policy issues, approximately 60 percent of the respondents agreed that tax credits should be given to landowners, biomass harvesters, and companies that utilize biomass intended for energy production (n=904). Around 41 percent of respondents agreed government subsidies should be provided to companies for selling biomass (n=901) while almost 45 percent agreed that incentive programs should be provided to supplement costs of

establishing biomass tree species (n=901). Over 62 percent of respondents agreed that grants should be awarded for research and development capable of advancing biomass production technologies (n=905).

Other tests were performed to see if demographics are related to key respondent perceptions. Respondents' ages were significantly related to beliefs that harvesting wood biomass negatively impacts wildlife habitat, air and water quality, and soil quality (**Table 5**). Also, the size of ownership had a statistically significant relationship with the environmental impacts of harvesting biomass. Utilizing the same test, respondent's income were significantly related to beliefs that harvesting wood biomass negatively impacts wildlife habitat (Spearman rho=-0.140, p=0.000, n=884), wood biomass negatively impacts air and water quality (Spearman rho=-0.143, p=0.000, n=909), and harvesting wood biomass negatively impacts soil quality (Spearman rho=-0.136, p=0.000, n=908). Ethnicity was neither correlated nor statistically significant in relation to perceptions of these biomass issues.

Table 5. Respondent Perceptions of Biomass Issues Related to Demographic Variables.

		Age				**Acres Owned**	
Environmental Issues	**n**	**ρ (rho)**	**p-value**		**n**	**ρ (rho)**	**p-value**
I believe harvesting wood biomass negatively impacts wildlife habitat	884	0.126	0.000		884	-0.175	0.000
I believe harvesting wood biomass negatively impacts air and water quality	909	0.115	0.000		909	-0.237	0.000
I believe harvesting wood biomass negatively impacts soil quality	908	0.092	0.000		908	-0.245	0.000
I believe harvesting wood biomass will reduce growth production on standing timber	873	0.051	0.065		896	-0.165	0.000

Concerning market and policy issues, respondents' ages were significantly related to whether or not tax credits should be given to landowners, harvesters, and companies that utilize biomass for bioenergy (**Table 6**). Age was also significantly related to whether or not respondents believe subsidies or incentive programs should be provided for the costs of establishing biomass crop species or for selling biomass residues. The size of ownership was significantly related to whether or not respondents believe tax credit or government programs should be provided for biomass establishment, selling, and utilization.

Table 6. Respondent Perceptions of Biomass Market and Policy Issues Related to Socio-demographic Variables.

		Age				**Acres Owned**	
Biomass Issues	**n**	**ρ (rho)**	**p-value**		**n**	**ρ (rho)**	**p-value**
Tax credits should be given to landowners, harvesters, and companies that utilize biomass for bioenergy	904	-0.142	0		896	0.382	0.01
Subsidies should be provided as an incentive to companies for selling biomass residues from forestry and mill operations	901	-0.104	0.002		898	0.443	0.005
Incentive programs should be provided to supplement the costs of establishing biomass tree crop species	901	-0.147	0		898	0.156	0.034

Other concerns included understanding the motivations of the forest community to be involved in bio-based markets. When asked what prerequisites would it take for respondents to participate in a biomass to bioenergy market, 21 percent chose "profit", 20 percent chose "doesn't harm wildlife habitat", 20 percent chose "doesn't cause erosion", 18 percent chose "doesn't deplete the soil of nutrients", 15 percent chose "knowledge and training", 4 percent chose "it might upset existing sectors that use the same raw materials (e.g. chips for pulp/paper),

and 2 percent chose “other” (n=942). Comments suggested in the “Other” option for participating included ‘professional services provided’, ‘ensure sustainability and reforestation’, ‘cooperative workshops provided’, and ‘must help local markets’ to name a few.

3.8 Conclusions

The forests of the U.S. have been utilized throughout the years to provide people an abundance of natural resources. Entrepreneurs, developers, energy producers, and politicians are looking for alternative energy sources to mitigate our energy crisis and climate change issues. Recent advancements in wood biomass technologies have spurred interest in the development of bio-based facilities. With a positive growth rate, the abundant forests of the U.S. (especially the Southeastern U.S.) could provide an excellent source of feedstock for emerging bio-based markets.

The U.S. South accounts for approximately 40 percent of the total forest lands in U.S. (Prestemon and Abt 2002). The majority of these forests are commonly referred to as “NIPF” or “family forests” due to the fact that they are privately owned by individuals or families (Birch 1994; Conner 2002). If the development of bio-based products continues to gain momentum in the marketplace, the supply of wood biomass feedstock will eventually be met by these private landowners. It is important to understand the motivations, characteristics, and attitudes of these individuals by interested parties in order to realize the potential of markets and not overestimate the actual supply of feedstock.

This study intended to determine NIPF landowners’ attitudes and perceptions towards key biomass concepts and issues as well as their willingness to participate in biomass management activities and emerging markets. To achieve this objective, data for the study were

acquired through a questionnaire of small to medium private forest landowners in Southwest Louisiana.

Recent studies show that the majority of the forestland owners were well educated males with an average age greater than 60 and an income higher than the general public (Butler and Leatherberry 2004; Measells et al. 2005; Perera 2008; Vlosky 2000). Respondent demographics from the study show that the majority of forestlands are owned by males over 55 years old, with a higher than average education and income level. The overwhelming majority of landowners reside in Louisiana (80 percent) and claim individual ownership (85 percent). Knowing key demographic factors helps interested parties hone in on a target market in which to provide valuable information about future biomass endeavors.

Trends in NIPF ownership over the years include increases in ownership numbers, decreases in ownership acreage, and disposal of lands (Conner 2002; USDA 2010). In slight contrast, this study shows over a third (37 percent) of landowners own more than 80 acres with a little over half owning their forests for less than 30 years. This supports the fact that the general trend of landowners was to acquire rather than dispose of their lands. The long-term commitment of bio-based facilities will likely depend upon the availability of supply within the area. It is important they stay abreast of ownership trends since landowners are ultimately the ones making decisions for their property (Conner 2002).

A portion of the results from this study highlights valuable information about forest landowners' knowledge, attitudes, and perceptions of biomass concepts and utilization. Results indicate the majority of landowners believe that economically viable technologies exist for converting wood biomass to bioenergy. Also, the larger percentage of respondents believe that wood biomass harvesting and collection doesn't require extra men and equipment, can be

transported with traditional equipment, and can be easily converted to bioenergy at most pulp/paper or saw mills. Research suggests that harvesting biomass will require extra men, some modified equipment, and will require add-ons to conventional mills or construction of new bio-facilities (Jackson et al. 2010). The high numbers of neutral responses indicate landowners' ineptitude toward the state of technological advancements in the conversion of wood biomass to bioenergy. Such responses could be considered an indicator of a low-level of familiarity landowners have on the emerging bio-based markets. These individuals should be looked at as an ideal base for administering information as well as involvement in future discussions from the forest industry.

In general, a rather large amount of respondent landowners feel positive or believe we should use wood biomass for bioenergy. Despite this percieved affinity, only about half are willing to supply biomass feedstock or participate in bio-based activities and even less (43 percent) believe a bioenergy market will be competitive compared to conventional energy markets. Therefore, a clear gap exists between the desire to utilize wood biomass and the percieved viability of bio-based markets amongst these landowners.

Motiviations for management activities, ownership, and knowledge of harvesting activities vary amongst determinant factors such as size of ownership, length of ownership, and other variables (Conway et al. 2003; Hodgden 2003; Perera 2008, Vokoun 2006). Results from this study indicate that respondents' perceptions of environmental, market, and policy issues were influenced by several socio-demographic variables. Results indicate that older landowners have a higher propensity to agree that harvesting biomass will negatively impact wildlife habitat, air, water, and soil quality. Also, they are more likely to believe tax credits, subsidies, and incentive programs should not be provided for biomass establishment, selling, and utilization. In

direct contrast, results indicate that larger landowners are less likely to agree that harvesting biomass will negatively impact wildlife habitat, air, water, and soil quality. Also, they are more likely to agree that tax credits, subsidies, and incentive programs should be provided for biomass establishment, selling, and utilization. Most of the landowners surveyed were older individuals with only a small percentage being medium to large landholders. This is an important note for policy makers, legislators, and local officials to take forward when creating policies intended to foster the development of bio-based markets.

Results from the study show that the majority of forest landowners (66 percent) have harvested trees from their property during their ownership. The top three products chosen were fuelwood for personal use, pulpwood for sale, and sawlogs for sale. Also, the majority of landowners (89 percent) plan to harvest trees for sale from their land within the next ten years or in the future. Despite the seemingly large amount of current and future production, a gross amount of landowners (88 percent) do not have written forestry plans. This coincides with the fact that the majority of respondent landowners did not use intensive management methods such as prescribed burns (72 percent) and herbicide treatments (80 percent) nor did the majority have any of their costs involve removing or burning slash and residue piles from harvesting activities (74 percent).

One important part of the study was to discern the willingness of landowners to participate in management activities requiring the harvesting of wood biomass. Results from the study indicate the majority of landowners (52 percent) either somewhat or strongly agree that wood biomass harvesting will help diversify the management activities of their timberland. More exacting, a small majority of landowners (51 percent) would be willing to participate in management activities specifically geared towards biomass production such as short rotation

woody crops. When asked what it would take to participate, the top answers were profit, no harm to existing markets, no harm to will be done to the environment, and knowledge or training. Reasons given in the "other" category include profit and taxes remain in local economy and area involvement or community assistance. Thus, there is an inherent need for these landowners to be reassured of the profitability of using wood as a feedstock for energy production, that no harm will be done to the environment during biomass harvesting, and need for educational programs and local, professional aid. Also, the apparent scarcity of intensive management activities coupled with the lack of written forestry plans beckon the overall need for professional assistance. For those unconsciously managing their forests or unwilling to participate in biomass management activities, the invaluable services of educational programs should be provided in order to help diversify their portfolios and bolster rural economies.

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Chapter 4. Louisiana and Mississippi Agricultural Producers' Attitudes and Perceptions towards Participating in New Bio-based Business Opportunities

4.1 Introduction

Cellulosic biomass from agricultural crop residues is a major source of feedstock for renewable natural energy (Millbrandt 2005). It has several advantages such as lowering carbon dioxide emissions and stabilizing energy dependence. Louisiana and Mississippi are rich in biomass resources with approximately a third of each state in farmland acreage (U.S.D.A. 2010). However, most of these farms are privately owned by either individuals or families (U.S.D.A. 2010). The decisions of these farm owners could affect key issues such as the environment, sustainability, and supply. It is important to understand their knowledge of key biomass issues and concepts as well as their willingness to participate in bio-based activities.

4.2 Problem Statement

National concerns about issues such as fossil fuel supplies and climate change have stimulated interest in renewable energy sources among energy producers, developers, legislators, and policy makers. Hydro-electric, geo thermal, wind, solar and biomass energy are the most common forms of renewable energy sources that are being used to replace dependency on fossil fuels. The current global energy consumption is estimated to be 8,000 MTOE (Million Tons of Oil Equivalent) per annum. Projections have shown energy consumption will increase to higher than 15,000 MTOE by 2050 (Komiyama et al. 2001). Bio-based renewable energy, such as bioenergy from agricultural biomass, could provide us with opportunities to help stabilize our energy use.

Both Louisiana and Mississippi are rich in agricultural biomass resources available for bioenergy production from the agricultural industry (de Hoop 2006;Jackson 2007). In Louisiana,

experts have estimated approximately 5.2 million wet tons of crop residues can potentially be used for bio-based products annually (de Hoop 2006). Also, agricultural producers in Mississippi could produce 2.2 million dry tons of biomass residues annually (Jackson 2007). Knowing the amount of available cellulosic biomass available could help advance the development of bio-based markets.

Attitudes and perceptions among agricultural producers are important to consider because their management decisions could affect sustainability of harvest yields, state and local economies, future policies, and health of ecosystems. It is critical for lawmakers, energy producers, and developers to interpret the willingness of agricultural producers to participate in the bio-based markets so as not to overestimate the supply of biomass.

Limited research covers issues concerning the attitudes and perceptions of agricultural producers towards bio-based opportunities, especially in Louisiana and Mississippi. Also, agricultural producers need the tools necessary to make informed decisions when integrating scientific-based, agricultural biomass management activities into existing business plans. The goal of providing unbiased information regarding cellulosic bio-based business opportunities can be realized through research so that agricultural producers may provide these resources to emerging bio-based markets.

4.3 Literature Review

4.3.1 Availability of Agricultural-Based Biomass Resources

Globally, agricultural productivity grew around 2.2 percent annually from the years of 1961-2007 with variations across commodities and regions (Fuglie 2010). The total potential production of bio-ethanol from crop residues and materials has been estimated at 491 GL (129.7

billion gallons) which could displace about 32 percent of the total worldwide consumption of gasoline (Kim and Dale 2004). Using the global distribution of potential plant production, abandoned agriculture land could produce between 1.6 and 2.1 billion tons of above ground biomass per year accounting for approximately ten percent of energy needs for most nations (Campbell et al. 2008).

Although the U.S. currently produces about three percent of its total energy production from renewable resources, the development and expansion of a biomass industry in the U.S. will require the use of bioenergy crops and agricultural residues (Walsh et al. 2003). In the year 2007, over 2.2 million farmers within the U.S. owned about 922 million acres of farmland accounting for $300 billion in total product sales (U.S.D.A. 2009). More than half of these sales came from livestock and poultry (and by-products) with approximately $9 billion from chicken broiler sales alone (measured in head) (U.S.D.A. 2009). A study by Millbrandt (2005) suggests crop residues have the largest percentage of available feedstock for biomass (**Figure 5**). Considering current sustainable biomass resources, the availability of biomass for bioenergy production is about 194 million dry tons annually in the U.S. from cropland; about 16 percent of total plant material produced (Perlack et al. 2005).

Historically, agriculture has played an important role in the economies of Southern states. Agriculture in Louisiana and Mississippi, the study regions, are multi-billion dollar industries (U.S.D.A. 2010). Both Louisiana and Mississippi are states rich in agricultural resources capable of sustainably supplying biomass-to-bioenergy facility. Also, understanding the role of agriculture in Southern states should foster the development of rural communities and economies within the region.

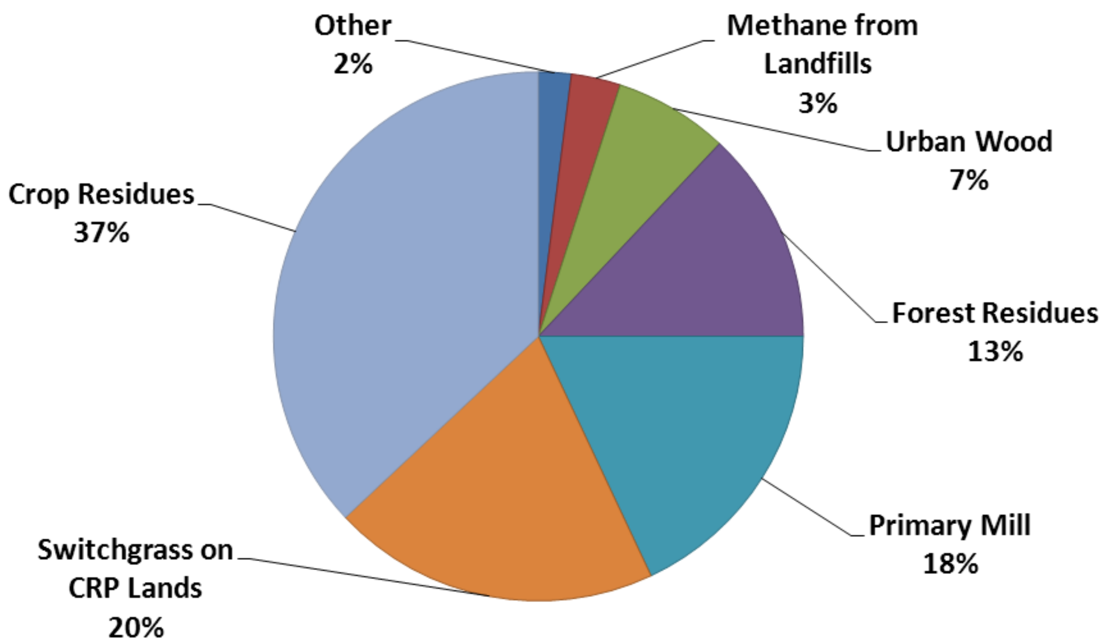

Figure 6. Percent Feedstock from Total Biomass (Source: Millbrandt 2005).

In Louisiana, businesses in food and fiber products and services generated $28 billion during 2007 (LSUAgCenter 2009). They accounted for approximately 4.26 percent of the total value-added and 9.7 percent of the total employment. In 2009, 30,000 farms generated over 1.77 billion dollars in total crop sales alone (U.S.D.A. 2010). The top three crop outputs were cane for sugar, rice, and soybeans. Farms in Louisiana covered more than eight million acres and averaged 269 acres in individual size (U.S.D.A. 2010). It is estimated that Louisiana is capable of producing 4.3 million dry tons of potential biomass from crop residues (Millbrandt 2005).

Agriculture is the leading industry in Mississippi adding approximately 6.3 billion dollars to the state's economy (Commerce 2010). About 42,000 farms in Mississippi generated a little over 1.5 billion dollars in total crop sales alone in 2009 (U.S.D.A. 2010). The top three crop outputs were chicken broilers, soybeans, and corn. It has a total farm area that covered more than 11 million acres and averaged 273 acres individually (U.S.D.A. 2010). The agricultural

producers within the state are capable of producing an estimated 2.2 million dry tons of biomass from crop residues (Millbrandt 2005).

4.3.2 Current State of Technological Advancements in Agricultural Biomass to Energy

Since World War II, technology within the agricultural sector has advanced at a rapid rate. Advances in plant and animal breeding, synthesized chemical fertilizers, and mechanization led to increasing economies of scale that spurred an increase in average farm size along with a reduction of number of farms and rural populations (Dimitri et al. 2005). With agricultural productivity on the rise, cellulosic biomass from agricultural feedstock has great potential to displace future gasoline production (Fuglie 2010; Kim and Dale 2004).

Advancements in mechanization increased the use of tractors and other equipment while almost eliminating the use of animals for power (Dimitri et al. 2005). A new method known as precision agriculture allows for more precise tuning and tracking of farm production through the use of several technologies (Zhang et al. 2002). Some of the technologies include geographic information systems, Global Positioning System, miniaturized computer components, in-field and remote sensing, automatic control, mobile computing, and telecommunications as well as others (Zhang et al. 2002).

Advancements in plant breeding have resulted in increased yields and quality (Dimitri et al. 2005). Thus, cellulosic sources offer immense potential as feedstock for future biofuel production (Westscott 2007; Powlson et al. 2005). However, corn was the primary feedstock for the approximately five billion gallons of ethanol produced in 2006 in the U.S (Westscott 2007). Due to the negative aspects of using food crops for bio-based products, extensive research has been performed on dedicated energy crops (Powlson et al. 2005; Walsh et al. 2003; Monique et

al. 2003). These sources of cellulosic biomass include a genetically diverse range of herbaceous crops and primarily tall grasses (Monique et al. 2003). Both herbaceous crops and tall grasses (e.g. *Miscanthus floridulus* and *Panicum virgatum*) can be planted, managed, and harvested using existing agricultural equipment (Walsh et al. 2003).

Logistic activities, such as transportation, will play a major role in optimally locating bioenergy facilities (Jackson et al. 2010). Optimization of transportation logistics often vary by region and product. Some common types of transportation available are trucking, rail, ship, and pipe.

The harvesting of agricultural crops within the U.S. is primarily a seasonal activity (Rentizelas et al. 2009). Thus, storage of agricultural biomass will play a key role in the logistics of producing bio-based products. Storage options for supplying biomass facilities include on-field storage, intermediate storage, and on-site facility storage (Rentizelas et al. 2009). Currently, on-site facility storage is the only viable means of accelerating the drying process, thus reducing the problems of quality degradation, fire damage, or formation of toxic microbes (Rentizelas et al. 2009).

Agricultural biomass refinement is often considered necessary to increase the potential gain of biomass to bio-energy efficiency. Refinement includes manipulation of its properties through both chemical and physical processes. However, chemical pretreatment of cellulosic biomass feedstock has been considered necessary to remove biomass recalcitrance for microbial and enzymatic processing during cellulosic ethanol production (Zhu and Pan 2010). Achieving the goal of pretreating agricultural biomass to remove lignin and other compounds increases hydrolysis of sugar yields to nearly ninety percent of theoretical yields in comparison to twenty percent of non-pretreated biomass (Jackson et al. 2010).

Biomass resources can be converted to energy using a variety of processes in order to meet the needs of society. Two broad categories of conversion technologies include thermochemical and biochemical processes. Several advancements have been made in thermochemical processes due to the relatively low costs when compared to biochemical (Jackson et al. 2010). Examples of thermochemical processes include direct combustion (e.g. furnaces, burners, and CHP), gasification, pyrolysis, and torrefaction. Biochemical conversion is a chemical decomposition of biomass' cell wall using cellulase enzymes or acids in order to extract sugars for conversion to ethanol (U.S.D.O.E. 2008).

4.3.3 Benefits of Agricultural Biomass as an Energy Source

Agricultural biomass is a form of stored solar energy that can be used to create bio-fuels, burned directly, converted to combustible gases by heating, or converted to a liquid by pyrolysis (Dukes 2003; Perlack et al. 2005). Cellulosic biomass has several economical and environmental advantages over fossil fuel. It is naturally abundant, renewable, and locally available when compared to most fossil fuels (Jackson et al. 2010).

Life cycle inventory of various bio-based products allow researchers to determine whether these alternative products provide benefits over the petrochemical products they displace (Heller et al. 2004; Hill et al. 2006). Increases in crop yields and biofuel production efficiency allow both ethanol from corn grain and biodiesel from soybean to have positive net energy balances (Hill et al. 2006). Relative to the fossil fuels they displace, both fuels reduce GHG's and release less pollutants. Also, other biofuels produced from low-input biomass grown on marginal crop land have the potential to provide greater supplies and environmental benefits than food-based biofuels (Hill et al. 2006).

4.3.4 Limitations of Agricultural Biomass as an Energy Source

While there is accelerating interest in agriculture biomass for bio-energy right now, growth for this new industry depends upon sustainable harvest levels, fiber prices, and transportation costs. Harvesting, collecting, and transporting agricultural biomass residues are difficult and expensive due to its low bulk density and a lack of cost efficient harvesting equipment. Higher transportation costs means agricultural biomass plants must gather their fuel near plants (Kumar and Flynn 2003; Searcy et al. 2007).

Producing biofuels from bioenergy crops are expensive relative to fossil fuels, despite the increase in fossil fuel prices (Walsh et al. 2003). Policy is often considered necessary to stimulate the use of dedicated energy agricultural crops (Walsh et al. 2003). Meanwhile, existing policy continues to increase the demand for ethanol production causing market adjustments that extend beyond the corn sector. Increased use of corn for ethanol results in higher corn prices, decrease in planting other crops (e.g. cotton or soy), and higher feed prices for livestock (Westscott 2007).

Demand for cellulosic biomass as an energy feedstock could escalate further if a cap-and-trade system for mitigating carbon dioxide is developed in the U.S. Such systems would promote investment by energy companies in biomass-driven power generation in an effort to stay below carbon dioxide emission caps. As of 2010, 19 energy companies were members of the Chicago Climate Exchange voluntary cap-and-trade system in the U.S. (ChicagoClimateExchange 2010) and they were mitigating their emissions in part through investments in forest establishment on retired agricultural lands and biomass-driven power generation. As of January 2011, the Chicago Climate Exchange voluntary cap-and-trade system

in the U.S. is defunct. If a federal cap-and-trade system was to develop in the U.S., it could also increase demand for wood pellets as has occurred in Europe in response to carbon dioxide caps.

This increased demand will raise environmental concerns about the quality and quantity of available agricultural biomass feedstock throughout the life of a biorefinery system. Both the quantity and quality of biomass available to support the industry on a renewable basis could depend on the methods and treatments of agriculture land. Some consequences of improper practices are soil erosion, soil nutrient depletion, failure to regenerate desired species, or significantly reduced crop productivity.

4.3.5 Public Policy Issues Concerning Biomass

Several government policy measures have been enacted to support fossil fuel independence and subsequent biomass markets. According to the 25 X'25 Vision Statement (2010), U.S. farms, forests and ranches will provide 25 percent of the total energy consumed in the United States by 2025. Congress declared that "it is the goal of the United States that no later than January 1, 2025, the agricultural, forestry and working land of the United States should provide from renewable resources not less than 25 percent of the total energy consumed in the United States while continuously producing safe, abundant and affordable food, feed and fiber" (25x25 2010).

On May 5, 2009, President Obama issued a presidential directive to the heads of the Department of Energy, Department of Agriculture and the Environmental Protection Agency to form a working group to aggressively accelerate the investment in and production of biofuels. Agriculture Secretary Thomas Vilsack will lead an unprecedented interagency effort to increase America's energy independence and spur rural economic development. Financing opportunities

from the Food, Conservation and Energy Act of 2008 will be made available before June 5, 2009. These opportunities include: loan guarantees for the development, construction, and retrofitting of commercial scale biorefineries and grants to help pay for the development and construction costs of demonstration-scale biorefineries; expedited funding to encourage biorefineries to replace the use of fossil fuels in plant operations by installing new biomass energy systems or producing new energy from renewable biomass; expedited funding to biofuels producers to encourage production of next-generation biofuels from biomass and other non-corn feedstocks; expansion of Renewable Energy Systems and Energy Efficiency Improvements Program; and guidance and support for collection, harvest, storage, and transportation assistance for eligible materials for use in biomass conversion facilities (U.S.D.A. 2009; U.S.D.O.E. 2010). Similarly, the 27 Member States of the European Union have set themselves ambitious policy objectives to increase the proportion of renewable energy sources in electricity and heat production, setting a target of 21 percent electricity and 20 percent heat from renewable sources in the total energy mix by 2020 (Energy 2009).

4.3.6 Market Development for Biomass

Government support of biomass-based energy during the initial stages of market development should help level the playing field in the heavily subsidized energy sector by financing the growers (farmers) and offering producers incentives, loan guarantees, and market assurances. Specific programs geared towards assisting growers (farmers) are the Biomass Crop Assistance Program (BCAP) funded by the USDA (U.S.D.A. 2010). They aid in the supply of agricultural biomass to the market by providing grants addressing the national challenge of utilizing low-value biomass products and financing to help farmers integrate energy feedstock

into existing cropland as well as the transition period. Other incentives of the BCAP include matching funds for the collection, harvesting, storage, and transportation of biomass feedstock (U.S.D.A. 2010).

Unusually low survival rates for first to market businesses deter costly and risky investing attempts to pioneer a new market and offset the pioneer's market share reward (Robinson and Min 2002). The DOE's Loan Guarantee Program attempts to expedite and stabilize utilization projects by providing much needed funding of investment costs (U.S.D.O.E. 2010). It is intended to encourage early commercial utilization of advanced or new technologies for GHG reduction (or avoidance) energy products (U.S.D.O.E. 2010).

The Volumetric Ethanol Excise Tax Credit (VEETC) or "blenders' credit", part of the American Jobs Creation Act of 2004, provides an economic incentive (tax credit) to oil companies for blending ethanol with gasoline (Stowers 2009). Also, U.S. ethanol imports are subject to a modest initial tariff and, to offset blenders' credit to any ethanol blended gas made in U.S., a stiffer secondary tariff is imposed on ethanol imports. Recently, the Renewable Fuel Standard (RFS) as part of the Energy Independence and Security Act of 2007 requires annual production of renewable fuels produced at specific levels at an increasing rate with the final amount set at 21 billion gallons by 2022 (U.S.E.P.A. 2010). Government support in the form of mandates and policy incentives should play a key role in emerging biomass markets from a demand perspective, thus fostering their success.

4.4 An Overview of Agricultural Producers in Louisiana and Mississippi

Farm structure within the U.S. is primarily privately owned small family operations at 98 percent of the total (Hoppe and Banker 2010). Small family farms averaging less than $250,000

made up 88 percent of U.S. farms and owned 63 percent of total farm land (Hoppe and Banker 2010). Agriculture provides a major portion of the economic productivity in rural areas of the Southeast. In 2007, the Southeast region was comprised of over 51,000 farms averaging approximately $374,000 in total income (Hoppe and Banker 2010). Louisiana and Mississippi are prime examples with around a third of their land in agricultural activities (U.S.D.A. 2010). Understanding the characteristics of these producers should have positive economic impacts for individuals, families, and communities within the study region.

Farmlands in Louisiana and Mississippi account for a significant portion of the land area and economic output (U.S.D.A. 2010). The total farmland in Louisiana is a little over 8 million acres or 29 percent of the total land area. The 30,000 farmland owners account for $1.77 billion dollars in final crop output (U.S.D.A. 2009). Mississippi farmers account for over 11 million acres or 38 percent of total land area. The 42,300 farmers in Mississippi produced $1.53 billion dollars in final crop output (U.S.D.A. 2009). The abundance and size of these farmers make them an ideal group for educational and research programs involving biomass to bioenergy.

Agricultural characteristics in Louisiana and Mississippi were consistently similar across most socioeconomic and demographic categories. In Louisiana, 85 percent of the farms have family or individual owners. The majority of these farmers (88 percent)were older males who average 57 years of age (U.S.D.A. 2009). Family and Individuals own the lion share in Mississippi also with a total of 86 percent. The majority of these farmers are on average 58 years old males (U.S.D.A. 2009). In both states, 94 percent of agricultural farms were less than 999 acres; one of the criteria for the chosen study group (U.S.D.A. 2009).

Similar to the forestry sector, motivations for management objectives are diverse despite characteristic consistencies. Most research shows economics to be the driving factor behind

decision making amongst farmers. However, some studies indicate that confidence levels, attitudes, farm size, and education affect the intentions of producers to adopt new technologies (Adrian et al. 2005; Cochrane 1993). A study by Jensen (2010) on poultry farmers shows that farmers with college degrees and higher income are more willing to participate in biomass to bioenergy activities than those with lower education and income. It is important for leaders in the biomass industry to understand the role of education in the development of a biomass market.

4.5 The Study

The purposes of this research was to survey small and medium agricultural producers in the U.S. Gulf South using Louisiana and Mississippi as a pilot states in order to identify current and potential business positions as well as identify willingness to participate in new bio-based business arrangements. Small agricultural producers are those having between 10-139 acres and medium producers as having 140-999 acres. The survey encompassed the Mississippi Delta Region which is a significant agricultural area that spans 18 counties and parishes in Louisiana and Mississippi (**Figure 7**). The study region chosen has characteristics similar to the agricultural lands in the Gulf South. Our intentions were to develop methods that could be utilized throughout most of the U.S. South.

The survey portion of this research was focused on developing qualitative and quantitative information on the agricultural sector. Specifically, the survey was conducted on small to medium size producers in Louisiana and Mississippi to get their views and opinions on an array of scenarios for different cellulosic bio-based products and business strategies. It was a survey of 2,964 small to medium agricultural producers with farm ownership within the focal region chosen by random sample from tax roll data. Information gained from the survey was

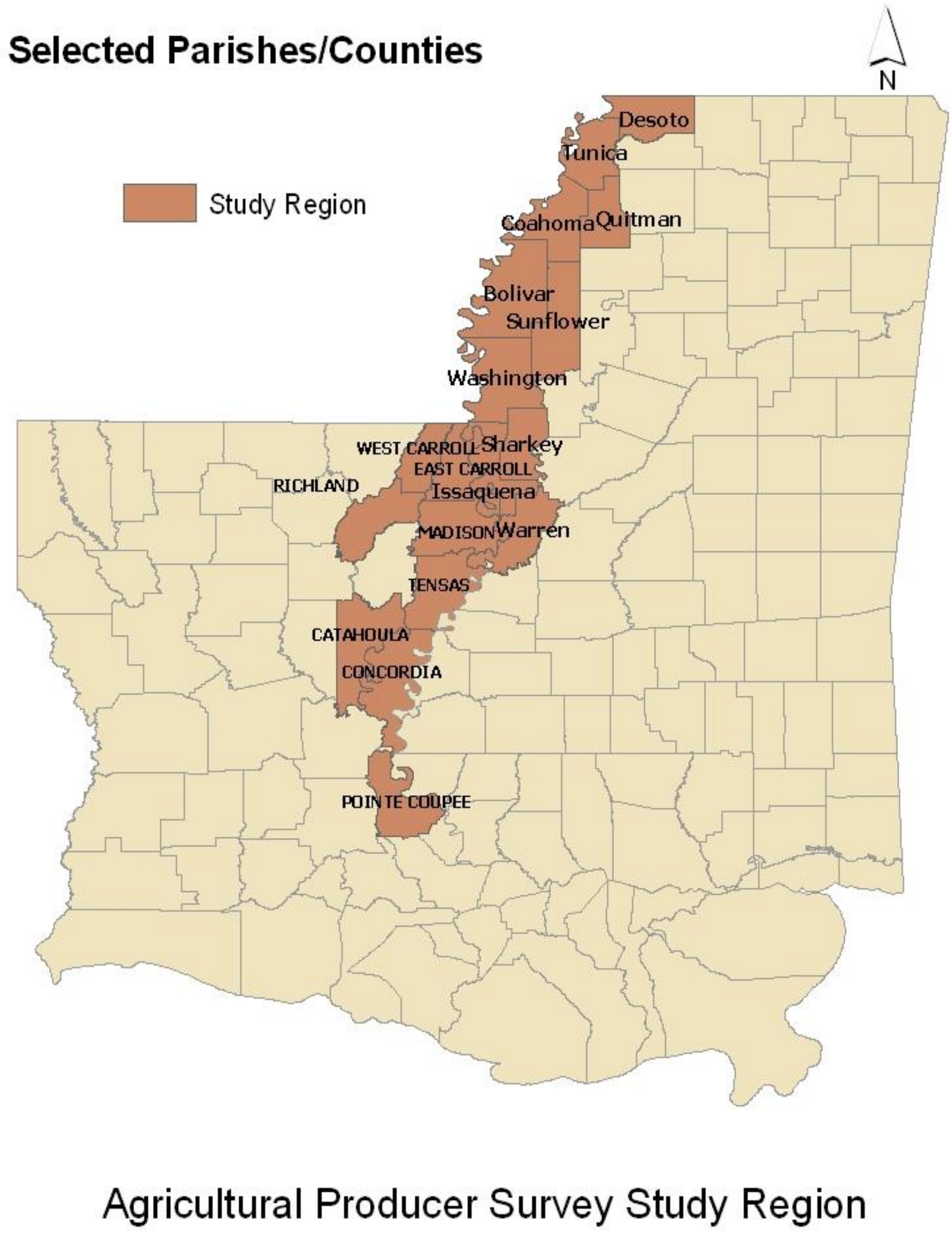

Figure 7. Agricultural Producer Survey Study Region of Louisiana and Mississippi.

further analyzed to characterize the populations and regions as well as rating scale data to aid in managerial decision making. This understanding and knowledge ensures landowners have access to all current and emerging markets in order to make informed decisions regarding participation in agricultural biomass-based business endeavors.

4.5.1 Study Objectives

The specific research objectives of the agricultural producer survey in LA and MS are

1. To develop a baseline understanding of the role that current agricultural products play in the supply chains from producers to consumers within the focal region.
2. For existing producers, to identify prerequisites and willingness to shift existing production to potentially higher value bio-based alternatives.
3. For producers with fallow land or non-productive land, to discern the willingness to plant bio-based forest species dedicated to producing bio-based products.

4.6 Methods

4.6.1 Research Population

This study is part of a larger project designed to identify high potential alternative bio-based revenue and profit streams for small and medium forest landowners, agricultural producers and poultry producers (SMAPFL) with land holdings in Louisiana and Mississippi. The study region was chosen because it represents the majority of mixed agricultural-forestry land uses in Louisiana and Mississippi as well as in other Gulf Coast states. The Mississippi Delta region is comprised of 18 combined counties and parishes in both Louisiana and Mississippi located along the Mississippi river. The Delta region was selected to explore the potential for land-use driven, utilitarian agricultural producers to become involved in dedicated bio-based based options that could diversify traditional agricultural production and contribute to rural development.

Agricultural producers provide a population that can benefit significantly from diversifying their business portfolios or adopting completely new business practices.

It's important to note that the study groups selected are small to medium agricultural producers in Louisiana and Mississippi. A specific survey was designed for the study region chosen. The Delta region survey consisted of 2,964 agricultural producers chosen by a random sample. The study samples were obtained from tax roll information and professional directory database companies provided within Louisiana and Mississippi.

4.6.2 Survey Instrument Design and Measures

The main topics of the survey for agricultural producers were covered in four sections. Each of the four sections contained questions involving issues relevant to ownership, biomass knowledge, biomass market and policy implications, and socio-demographics. All surveys contained a cover letter, the survey, and a return envelope. Survey procedures, follow up efforts, and data analysis were conducted in accordance with Tailored Design Method (Dillman 2000). The surveys contained fixed response, scale, and open ended questions to measure the major concepts. The scale questions were based upon Likert scale types (Bruner et al. 2001). The open ended questions were designed to give questionnaires the opportunity to express their opinions not covered in other questions.

4.6.3 Data Analysis

The data from the two mailings were entered into three Microsoft Excel databases. When required, returns were codified according to return responses, request to remove from list, undeliverables, non-applicable, and change of name or address. The categorized data were analyzed using SPSS, SAS, and/or STATA; statistical software commonly used and accepted in

human dimension sciences. The majority of the analysis utilized descriptive statistics such as simple frequencies, mean responses, as well as correlation and t-tests.

4.7 Results

4.7.1 Response Rate and Demographics

Of the 2,964 surveys mailed, 299 were either undeliverable, inappropriate due to respondent being deceased, non-agricultural landowner, or unwilling to participate in the survey. They were a total of 50 unusable surveys and 771 usable surveys. The overall adjusted response rate for this survey was 26.6 percent. Adjusted response rate was calculated as follows.

Adjusted Response Rate = Usable Surveys / [Total Sample – (Undeliverables + Unusables)] %

Non-response bias was assessed between respondents from the first and second mailings. Due to the fact that the respondents from the second mailing required a reminder postcard, they can be perceived as less eager to respond (Adams 1986). Also, the respondents from the second mailing are considered likely to be a fair representation of non-respondents (Armstrong 1977).

To investigate non-response bias, these two groups were compared across all applicable survey questions. T-test statistics were used to compare continuous variables and chi square tests were used to compare categorical data. The Wilcoxon-Mann-Whitney test is a non-parametric test used for variables without a normal distribution. Approximately eighty-two percent of the questions were not significantly different at α=0.05 level; therefore, most of the research results can be considered a fair representation of the sample frame. However, all nine questions that were statistically significant came from the biomass market section like the viability of biomass as a feedstock for bioenergy or whether or not it's a low-value product

compared to traditional products. Therefore, the results from this section should be considered to be representative of the respondents group only.

Over 81 percent of respondents were male (n=735) and approximately 80 percent were 55 years or older (n=773). The respondents were predominately Caucasian at 98 percent (n=698). Almost 8 percent of respondents were in the lowest income category of under $20,000 with 21 percent in the highest category of over $150,000 (n=626). Just over 68 percent of respondents had some college education and over 45 percent earned an undergraduate or graduate degree (MS or PhD) (n=730). Approximately 61 percent claimed ownership of agricultural land in LA, 37 percent claimed ownership in MS, and 2 percent in both (n=766).

4.7.2 Ownership Profile

During the last 10 years, about 66 percent of respondents acquired agricultural property with 41 percent acquiring less than 100 acres (n=766). Also, 50 percent of respondents sold no property and 40 percent disposed of less than 100 acres of agricultural land (n=766). During this time frame, the general tendency of respondent producers was to acquire land rather than to dispose or sell their lands.

Over 59 percent of respondents owned less than 250 acres of land with the highest percentage (19 percent) in the 30-79 range (**Figure 6**). The majority of respondents (82 percent) chose the individual ownership category which included joint husband, wife, and family ownerships other than family corporations (n=771).

4.7.3 Management Issues

The questionnaire included questions intended to identify the current management activities of agricultural landowners within the study region. Soybeans (33 percent), other (24

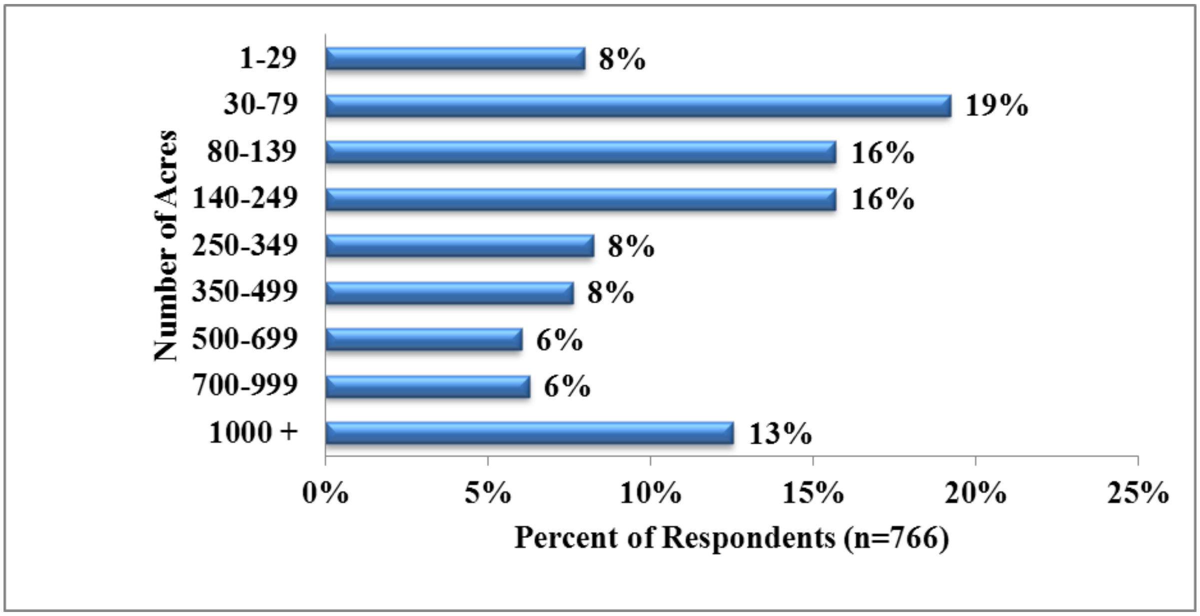

Figure 8. Number of Acres Owned by Percent of Respondents in the Region.

percent), corn (12 percent), and cotton (10 percent) were chosen, respectively, as the top agricultural crops under which the majority of respondents' landholdings fall (**Figure 7**). Together they represented 55 percent of all responses. Some of the "other" responses included trees, grain sorghum, and fruits. Over 89 percent of respondents believe they practiced sustainable agriculture (n=709). When asked if part of their management costs involve burning and/or removing residues associated with harvesting activities, 37 percent of respondents answered "yes" (n=711). Approximately 87 percent of respondents reported no business or other organization associated with their ownership (n=673).

Questions were asked to identify agricultural producer management activity levels. The majority of respondents were neutral (44 percent) when asked if they believe bio-based activities will improve the health of their land while over 31 percent agreed (n=729). Almost 52 percent believed biomass harvesting will help diversify the management activities of their agricultural land (n=731). When asked if respondents believe agricultural residues from harvesting activities

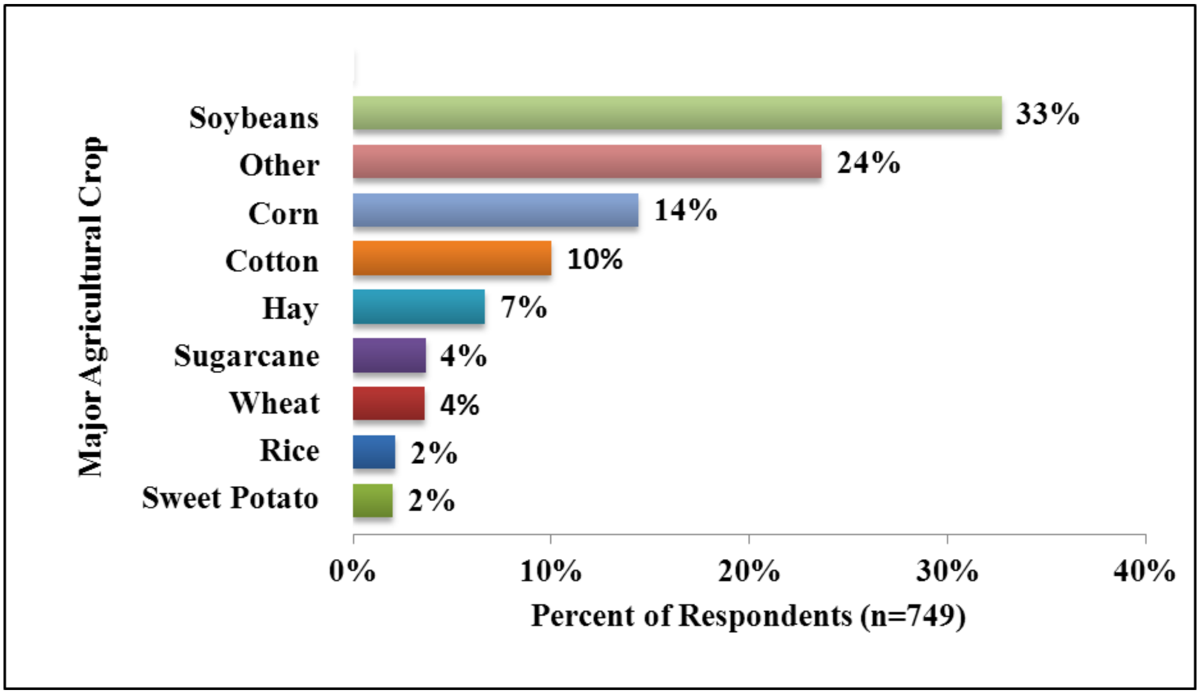

Figure 9. Major Agricultural Crop by Percent of Respondents in the Region.

should be used for bioenergy production, a little over 63 percent agreed while only 12 percent disagreed (n=729). More exacting, one question asked respondents if they would be willing to participate in management activities specifically geared toward biomass production such as short rotation energy crops. A narrow majority (51 percent) of agricultural producers were willing to participate in activities specifically geared towards biomass production such as dedicated energy crops (n=694).

4.7.4 Biomass Perceptions and the Impetus for Policy and Markets

The questionnaire attempted to discover agricultural producers' knowledge and perceptions on biomass concepts and utilization. The majority of respondents (56 percent) agreed that economically viable technologies exist for converting agricultural biomass to bioenergy (**Table 7**). Also, the larger percentage of respondents (43 percent) disagreed that agricultural biomass harvesting/collection does not require extra men and equipment. The larger

percentage of respondents (49 percent) agreed when asked if agricultural biomass transportation can be done with traditional agricultural equipment. Approximately 41 percent of respondents were neutral when asked if the conversion of agricultural biomass is a simple process that can be done at most agricultural processing facilities. Research suggests that harvesting biomass will require use of dedicated energy crops, extra men, and some modified equipment among other things (Jackson et al. 2010, Walsh 2003). Also, research suggests production of energy from biomass feedstock will require either add-ons to conventional mills or construction of new bio-facilities (Jackson et al. 2010). The high number of neutral responses indicates agricultural producers' uncertainty towards the state of technological advancements in the conversion of agricultural biomass to bioenergy. Such responses could be considered an indicator of a low-level of familiarity agricultural producers have on the emerging bio-based markets.

Table 7. Agricultural Producers' Knowledge of Biomass Concepts, 2011.

Biomass Issues	**Strongly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
Economically viable technologies exist for converting biomass to bioenergy (n=732).	4%	10%	30%	38%	18%
Agricultural biomass harvesting and collection will not require extra men and equipment (n=729).	13%	30%	32%	19%	6%
Agricultural biomass transportation can be done with traditional agricultural equipment (n=725).	4%	17%	30%	36%	13%
Converting agricultural biomass to bioenergy is a simple process that can be done at most agricultural processing facilities (n=728).	12%	23%	41%	18%	6%
Agricultural biomass requires utilizing entire crop as well as residual feedstock (n=730).	11%	22%	31%	27%	9%

Statistical tests were performed based on normality of variables in order to determine the relationship between socio-demographic characteristics and respondents' knowledge and opinion of key biomass issues. For Likert scale questions, one sample t-tests and median tests were employed for either normal or non-normal variables to determine if their mean value was significantly different from "3" or neutral. Only the question "I believe agricultural biomass requires utilizing entire crop as well as residual feedstock" was not statistically significant below the α=.05 level, or failure to reject the null hypothesis that the mean of the variable was equal to "3" (t=-0.326, p=0.745, n=728).

The Spearman correlation test was used to compare socio-demographic variables and producers' perceptions on key biomass issues (**Table 8**). All three values for rho were positive indicating as age increases for respondents so did their beliefs that harvesting agricultural biomass negatively impacts the stated environmental issues. Respondents' ages were significantly related to whether or not they would supply agricultural biomass to bio-refineries capable of producing energy at the local level, the state level (Spearman rho=-0.106, p=0.002, n=707), and the national level (Spearman rho=-0.114, p=0.001, n=707). The negative values of all three rho indicates as age increases respondents were less likely to supply agricultural biomass at either level.

Also, respondents' ages were related to a series of market and policy issues. Age was related to the belief that agricultural biomass is a low value product compared to traditional crops. The positive rho value indicates as age increased agricultural respondents were more likely to believe that biomass was a low value product. It was also related to whether or not respondents believed tax credits should be given to landowners, harvesters, and companies that utilize biomass; government subsidies should be provided to companies for selling biomass

Table 8. Agricultural Producers Perceptions and Age, 2011.

	Age		
Environmental Issues	**n**	**p(rho)**	**p-value**
I believe harvesting agricultural biomass negatively impacts wildlife habitat	709	0.109	0.003
I believe harvesting agricultural biomass negatively impacts air and water quality	710	0.107	0.004
I believe harvesting agricultural biomass negatively impacts soil quality	704	0.094	0.012
Policy Issues			
Tax credits should be given to landowners, harvesters, and companies that utilize biomass for bioenergy	703	-0.116	0.001
Subsidies should be provided as an incentive to companies for selling biomass residues from agricultural operations	704	-0.112	0.001
Incentive programs should be provided to defray the costs of establishing biomass crop species	704	-0.104	0.002
Market Issues			
I would supply agricultural biomass to bio-refineries capable of producing energy for rural/local needs.	708	-0.144	0.000
Secured loans should be provided to develop and construct commercial scale bio-refineries.	704	-0.146	0.000
I believe agricultural biomass is a low value product compared to traditional commodity crops.	708	0.069	0.031

residues; and government incentive programs should be provided to defray the costs of establishing biomass crop species. Age was also related to whether or not grants should be awarded for research and development of biomass technologies (Spearman rho=-0.137, p=0.000, n=704) and secured loans should be provided to develop and construct commercial scale bio-refineries (Spearman rho=-0.146, p=0.000, n=704). The negative values for all rho indicates as age increases agricultural respondents were less likely to agree with providing government

programs or incentives for the research, establishment, sale, or use of agricultural biomass intended for energy production. When asked about the viability of using biomass for bioenergy, age was significantly related (Spearman rho=-0.107, p=0.002, n=712). The negative value of rho indicates as age increases respondents were more likely to have negative opinions on the viability of biomass for bioenergy.

Utilizing the same test, respondents' incomes were significantly related to questions concerning respondents' opinion or knowledge of concepts of agricultural biomass utilization. Income was significantly related to whether or not respondents agreed with the belief that their state can achieve governmental mandates requiring a percentage of total energy production come from renewable resources (Spearman rho=-0.071, p=0.035, n=609). Income was significantly related to whether or not respondents agreed economically viable technologies exist for converting biomass to bioenergy (**Table 9**). Negative rho values means as income increased respondents were less likely to agree that viable technologies exist for conversion of biomass and their state could achieve mandates for the requirements of renewable energies. Income was related to respondents' beliefs that harvesting agricultural biomass would not require extra men and equipment, can be easily stored for long periods of time using traditional agricultural storing methods, and converting biomass to energy is a simple process that can be done at most agricultural processing facilities. Negative rho values indicate as income increased respondents had a higher propensity to disagree with these biomass concept issues. Income was not significantly related to environmental, market, and policy issues.

Also, respondents' education levels were significantly related to questions concerning their opinion or knowledge of concepts of agricultural biomass utilization. Education level was

Table 9. Agricultural Producers' Perceptions of Biomass Concepts and the Relationship with Income and Education, 2011.

		Income			Education	
Biomass Concepts	**n**	**ρ (rho)**	**p-value**	**n**	**ρ (rho)**	**p-value**
In my opinion, economically viable technologies exist for converting biomass to bioenergy	609	-0.071	0.035	706	-0.096	0.005
I believe agricultural biomass harvesting and collection will not require extra men and equipment	608	-0.178	0.000	704	-0.098	0.004
I believe agricultural biomass can be easily stored for long periods using traditional storage methods	608	-0.085	0.015	704	-0.078	0.038
I believe converting agricultural biomass to bioenergy is a simple process that can be done at most agricultural processing facilities	610	-0.174	0.000	705	-0.192	0.000

significantly related to whether or not respondents agreed with the existence of economically viable technologies for converting biomass to bioenergy. The negative rho value indicates as education levels increased respondents were less likely to agree that viable conversion technologies exist. Education level was related to respondents' beliefs that harvesting agricultural biomass would not require extra men and equipment, can be easily stored for long periods of time using traditional agricultural storing methods, and converting biomass to energy is a simple process that can be done at most agricultural processing facilities. Negative rho values indicate as education levels increased respondents had a higher propensity to disagree with these biomass concept issues. Education was not significantly related to market and policy issues.

Also mentioned in the literature review, particular variables influenced the willingness of respondents to participate in bio-based activities. In exploring this proposal, respondents were asked if they would participate in a biomass to bioenergy market with an option of "No", "Yes", or "Not Sure". Over 17 percent said they would not participate and 26 percent said they would participate (n=729). However, the majority of respondents (57 percent) were unsure if they would participate in a bio-based market.

4.8 Conclusions

Entrepreneurs, developers, energy producers, and politicians are looking for alternative energy sources to mitigate our energy crisis and climate change issues. Recent advancements in agricultural biomass technologies have spurred interest in the development of bio-based facilities. A study by Millbrandt (2005) suggests crop residues have the largest percentage of available feedstock for biomass. With continued increases in productivity, the agricultural community could supply bio-based facilities with an excellent source of feedstock to meet the demands of emerging bio-based markets.

Historically, agriculture has provided a major portion of the economic productivity in the rural areas of the Southeast. Agriculture in Louisiana and Mississippi rank number two and one, respectively, among the top industries within the state (U.S.D.A. 2010). Farm structure within the U.S. is primarily privately owned small family operations at 98 percent of the total (Hoppe and Banker 2010). If the development of bio-based products continues to gain momentum in the marketplace, the supply of agricultural biomass feedstock will eventually be met by these private farmers. It is important to understand the motivations, characteristics, and attitudes of these

individuals by interested parties in order to realize the potential markets and not overestimate the actual supply of feedstock.

This study intended to determine agricultural producers' attitudes and perceptions towards key biomass concepts and issues as well as their willingness to participate in biomass management activities and emerging markets. To achieve this objective, data for the study were acquired through a questionnaire of small to medium private agricultural producers in Louisiana and Mississippi.

According to the U.S.D.A. (2009) most farmers were older males who reside in the state where they own their farms. Respondent demographics from the study show that the majority of agricultural producers are males over 55 years with higher than average education and income levels. The overwhelming majority of these agricultural producers reside in the state where they own their farm (95 percent) and claim individual ownership (82 percent). Knowing key demographic factors helps hone in on a target market in which to provide valuable information about future biomass endeavors.

This study shows well over half (59 percent) of agricultural producers who responded own less than 250 acres and they (58 percent) have owned these farms for more than 30 years. The general trend of these agricultural producers was to acquire rather than dispose of their lands. The long term commitment of bio-based facilities will depend upon the availability of supply within the area. It is important they stay abreast of ownership trends since agricultural producers are ultimately the ones making decisions for their property

A portion of the results from this study shows agricultural producers' knowledge, attitudes, and perceptions of biomass concepts and utilization. Results indicate the majority of producers (56 percent) believe that economically viable technoligies exist for converting

agricultural biomass to bioenergy. Also, the larger percentage of respondents (43 percent) disagreed that agricultural biomass harvesting/collection does not require extra men and equipment. The larger percentage of respondents (49 percent) agreed when asked if agricultural biomass transportation can be done with traditional agricultural equipment. A large portion of producers (41 percent) remain neutral about whether or not converting biomass is a simple process which can be done at most agricultural facilities. Research suggests that harvesting biomass will require use of dedicated energy crops, extra men, and some modified equipment among other things (Jackson et al. 2010, Walsh 2003). Also, research suggests production of energy from biomass feedstock will require either add-ons to conventional mills or construction of new bio-facilities (Jackson et al. 2010). The high numbers of neutral responses indicate producers' ineptitude toward the state of technological advancements in the conversion of agricultural biomass to bioenergy. Such responses could be considered an indicator of a low-level of familiarity agricultural producers have on the emerging bio-based markets. These individuals should be looked at as an ideal base for administering information as well as involvement in future discussions from the biomass industry.

In general, a rather large amount of respondent producers (63 percent) believe agricultural residues from harvesting activities should be used for bioenergy production. Despite this percieved affinity, only about half are willing to supply biomass feedstock, participate in bio-based activities, and believe a bioenergy market will be comparatively competitive to conventional energy markets. Therefore, a clear gap exists between the desire to utilize agricultural biomass and the viability of bio-based markets.

Some studies indicate that confidence levels, attitudes, farm size, and education affect the intentions of producers to adopt new technologies (Adrian et al. 2005; Cochrane 1993). Results

from this study indicate that agricultural producers' perceptions of environmental, market and policy, and concept issues were influenced by several socio-demographic variables. This study shows older producers have a higher propensity to agree that harvesting biomass will negatively impact wildlife habitat, air, water, and soil quality. They are more likely to agree that tax credits, subsidies, and incentive programs should not be provided for biomass establishment, selling, and utilization. Agricultural respondents were less likely to agree that secured loans should be provided to develop commmercial scale bio-refineries. Some of the observed antagonistic attitudes continue with education and income levels of producers. Agricultural producers with higher education and income levels were less likely to agree that economically viable technologies exist for biomass or that biomass can be easily converted at local agricultural facilities. Most of the agricultural producers surveyed were older individuals with higher than average income and education levels. These perceptions could belie state and local officials' incentives needed to attract developers and energy producers. This is an important note for policy makers, legislators, and local officials to take forward when creating policies intended to foster the development of bio-based markets.

One important part of the study was to discern the willingness of agricultural producers to participate in bio-based activities. Results from the study show that the top three agricultural crops under which the majority of agricultural producers landholdings fall are soybeans (33 percent), corn (12 percent), and cotton (10 percent). The majority of landowners (89 percent) believe they practice sustainable agriculture. Over a third of agricultural producers' costs (37 percent) involve burning or removing residues associated with harvesting activities. Despite the seemingly large amount of current production and the costs accrued from disposing of harvest residues, only 26 percent would participate in a biomass to bioenergy market. The majority of

producers were unsure (57 percent) if they would participate in bio-based markets. The lack of clarity for agricultural producers to participate in bio-based markets should be of concern for developers, producers, and investors of bio-based facilities. Thus, there is an inherent need for increased educational services about the advancements in bio-based technologies and potential profits in order to help bridge the gap between suppliers and producers.

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Chapter 5. Poultry Producers' Attitudes and Perceptions towards Participating in New Bio-based Business Opportunities

5.1 Introduction

Biomass from poultry litter is gaining recognition as a feedstock for renewable natural energy. The 2007 Census of Agriculture shows significant changes in both production levels and producer characteristics (U.S.D.A. 2007). The decisions of these poultry producers could affect key issues such as the environment, sustainability, and supply of biomass. It is important to understand their knowledge of key biomass issues and concepts as well as their willingness to participate in bio-based activities.

5.2 Problem Statement

National concerns about issues such as fossil fuel supplies and climate change have stimulated interest in renewable energy sources among energy producers, developers, legislators, and policy makers. Hydro-electric, geo thermal, wind, solar and biomass energy are the most common forms of renewable energy sources that are being used to replace dependency on fossil fuels. The current global energy consumption is estimated to be 8,000 MTOE (Million Tons of Oil Equivalent) per annum. Projections have shown energy consumption will increase to higher than 15,000 MTOE by 2050 (Komiyama et al. 2001). Bio-based renewable energy, such as bioenergy from poultry litter, could provide us with opportunities to help stabilize energy use.

The U.S. is the world's leading producer of poultry meat (U.S.D.A. 2010). Many states have increased production to meet both local and international demand for poultry (U.S.D.A. 2007). This plethoric production generates millions of tons of poultry litter/manure annually (Livingston 2004; Perera et al. 2010). Issues of poultry litter as a fertilizer along with regulations against poultry litter use as cattle feed are narrowing the options of litter disposal (Livingston

2004; Perera et al. 2010). Therefore, it has become instrumental for poultry producers to create an environmentally sound and technologically viable alternative for poultry litter. Also, knowing the amount of available litter could help advance the development of bio-based markets.

Attitudes and perceptions among agricultural producers are important to consider because their management decisions could affect sustainability of harvest yields, state and local economies, future policies, and health of ecosystems. It is critical for lawmakers, energy producers, and developers to interpret the willingness of poultry producers to participate in the bio-based markets so as not to overestimate the supply of biomass.

Limited research covers issues concerned with the attitudes and perceptions of poultry producers towards bio-based opportunities. Also, the poultry producers need the tools necessary to make informed decisions when integrating scientific-based cellulosic biomass management activities into existing business plans. The goal of providing unbiased information regarding cellulosic bio-based business opportunities can be realized through research so that poultry producers may provide their resources to emerging bio-based markets.

5.3 Literature Review

5.3.1 Availability of Poultry-Based Biomass Resources

The value of poultry and egg production in the U.S. is on the rise with sales accounting for 12 percent of all agricultural products sold (U.S.D.A. 2007). Also, the U.S. produces more poultry meat than any other country at nearly 50 billion pounds of broilers annually (U.S.D.A. 2009) (**Figure 10**). This produces millions of tons of poultry litter annually (Livingston 2004; Perera et al. 2010). Poultry litter is a composition of poultry manure and bedding material comprised of wood shavings, sawdust, peanut hulls, shredded sugar cane, straw, and other dry

absorbent low-cost organic materials (Perera et al. 2010). Due to its composition, poultry litter has remarkable potential as a bio-fuel source.

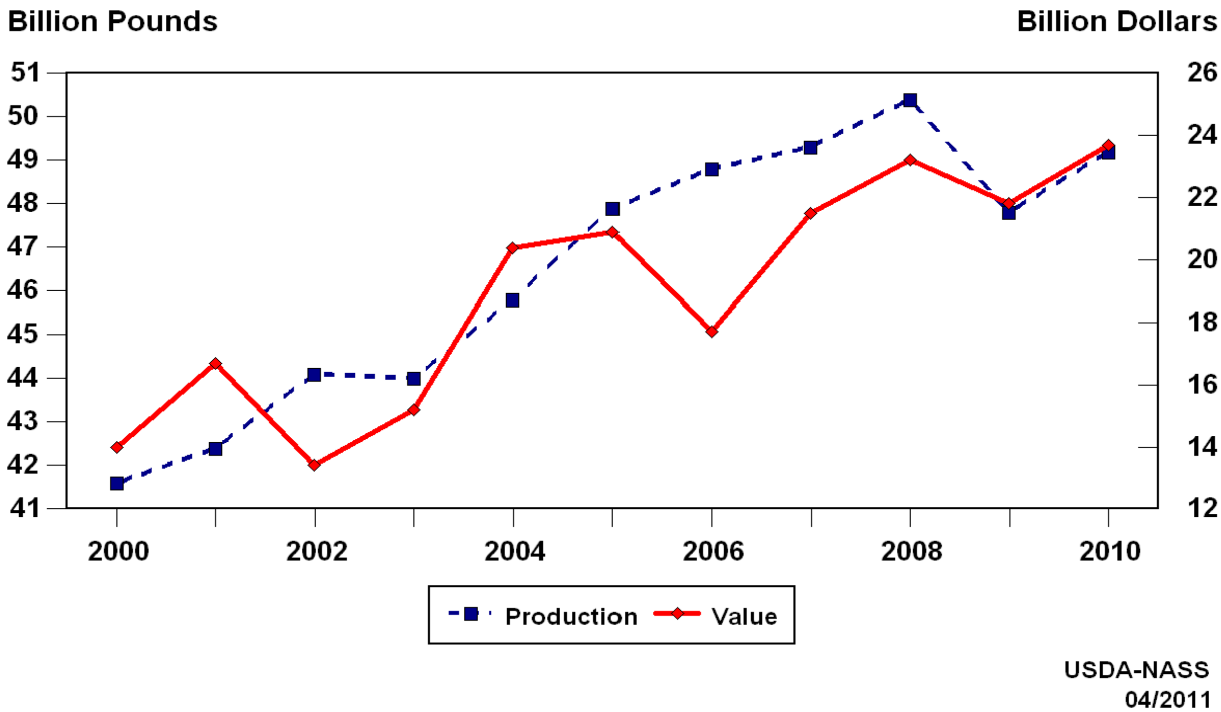

Figure 10. Total Annual Broiler Production (lbs.) and Value in U.S. from 2000-2010 (Source: U.S.D.A.).

A major proportion of poultry and egg sales are derived from the Southeast (U.S.D.A. 2007). The top six states from within this region account for more than 50 percent of the total value of U.S. poultry and egg sales (U.S.D.A. 2007). North Carolina, Georgia, and Arkansas reported the largest increases in sales, production, and subsequent litter production. With broiler production increasing dramatically in the Southeastern U.S., bioenergy from poultry litter addresses environmental concerns while providing an excellent option for reducing operational expenses.

As a Southeastern state, Louisiana's poultry industry has steadily increased as the state recently generated approximately $603 million in farm revenue and $579 million in value added

products (Paudel et al. 2010). Considering a case study in Louisiana by Paudel et al. (2010), three parishes (Claiborne, Union, and Lincoln) produced around 150,000 tons of surplus litter in 2008. They figured this amount is capable of producing 10.5 MW of electricity with an annual direct value of $6.1 million. Louisiana is one of many states in the U.S. South with increasing interest in poultry litter as a biomass feedstock.

Mississippi ranks in the top five nationally in poultry production generating approximately $2.5 billion in total production value (U.S.D.A 2007). A total of 1,478 poultry farms in Mississippi produced approximately 817, 000 broilers in 2010 (U.S.D.A. 2010) A study by Whittington (2007) estimated nine counties in central Mississippi were capable of producing a little over 814 thousand tons of poultry litter annually. Previous studies by Fibrowatt and BRI estimate 400,000 tons of litter could produce 30 million gallons of ethanol or supply a 40 MW energy plant (Whittington 2007). Thus, this nine-county region has the potential to produce twice this amount. Since poultry litter is kept in close proximity to broiler houses, energy produced in the area could supply local plants, boost regional economies, and help diversify the portfolio of local producers.

5.3.2 Current State of Technological Advancements in Poultry Litter to Energy

Historically, poultry litter was disposed of on nearby land, used as a fertilizer for crops, sold as agricultural feed, or composted for horticultural purposes. Increased litter production has led to the realization that suitable land for receiving litter is finite. Coupled with this, environmental and health issues are causing concerns of using litter as a long-term fertilizer and feedstock (Kelleher et al. 2002; Siefert et al. 2004; Whitely et al. 2006). Such concerns include nitrate contamination of groundwater, atmospheric deposition of ammonia, and poultry litter as a

feedstock resulting in a recent band on cattle feed by the Food and Drug Administration (FDA) due to concerns over BSE (mad cow disease) (Blitzer and Sims 1988; FDA 2004; Siefert et al. 2004). Limitations of the use or disposal of poultry litter have promoted research in advanced methods for utilization of this primarily low value product.

Composting of nutrient-rich poultry litter renders a potting medium ideal for ornamental horticulture and lawn and garden markets (Blitzer and Sims 1988). Composting involves the aerobic degradation of biodegradable organic waste (Kelleher et al. 2002). Areas of study show that amendments added during composting along with improved composting methods have increased composting optimization (Kelleher et al. 2002). Concerns still exist in the loss of nitrogen despite the advancements in nitrate reductions. Also, the sale of compost could be considered only a minimal reduction in the exorbitant amount of litter produced annually.

One of the leading alternatives from an environmental and economic standpoint is using poultry litter for energy production. The energy produced could be used for heating poultry houses or power generation by means of anaerobic digestion, direct combustion, co-firing, and gasification and/or pyrolysis. Poultry litter has good burning qualities rendering heating/calorific values with a range from 4,637 to 6,950 BTU/lb (Perera et al. 2010; Whitely et al. 2006). As an energy source, it could provide a constant supply as a burner feedstock, improve on-farm efficiency, and lower or eliminate disposal costs.

Anaerobic digestion is a relatively efficient conversion process for poultry litter that involves the degradation of organic material under anaerobic conditions (Kelleher et al. 2002). In the first stage of the process, manure is hydrolyzed into simple organic compounds by anaerobic bacteria in order to be converted to organic acids (e.g. acetogenesis) (Kelleher et al. 2002; Perera et al. 2010). The second stage converts the organic acids to gases by several

species of strictly anaerobic bacteria (e.g. methanogenesis) (Kelleher et al. 2002; Perera et al. 2010). The process produces a biogas mixture with an average methane content of 60 percent (Kelleher et al. 2002).

Modern boiler systems provide efficient combustion with advanced gas reduction methods to reduce pollution. Poultry litter is incinerated with excess oxygen during direct combustion. The hot flue gases are used to produce the steam necessary for energy production from the steam turbine generators. Different boiler types include fluidized bed, cyclonic, rotary kiln, as well as liquid and gaseous incinerators (Kelleher et al. 2002). The addition of electrostatic precipitators helps to control particulate emissions after combustion (Kelleher et al. 2002).

Co-firing of animal or wood wastes is being considered among energy producers as a low-cost method of GHG reduction. The poultry litter is simultaneously combusted with coal or gas in existing boilers or modern boilers (Li et al. 2008). One study shows that co-firing litter with coal reduces sulfur dioxide and increases freeboard temperatures but increases carbon monoxide emissions depending upon litter to coal ratios (Li et al. 2008).

In gasification, organic materials are heated in a high temperature environment with steam, air, and oxygen until volatile gases are released (Combs 2008). The gaseous mixture of hydrogen, carbon monoxide, carbon dioxide and other compounds can be mixed with oxygen and burned to produce steam to operate a turbine and generate electricity. Alternatively, the gases can be cooled, filtered, purified and stored as a synthesis gas, or syngas, to be used as fuel for internal combustion engines, gas turbines, etc. (Jackson et al. 2010). A major cost associated with gasification is tar removal and/or clean up (Jackson et al. 2010). However, another gasification process using supercritical water (high temperature steam conditions) offers low

levels of char formation and the ability to use high moisture feedstocks. Pyrolysis is the gasification of biomass in the absence of oxygen and converts biomass to a mixture of solid, liquid and gas (Jackson et al. 2010).

5.3.3 Benefits of Poultry Biomass as an Energy Source

With poultry litter production on the rise, concerns have increased over disposing it in an environmentally safe manner. Composting and land applications are common accepted practices for disposing of this nutrient-rich product (Perera et al. 2010). Composted poultry litter is odorless, easy to handle, and pathogen free (Kelleher et al. 2002). Areas of study show that amendments added during composting stage reduce nitrate loss and ammonia volatilization into atmosphere (Kelleher et al. 2002). Contrary to such benefits, a study by Dunkley et al. (2011) shows that most farmers apply poultry litter directly from poultry houses to their fields instead of composting litter before applying to their fields.

Anaerobic digestion is a relatively efficient conversion process for poultry litter which produces biofuels such as methane (Kelleher et al. 2002). The resulting biofuel can be used on-farm in boilers to produce heat for poultry houses or in energy generators to produce electricity. As a market product, it could possibly be sold as a replacement for natural gas or fuel oil. Also, any excess electricity produced on-farm could be sold back to the grid or to local businesses (Kelleher et al. 2002).

Power generation is considered one of the best alternatives of poultry litter management (Kelleher et al. 2002; Paudel et al. 2010; Perera et al. 2010; Whitely et al. 2006). Direct combustion techniques are some of the lowest cost and most developed bio-energy technologies (Flora and Riahi-Nezhad 2006; Perera et al. 2010). The use of poultry litter as a feedstock has

the benefit of producing heat or electricity close to where it is produced either on its own or mixed with other animal or industrial wastes (Kelleher et al. 2002). Several models are either in the test phase or commercially available in both small and large scales (Kelleher et al. 2002; Perera et al. 2010; Whitely et al. 2006). Currently, Fibrowatt operates a 55-megawatt litter-fueled power plant in Minnesota that produces enough electricity to serve 40,000 homes (Fibrowatt 2010).

5.3.4 Limitations of Poultry Biomass as an Energy Source

While there is clearly accelerating interest in poultry litter as a bio-based resource right now, growth for this new industry depends upon amount of available litter, litter prices, and transportation costs. Harvesting, collecting and transporting poultry litter is difficult and expensive due to the low bulk density of this low-value product. In a study by Paudel et al. (2010), the authors found that broiler litter is not cost-effective to transport farther than 24 miles under given circumstances. Therefore, generating energy, electricity, or other related products from poultry litter is more applicable in regions where sustainable levels of poultry litter are readily available.

The geographical concentration of poultry houses around processing facilities raises environmental concerns about disposal (Ribaudo et al. 2003). Poultry litter represents the majority of excess on-farm nutrients generated from animal manures at the county/parish level in the U.S. (Collins and Basden 2006; Gollehon et al. 2001). Policy is often considered necessary to stimulate the use of poultry litter, especially beyond the concentrated production area. For example, West Virginia implemented a transport subsidy litter program intended to attract litter users in economically feasible counties and provide environmental protection from litter storage

and application that is comparable to poultry growers (Collins and Basden 2006). A study by Collins and Basden (2010) found that most litter transported under the subsidy program was utilized by the farmers in counties where litter was less costly than commercial fertilizer (Collins and Basden 2006). Also, they found that most respondents indicated they would not purchase litter without the transport cost subsidies.

5.3.5 Public Policy Issues Concerning Biomass

Several government policy measures have been enacted to support fossil fuel independence and subsequent biomass markets. According to the 25 X'25 Vision Statement (2010), U.S. farms, forests, and ranches will provide 25% of the total energy consumed in the United States by 2025. Congress declared that "it is the goal of the United States that no later than January 1, 2025, the agricultural, forestry and working land of the United States should provide from renewable resources not less than 25% of the total energy consumed in the United States while continuously producing safe, abundant and affordable food, feed and fiber" (25x25 2010).

On May 5, 2009, President Obama issued a presidential directive to the heads of the Department of Energy, Department of Agriculture, and the Environmental Protection Agency to form a working group to aggressively accelerate the investment in and production of biofuels (U.S.D.A. 2009). Agriculture Secretary Thomas Vilsack will lead an unprecedented interagency effort to increase America's energy independence and spur rural economic development. Financing opportunities from the Food, Conservation, and Energy Act of 2008 were made available before June 5, 2009. These opportunities include: loan guarantees for the development, construction, and retrofitting of commercial scale biorefineries and grants to help pay for the

development and construction costs of demonstration-scale biorefineries; expedited funding to encourage biorefineries to replace the use of fossil fuels in plant operations by installing new biomass energy systems or producing new energy from renewable biomass; expedited funding to biofuels producers to encourage production of next-generation biofuels from biomass and other non-corn feedstocks; expansion of Renewable Energy Systems and Energy Efficiency Improvements Program; and guidance and support for collection, harvest, storage, and transportation assistance for eligible materials for use in biomass conversion facilities (U.S.D.A. 2009).

5.3.6 Market Development for Biomass

Government support of biomass-based energy during the initial stages of market development should help level the playing field in the heavily subsidized energy sector by financing the farmers and offering producers incentives, loan guarantees, and market assurances. Specific programs geared towards assisting businesses, utilities, and governments include the renewable energy incentives under the American Recovery and Reinvestment Act (2009) providing tax credits and bonds. Basically, it is a per kilowatt-hour tax credit for electricity that is generated by qualified renewable energy resources.

Current competition between the green energy sector and the fertilizer sector combined with increasing commercial fertilizer prices is expected to strengthen the demand for poultry litter. Prices for litter can vary widely due to influences from area/location, composition of bedding, distance, and individual needs. A study by Paudel et al. (2010) suggests one ton of litter as a fertilizer to be worth around $116. However, studies have shown that the average purchase price of broiler litter was $26 per ton (Carreira et al. 2006). Currently, advertised

prices at the Georgia Poultry Federation Litter Market website vary from $20-$24 per ton (Market 2010).

Pellitization is a new technology pioneered by Perdue AgriRecycle, LLC (Lichtenberg et al. 2002; Perera et al. 2010). Estimates show the company could pay on average as much as $8.50 per ton while earning $10 per ton of pelletized product (Lichtenberg et al. 2002). Fibrowatt Ltd. produces electricity from litter in Minnesota with future projects slated for Arkansas, Georgia, Maryland, Mississippi, and North Carolina. (Fibrowatt 2010). Recent reports show contracts offered to pay poultry growers $2-$4.50 per ton of litter based on removal and cleaning fees (Hubbard 2010).

Unusually low survival rates for first to market businesses deter costly and risky investing attempts to pioneer a new market and offset the pioneer’s market share reward (Robinson and Min 2002). The DOE’s Loan Guarantee Program attempts to expedite and stabilize utilization projects by providing much needed funding of investment costs (U.S.D.O.E. 2010). It is intended to encourage early commercial utilization of advanced or new technologies for GHG reduction (or avoidance) energy products (U.S.D.O.E. 2010).

5.4 An Overview of Poultry Producers

The number of farms in the U.S. increased by four percent from 2002-2007 totaling a little more than 2.2 million farms (U.S.D.A 2007). The average farm size nationwide was 418 acres with new farms averaging 201 acres (U.S.D.A. 2008). Poultry and egg farm operations saw increases in both total production expenses and total farms (U.S.D.A 2007). The abundance and size of these farmers make them an ideal group for educational and research programs involving biomass to bioenergy.

Over a 10 year period, the total value of layers, pullets, and all chickens has increased within the U.S. making it the world leader in poultry production (U.S.D.A. 2010). During 2007, U.S. sales of poultry and eggs totaled $37 billion, an increase of $13.1 billion, or 55 percent, from 2002. Total sales of poultry and eggs accounted for 12 percent of all agricultural products sold in the United States during 2007. Around 97 percent of a total 32,688 farms had less than 400 layers producing more than 1.6 billion broilers in the U.S. (U.S.D.A. 2010). Considering a state level case of poultry operators alone, Mississippi has approximately 1,478 poultry farms (Kidd et al. 2007). Poultry produced approximately $2.29 billion of agricultural income primarily from the 90 percent broilers. Mississippi produced about 853 million broilers during 2010. On average an operator will have three broiler houses consisting of approximately 23,000 birds (Kidd et al. 2007). The abundance and size of these farmers in Mississippi and throughout the U.S. make them an ideal group for educational and research programs involving bio-based entities.

Significant changes occurred in the characteristics of U.S. poultry producers according to the National Agricultural Census recorded every five years (U.S.D.A 2007). The majority of producers were male (81 percent), however, statistics show female operators increased by approximately four percent. The majority of operators (58 percent) were in the range of 45-64 years old yielding an average age of 53. A little over 52 percent of operators listed farming as a primary occupation; down 17 percent from the previous census. The poultry and egg industry as a whole is highly concentrated. Family or individual owners represent more than 90 percent of all poultry operations, however, they account for only 31 percent of inventory and 62 percent of sales. This leaves 4 percent of corporations having 52 percent of inventory and 28 percent of sales (U.S.D.A 2007).

Increased interest in surplus poultry litter as a bioenergy feedstock has stemmed from its negative environmental issues as a fertilizer, bans as a cattle feedstock, and high costs of removal (Jensen et al. 2010; Kelleher et al. 2002; Perera et al. 2010). However, limited research is available on poultry producers' willingness to supply poultry litter as a feedstock for energy production. One study by Jensen et al. (2010) examined the farm characteristics/demographics on willingness to sell for energy conversion as well as their willingness to invest in an energy conversion cooperative. Their study suggests operators producing more litter and who are selling litter or giving it away are willing to commit poultry litter to a project. Knowledge of producers to commit resources helps determine the potential of future bio-based projects

Similar to the forestry sector, motivations for management objectives are diverse despite characteristic consistencies. Most research shows economics to be the driving factor behind decision making amongst farmers. However, some studies indicate that confidence levels, attitudes, farm size, and education affect the intentions of producers to adopt new technologies (Adrian et al. 2005; Cochrane 1993). A study by Jensen (2010) on poultry farmers shows that farmers with college degrees and higher income are more willing to participate in biomass to bioenergy activities than those with lower education and income. It is important for leaders in the biomass industry to understand the role of education in the development of a biomass market.

5.5 The Study

The purpose of this research was to survey poultry producers in the U.S. in order to identify current and potential business positions and their willingness to participate in new bio-based business arrangements. Specifically, the survey was conducted on poultry producers to get their views and opinions on an array of scenarios for different cellulosic bio-based products and

business strategies. It was a survey of 846 poultry producers with farm ownership within the focal region chosen by random sample. Information gained from the survey was further analyzed to characterize the populations and regions as well as rating scale data to aid in managerial decision making. This understanding and knowledge ensures landowners have access to all current and emerging markets in order to make informed decisions regarding participation in cellulosic biomass-based business endeavors.

5.5.1 Study Objectives

The specific research objectives of the poultry producer survey are

1. To develop a baseline understanding of the role that current poultry products play in the supply chains from producers to consumers within the focal region.
2. For existing producers, to discern the level of knowledge as well as attitudes and perceptions of key biomass concepts.
3. For existing producers, to discern the willingness to participate in bio-based activities in order to supply emerging biomass markets.

5.6 Methods

5.6.1 Research Population

This study is part of a larger project designed to identify high potential alternative bio-based revenue and profit streams for small and medium forest landowners, agricultural producers, and poultry producers (SMAPFL). The original intent of this research was to survey poultry producers in a seven-county region in central Mississippi (Jones, Leake, Neshoba, Newton, Scott, Simpson, and Smith) in order to identify current and potential business positions as well as identify willingness to participate in new bio-based business arrangements. However, there was a need to broaden the scope of the survey in order to satisfy the integrity of the study

from an analytical perspective. The newly chosen survey region encompassed poultry producing owners within the contiguous U.S. Our intentions were to develop methods that could be utilized within Mississippi and abroad.

The study region for this survey covered the entire United States. The study region was selected because it represents the majority poultry producers within the U.S. A specific survey was designed for the study region chosen. The poultry study consisted of 846 poultry producers chosen from a random sample. The study samples were obtained from professional directory database companies. Poultry producers provide a population that can benefit significantly from diversifying their business portfolios or adopting completely new business practices.

5.6.2 Survey Instrument Design and Measures

When surveying poultry producers, four sections were covered concerning biomass issues. Each of the four sections contained questions involving issues relevant to ownership, biomass knowledge, biomass market and policy implications, and socio-demographics. All surveys contained a cover letter, the survey, and a return envelope. Survey procedures, follow up efforts, and data analysis were conducted in accordance with Tailored Design Method (Dillman 2000). The surveys contained fixed response, scale, and open ended questions to measure the major concepts. The scale questions were based upon Likert scale types (Bruner et al. 2001). The open ended questions were designed to give questionnaires the opportunity to express their opinions not covered in other questions.

5.6.3 Data Analysis

The data from the two mailings were entered into three Microsoft Excel databases. When required, returns were codified according to return responses, request to remove from list,

undeliverables, non-applicable, and change of name or address. The categorized data were analyzed using SPSS, SAS, and/or STATA; statistical software commonly used and accepted in human dimension sciences. The majority of the analysis utilized descriptive statistics such as simple frequencies, mean responses, as well as correlation and t-tests.

5.7 Results

5.7.1 Response Rate and Respondent Demographics

Of the 846 surveys mailed, 76 were either undeliverable, inappropriate due to respondent being deceased, non-forest landowner, or unwilling to participate in the survey. They were a total of 5 unusable surveys and 168 usable surveys. The overall adjusted response rate for this survey was 21.9 percent. Adjusted response rate was calculated as follows.

Adjusted Response Rate = Usable Surveys / [Total Sample – (Undeliverables + Unusables)] %

Non-response bias was assessed between respondents from the first and second mailings. Due to the fact that the respondents from the second mailing required a reminder postcard, they can be perceived as less eager to respond (Adams 1986). Also, the respondents from the second mailing are considered likely to be a fair representation of non-respondents (Armstrong 1977).

To investigate non-response bias, these two groups were compared across all applicable survey questions. T-test statistics were used to compare continuous variables and chi square tests were used to compare categorical data. The Wilcoxon-Mann-Whitney test is a non-parametric test used for variables without a normal distribution. All of the questions were not significantly different or related at $\alpha=0.05$ level; therefore, the research results can be considered a fair representation of the sample frame.

Over 89 percent of respondents were male (n=157). The largest percentage of respondents (35 percent) were in the 35-44 age range with almost 57 percent over 55 years old (n=161). The respondents were predominately Caucasian at 94 percent (n=159). Approximately 64 percent of respondents claimed an annual income with a value greater than $80,000 (n=148). Despite income level being rather evenly distributed across all ranges, the larger percentage of respondents (27 percent) was in the highest category of over $150,000.

Just over 46 percent of respondents had an education of high school degree or less and 21 percent earned an undergraduate or graduate degree (MS or PhD) (n=160). Almost 43 percent of respondents have owned their poultry farm within the 10-19 year range and 73 percent had ownership of less than 29 years (n=160). Almost 75 percent of respondents were individual owners which included joint husband, wife, and family ownerships other than family corporations. The next largest category of ownership was corporations at 18 percent (n=165).

5.7.2 Ownership Profile

Respondents were asked to report the total production of their poultry farm as either "number of layers maintained in 2009", "number of broilers finished in 2009", or "number of pullets produced in 2009". The mean number of layers produced was 114,043 (sd=272,283) (**Figure 9**). The number of broilers produced varied tremendously with a mean of 627,344 (sd=1,228,594) from 105 respondents (**Figure 10**). The same held true with the number of pullets with a mean of 458,189 (sd=1,006,087) (**Figure 11**). Over 78 percent of respondents reported no business or other organization associated with their ownership (n=152).

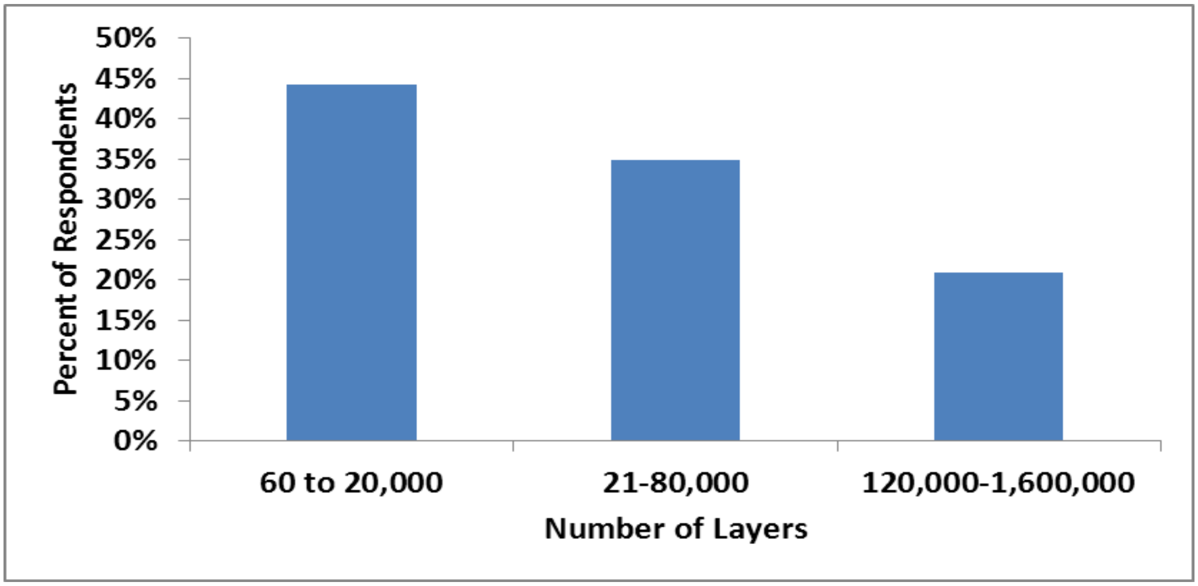

Figure 11. Number of Layers Produced by Percent Respondents in the Region (n=43).

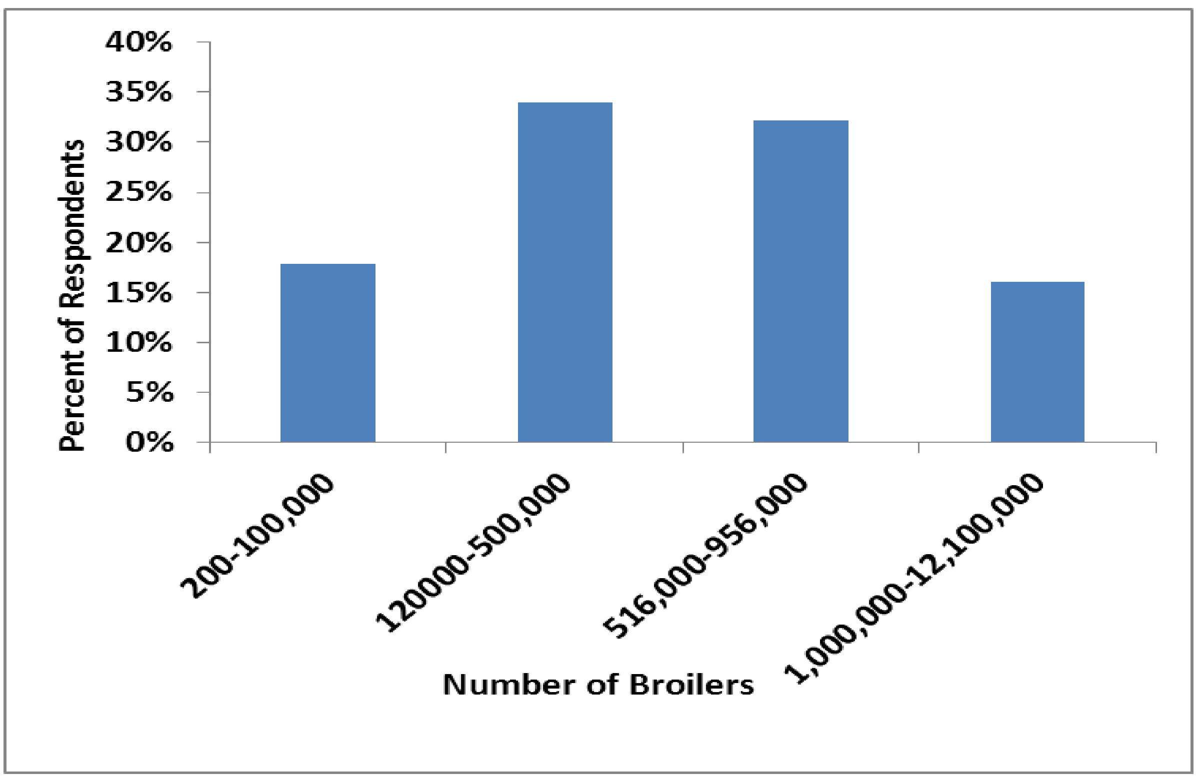

Figure 12. Number of Broilers Produced by Percent Respondents in the Region (n=105).

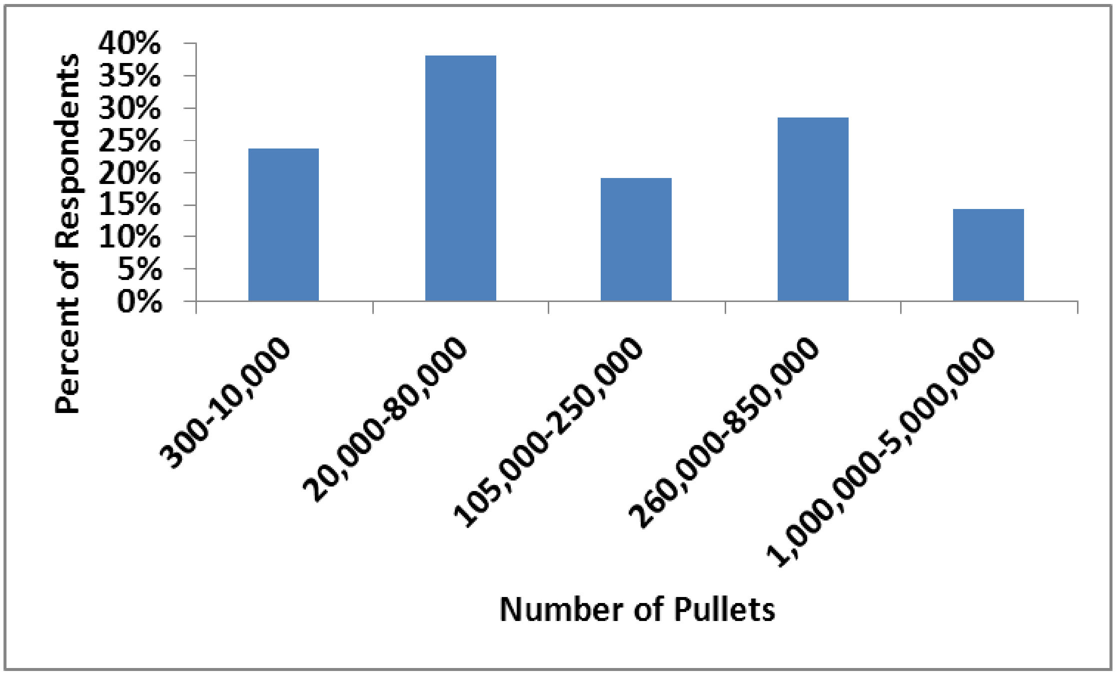

Figure 13. Number of Pullets Produced by Percent Respondents in the Region (n=26).

5.7.3 Management Issues

The questionnaire included questions intended to describe the current management activities of poultry producers. Around 98 percent of respondents believe they practice sustainable agriculture (n=161). Almost 50 percent of respondents' management costs involve burning and/or removing residues associated with harvesting activities (n=159) and 24 percent of respondents incurred a financial loss from burning or removing poultry litter (n=162).

The utilization of Likert scale type questions ranging from 1-5 with 1 being strongly disagree, 3 being neutral, and 5 being strongly disagree allowed respondents to divulge their opinions of management activities intended for using poultry litter biomass for bioenergy. Over 74 percent of respondents tested the nutrient content of their litter for fertilizer value (n=163) and 82 percent did not incorporate phytase into their ration (n=114). When asked if respondents believe biomass sales will help diversify the management activities of their poultry farm, almost

58 percent agreed (n=164). Respondents were specifically asked if they would be willing to participate in the sale of poultry litter as biomass for the production of bioenergy. The overwhelming majority of respondents (77 percent) answered “yes”.

5.7.4 Biomass Perceptions and the Impetus for Policy and Markets

The questionnaire also attempted to identify poultry producers’ knowledge and perceptions on biomass concepts and utilization. For Likert scale questions, one sample t-tests and median tests were employed for either normal or non-normal variables to determine if their mean value was significantly different from “3” or neutral. Only on two questions was there a failure to reject the null hypothesis that the mean was equal to “3” or neutral. The two questions were “I believe poultry litter biomass harvesting and collection will not require extra men and equipment” (t=-0.962, p=0.151, n=163) and “I believe converting poultry litter biomass to energy is a simple process that can be done at most agricultural facilities” (t=-0.996, p=0.151, n=163). The majority of respondents at 52 percent did not agree that poultry litter biomass harvesting negatively impacts air and water quality (n=163). A little over 62 percent did not agree that harvesting poultry litter biomass negatively impacts soil quality (n=164). The majority of respondents (69 percent) agreed that poultry litter should be used as feedstock for bioenergy markets (n=163).

The same Likert scale questions were utilized to interpret poultry producers’ knowledge of key concepts associated with converting biomass to bioenergy. A large majority of respondents agreed that technologies exist for converting biomass to energy (**Table 10**). The larger percentage of respondents disagreed that poultry litter biomass harvesting will not require extra men and equipment. The larger percentage of respondents agreed that poultry litter

biomass transportation can be done with traditional poultry equipment. Also, the larger percentage of respondents disagreed that converting litter to energy is simple and can be done at most agricultural facilities and litter is currently being used in their state for energy production. Research suggests that harvesting biomass will require use of extra men and some modified equipment among other things (Jackson et al. 2010, Walsh 2003). Also, research suggests production of energy from biomass feedstock will require either add-ons to conventional mills or construction of new bio-facilities (Jackson et al. 2010). In general, poultry producers had a smaller number of choices being neutral. Thus, poultry producers are more opiniated towards current biomass concept issues covered in this study. This could be due, in part, to the higher level of educational dissemination of current subjects typical of the vertically integrated poultry industry.

Table 10. Poultry Producers' Perceptions of Biomass Concepts, 2011.

Biomass Issues	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
I believe technologies exist for converting biomass to energy (n=163)	2%	3%	11%	40%	44%
I believe poultry litter biomass harvesting and collection will not require extra men and equipment (n=163)	13%	28%	28%	18%	13%
I believe poultry litter biomass transportation can be done with traditional poultry equipment (n=162)	8%	27%	16%	34%	15%
I believe converting poultry litter biomass to energy is a simple process that can be done at most agricultural facilities (n=163)	13%	28%	25%	25%	9%
At this point in time, poultry litter biomass is currently being utilized in our state for energy production (n=160)	26%	12%	47%	9%	6%

Previous studies indicate that certain socio-demographic characteristics were expected to influence respondents' knowledge and opinion of key biomass issues. Appropriate statistics were performed based on normality of variables in order to investigate the relationships between socio-demographic characteristics and respondents' knowledge and opinion of key biomass issues.

The Spearman correlation test was used to see if demographics are related to key respondent perceptions. Respondents' ages were significantly related to beliefs that harvesting poultry litter negatively impacts air and water quality (Spearman rho=0.178, p=0.012, n=159), and reduces growth production of poultry (Spearman rho=0.136, p=0.043, n=159). Both values for rho were positive indicating as age increased for respondents they were more likely to agree that harvesting poultry litter negatively impacts these environmental issues.

Respondents' ages were significantly related to whether or not respondents believed poultry litter as biomass is a low value product compared to traditional products such as fertilizer (Spearman rho=0.185, p=0.005, n=160). The positive rho value indicates as age increased respondents had a higher propensity to agree that poultry litter as biomass is comparatively a low-value product. Respondents' ages were not related to any of the issues concerning policy or key concepts of converting biomass to bioenergy.

Utilizing the same test, respondents' incomes were significantly related to questions concerning respondents' opinion of poultry litter as biomass for bioenergy. Income was significantly related to whether or not respondents believe poultry litter biomass used for energy production can help supplement our state's energy needs (Spearman rho=0.138, p=0.045, n=147)and the belief that their community is capable of supplying a biomass to bioenergy market (Spearman rho=0.256, p=0.001, n=144). The positive rho values indicate as income increased

respondents were more likely to agree that poultry litter used for energy production can supplement the state's energy needs as well as their community is capable of supplying a biomass to bioenergy market. Income was also related to respondents' beliefs that poultry litter as a biomass is a low value product compared to traditional products such as fertilizer (Spearman rho=-0.194, p=0.005, n=147). The negative rho value indicates as income increases respondents had a higher propensity to disagree that poultry litter is a comparatively low value product. Income was not significantly related to other market, environmental, and policy issues.

Also, using the same test, respondents' education levels were weakly yet significantly related to some questions concerning respondents' opinion of poultry litter as biomass for bioenergy. Education level was significantly related to whether or not respondents believe poultry litter as biomass is a low value product compare to traditional products such as fertilizer (Spearman rho=-0.164, p=0.039, n=159). The negative rho value means as education increases respondents were more likely to disagree that poultry litter as biomass is comparatively a low value product. Education level was related to respondents' beliefs that we should use poultry litter biomass as feedstock for bioenergy markets (Spearman rho=0.143, p=0.035, n=156). The positive rho value indicates as education increased respondents had a higher propensity to agree with the use of biomass as a feedstock for bioenergy. Education was not significantly related to other market, environmental, and policy issues.

As covered in the lit review, particular variables influence the willingness of respondents to participate in bio-based activities. In exploring this proposal, respondents were asked if they would participate in a biomass to bioenergy market with an option of either "No" or "Yes". A rather large majority of poultry producers said they would participate in a bio-based market (n=150).

The Pearson X2 test was utilized to determine if a relationship exists between variables that were either categorical or not assumed to be normally distributed. The age of respondents, respondents' education, and respondents' length of ownership all have a statistically significant relationship with the willingness to participate in a bio-based market (**Table 11**).

Table 11. Relationship between Poultry Producers' Perceptions/Demographics and Participation in Biomass Market ($\chi 2$ results).

	Participation in Biomass Market		
Socio-Demographics	**n**	**$\chi 2$**	**p-value**
Respondents' Age	148	8.078	0.022
Respondents' Education Level	145	7.974	0.045
Respondents' Length of Ownership	147	14.372	0.005
Market Issues			
Would you be willing to participate in the sale of poultry litter as biomass for the production of bioenergy?	142	76.311	0.000
Have you ever incurred a financial loss from burning or removing poultry litter?	149	9.910	0.001

As mentioned earlier, economics is the major driving force behind farmers' decision-making while several poultry farmers either pay to have their litter removed or give it away. The willingness of respondents to sell poultry litter as biomass for energy production was strongly and significantly related to their willingness to participate in biomass to bioenergy markets. Also, whether or not respondents incurred a loss from burning or removing poultry litter was significantly related to their willingness to participate in biomass to bioenergy markets.

5.8 Conclusions

Entrepreneurs, developers, energy producers, and politicians are looking for alternative energy sources to mitigate our energy crisis and climate change issues. Recent advancements in

poultry litter biomass technologies have spurred interest in the development of bio-based facilities. Many states have increased production to meet both local and international demand for poultry (U.S.D.A. 2007). This production generates millions of tons of poultry litter/manure annually (Livingston 2004; Perera et al. 2010). With continued increases in poultry litter, poultry producers could supply bio-based facilities an excellent source of feedstock to meet the demands of emerging bio-based markets.

The U.S. is the world's leading producer of poultry meat (U.S.D.A. 2010). Farm structure within the U.S. is primarily privately owned small family operations at 98% of the total (Hoppe and Banker 2010). If the development of bio-based products continues to gain momentum in the marketplace, the supply of poultry litter biomass as a feedstock will eventually be met by these private farmers. It is important to understand the motivations, characteristics, and attitudes of these individuals by interested parties in order to realize the potential markets and not overestimate the actual supply of feedstock.

This study intended to determine poultry producers' attitudes and perceptions towards key biomass concepts and issues as well as their willingness to participate in biomass management activities and emerging markets. To achieve this objective, data for the study were acquired through a questionnaire of poultry producers within the U.S.

According to the USDA (2009) most farmers were older males who reside in the state where they own their farms. Respondent demographics from the study show that the majority of poultry producers (35 percent) are in the 35-44 age range. However, almost 57 percent are over 55 years old. The education and income level are rather evenly dispersed across all ranges. This could be attributed to the large variation in farm sizes. Nevertheless, the majority of producers have higher than average income and education levels. The majority of these poultry producers

reside in the state where they own their farm (96 percent) and claim individual ownership (82 percent). Knowing key demographic factors helps hone in on a target market in which to provide valuable information about future biomass endeavors.

Results indicate the majority of producers (89 percent) who maintain layers produce less than 80,000 layers with an overall average for the group of 114,043. For those who produce finished broilers, the majority (75 percent) are under 650,000 with an overall average of 627,344. The majority (73 percent) who produce pullets have less than 270,000 with an overall average of 458,189 pullet production. Therefore, the few large poultry producers own the majority of the poultry market. This could be due to the high level of vertical integration of the poultry market. The long term commitment of bio-based facilities will depend upon the availability of supply within the area. It is important they stay abreast of ownership levels, production contracts, and vertical integration that dominates the modern poultry market.

A portion of the results from this study offer insight into poultry producers' knowledge, attitudes, and perceptions of biomass concepts and utilization. Results indicate the majority of producers believe that economically viable technologies exist for converting biomass to bioenergy. They also believe that poultry biomass harvesting and collection does require extra men and equipment and can be transported with traditional equipment. A small majority of producers do not believe converting biomass is a simple process which can be done at most agricultural facilities. Research suggests that harvesting biomass will require use of extra men and some modified equipment among other things (Jackson et al. 2010, Walsh 2003). Also, research suggests production of energy from biomass feedstock will require either add-ons to conventional mills or construction of new bio-facilities (Jackson et al. 2010). In general, poultry producers had a smaller number of choices being neutral. Thus, poultry producers are more

opiniated towards current biomass concept issues covered in this study. This could be due, in part, to the higher level of educational dissemination of current subjects typical of the vertically integrated poultry industry. The technological progress along with innovation and educational dissemination typical of the production contract oriented poultry industry creates a great opportunity for developers, entreprenuers, and energy producers to work with an already knowledgeable workforce.

Results from this study show a rather large amount of producers believe poultry litter should be used as feedstock for bioenergy markets. The overwhelming majority (77 percent) of poultry producers are willing to participate in a biomass to bioenergy market. Also, producers with higher incomes were more likely to agree their community is capable of supporting a biomass to bioenergy market. Despite this percieved affinity, older producers with higher incomes were less likely to agree that poultry litter is a low value product compared to traditional products. Therefore, a clear gap exists between the desire to utilize wood biomass and the viability of bio-based markets.

One important part of the study was to discern the willingness of agricultural producers to participate in bio-based markets. Approximately a quarter of poultry producers' costs involve burning or removing poultry litter. Almost 80 percent are willing to sale poulty litter as biomass for bioenergy production. The overwhelming majority (77 percent) of poultry producers are willing to participate in a biomass to bioenergy market. Also, the will of producers to sale poultry litter as well as the financial loss from removal influenced the will of producers to participate in a biomass to bioenergy market implying economics as a motivation for participation. The willingness of poultry producers to participate in bio-based endeavors and

their increased level of familiarity of bio-based issues makes them an ideal group for the biomass sector to include in future discussions of biomass energy production.

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Chapter 6. General Discussions and Conclusions

Society has and will continue to utilize the forests, agriculture, and livestock in order to sustain life. Advancements in modern technology within the U.S. have created a highly mechanized society relatively dependent upon energy consumption as well. Negative externalities associated with energy consumption, such as noxious emissions and dependency on fossil fuels, have stimulated interests in alternative energy sources from entrepreneurs, developers, energy producers, politicians, and the public. Biomass from forest, crop, and animal residues could provide interested parties renewable feedstock needed for producing bio-based products and energy for biofacilities.

Recently, advancements in wood, agricultural crop, and poultry litter biomass technologies have spurred interest in using these materials as feedstock for of bio-based facilities. A few companies are in operation with more under contract for development. The long-term success and viability of bio-based markets will depend upon a steady supply of biomass feedstocks as well as other variables. With a positive growth rate and increased production levels, forest and crop residues as well as poultry litter biomass render a great source of renewable natural feedstocks for the emerging biomass markets.

However, most of the forests and farms of the U.S. South are privately owned by individuals or families (Birch 1994; Conner 2002). If the development of bio-based products continues to gain momentum in the marketplace, the demand of biomass feedstock will eventually have to be met by these private landowners, agricultural producers, and poultry producers. It is important for interested parties to understand the motivations, characteristics,

and attitudes of these individuals in order to realize the potential of markets and not overestimate the actual supply of feedstock.

This study intended to determine NIPF landowners', agricultural producers', and poultry producers' attitudes and perceptions towards key biomass concepts and issues as well as their willingness to participate in biomass management activities and emerging markets. To achieve this objective, data for the study were acquired through questionnaires for small to medium private forest landowners in Southwest Louisiana, agricultural producers within the Delta region of Louisiana and Mississippi, and poultry producers throughout the U.S.

Recent studies show that the majority of the forest landowners were well educated males with an average age greater than 60 and an income higher than the general public (Butler and Leatherberry 2004; Measells et al. 2005; Perera 2008; Vlosky 2000). Also, according to the USDA (2009) most farmers were older males who reside in the state where they own their farms. Respondent demographics from the study show that the majority of forest landowners, agricultural producers, and poultry producers are males over 55 years old with higher than average education and income levels. The overwhelming majority of landowners and producers reside in the state where they own their land or farm and claim individual ownership. Knowing key demographic factors helps hone in on a target market in which to provide valuable information about future biomass endeavors.

Results show that well over half (59 percent) of agricultural producers own less than 250 acres and they (58 percent) have owned these farms for more than 30 years. Over a third (37 percent) of landowners own more than 80 acres with a little over half owning their forests for less than 30 years. This supports the fact that general trend of landowners was to acquire rather than dispose of their lands. As for poultry producers, the study shows a diverse range of farm

sizes as reported in number of layers maintained, broilers finished, and pullets produced. Results also indicate that a few large poultry producers own the majority of the poultry production. This could be due in part to the high level of vertical integration of the poultry market. The long term commitment of bio-based facilities will depend upon the availability of supply within the area. It is important they stay abreast of ownership levels and trends since landowners and producers are ultimately the ones making decisions for their property. Also, socio-demographic characteristics, such as age, education, and ownership size, are reported to influence landowners' and producers' attitudes and perceptions of significant forestry and agricultural issues and their subsequent activity levels.

The general perception of landowners, agricultural producers and poultry producers about using biomass for bio-based activities is good. Despite this perceived affinity, only about half of forestry landowners and agricultural producers are willing to supply biomass feedstock on a local or state level while less than half of all three groups believe a bioenergy market will be comparatively competitive to conventional energy markets. Therefore, a clear gap exists between the desire to utilize biomass and the viability of bio-based markets.

A portion of this study provides valuable insight into landowners' and producers' knowledge, attitudes, and perceptions of biomass concepts and utilization. As for forestry landowners and agricultural producers, the high number of neutral responses indicate their ineptitude toward the state of technological advancements in the conversion of biomass to bioenergy. Such responses also underscore the limited level of familiarity they have on certain biomass issues. In contrast, a large percentage of poultry producers had a smaller number of choices being neutral. Thus, poultry producers are more opiniated towards current biomass

concept issues covered in this study. This could be due, in part, to the higher level of educational dissemination of current subjects typical of the vertically integrated poultry industry.

Motivations for management activities, ownership, and knowledge of harvesting activities vary amongst determinant factors such as size of ownership, length of ownership, and other variables (Conway et al. 2003; Hodgden 2003; Perera 2008, Vokoun 2006). Also, some studies indicate that confidence levels, attitudes, farm size, and education affect the intentions of producers to adopt new technologies (Adrian et al. 2005; Cochrane 1993). Results from this study indicate that forest landowners' and agricultural producers' perceptions of environmental, market, and policy issues were influenced by several socio-demographic variables. This study shows that older landowners and producers had a higher propensity to believe that harvesting biomass will negatively impact the environment. They were more likely to believe that tax credits, subsidies, and incentive programs should not be provided for biomass establishment, selling, and utilization. To add to this, agricultural producers with higher education and income levels were less likely to believe that economically viable technologies exist for biomass or that biomass can be easily converted at local agricultural facilities. As mentioned earlier, most of the landowners and producers are older and well educated with higher than average incomes. This is an important note for policy makers, legislators, and local officials to take forward when creating policies intended to foster the development of bio-based markets.

One important part of the study was to discern the willingness of forest landowners, agricultural producers, and poultry producers to participate in bio-based activities or markets. Results from the study show that most forest landowners have harvested trees from their property during their ownership or plan to in the future. It also shows that a high number of agricultural producers have sustainable practices and over a third of their costs come from removing or

burning harvest residues. Despite the seemingly large amount of current and future production as well as the costs accrued from disposing of harvest residues, only a 51 percent of forest landowners are willing to participate in management activities specifically geared toward biomass production while only 26 percent of agricultural producers would participate in a biomass to bioenergy market. The majority of agricultural producers were unsure (57 percent) if they would pariticipate in bio-based markets. When asked what it would take to participate, the majority of forest landowners report "profit" with assurance that "no harm will be done to the environment" , and "knowledge and training" following close behind. According to the results, age, income, and gender influenced the willingness of agricultural producers to participate in bio-based markets. Thus, there is an inherent need for increased educational services about the advancements in bio-based technologies and potential profits in order to help bridge the gap between suppliers and producers. As for the poultry producers, the overwhelming majority (77 percent) of poultry producers are willing to participate in a biomass to bioenergy market. According to the results, the length of ownership, age, education, and economics influenced the willingness of producers to participate in bio-based markets. The willingness of poultry producers to participate in bio-based endeavors and their increased knowledge base of bio-based activities makes them an ideal group for the biomass sector to include in future discussions of biomass energy production. This research helps fill the gap between suppliers and producers by better understanding forest landowners', agricultural producers', and poultry producers' attitudes and perceptions towards bio-based activities and their subsequent markets.

6.1 Implications

Non-industrial private forest landowners, agricultural producers, and poultry producers play a major role in the ownership of forestland and farms as well as the economy of rural areas. The management activities of their properties are diverse as they supply food and fiber to various industries. This research fills the gap by providing landowners' and producers' attitudes and perceptions of high potential alternative bio-based revenue and profit streams. Understanding landowners' and producers' will to supply biomass feedstock, that of which is necessary for bioenergy production, will aid officials and professionals in setting production levels comparable to actual supply levels.

Findings from this research provide a base for entrepreneurs, developers, energy producers, and politicians to create alternative management practices and strategies for landowners and producers to incorporate into current management plans or entirely new plans. Rural economies, especially in the U.S. South, are historically some of the poorest in the nation. The development of bio-based facilities in rural communities will strengthen the economy through increased revenue and taxes. In order to maintain a sustainable supply, forestry, agricultural and poultry professionals could develop new generation cooperatives that offer farmers and producers leverage and strength in the form of community involvement; especially when faced with the uncertainty of various crop rotations and mixed, multiple, or international markets. Landowner's and producers' perceptions of bio-based activities along with their current management structures are vital to such decisions.

The research findings can aid government officials, forestry professionals, and cooperative extension services as they develop viable management techniques to be utilized in the field or on the farm in order to ensure the current and future success of landowners,

agricultural and poultry producers. Overall, the majority of the respondents from these groups are positive about utilizing biomass for bioenergy and will participate in bio-based management activities. An assurance of profit, more knowledge, and professional assistance are needed for those not willing to participate. Entities such as land grant university cooperative extension services, state departments of agriculture, and other information providers should develop outreach and educational materials/programs that provide information on innovative management methods. Topics could include dedicated energy species, agroforestry, or future and forwards contracts. Such information could lower insecurity due to lack of knowledge and alleviate risks associated to participate in bio-based opportunities for small and medium forest landowners, agricultural producers, and poultry producers.

The concept of bio-based activities is relatively new. Therefore, previous biomass studies on landowners or producers offer little applicable insight, especially in Louisiana and Mississippi. Also, this is a one-time study focused primarily on forestry and agricultural producers as well as poultry producers. It would be advantageous to study other regions and other segments of the market such as the logging industry and energy producers to ensure the long-term prosperity of bio-based markets. Future studies should be provided during the various stages of market development to measure the success of current and future studies.

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Appendix A: Southwest Louisiana Forest Landowner Survey

FOREST LANDOWNER'S BIOMASS QUESTIONNAIRE

Section I. Forestland Ownership

1. Do you own Forestland in Louisiana? **(Please fill in the correct response)**

O NO ⇨ IF **NO**, PLEASE STOP HERE AND RETURN THE SURVEY IN THE POSTAGE PAID ENVELOPE.

O YES If **YES**, please continue

Please indicate how much forestland you currently own in Louisiana. **(Please fill in only one)**

O 1-29 acres	O 140-249 acres	O 500-699 acres
O 30-79 acres	O 250-349 acres	O 700-999 acres
O 80-139 acres	O 349-499 acres	O 1000 or more acres

2. Please indicate how much forestland you have acquired in the last 10 years in Louisiana. **(Please fill in only one)**

O 1-9 acres	O 50-99 acres	O 200-299 acres
O 10-24 acres	O 100-149 acres	O 300-499 acres
O 25-49 acres	O 150-199 acres	O 500 or more acres

3. Please indicate how much forestland you have disposed of (sold or deeded to others) in the last 10 years in Louisiana. **(Please fill in only one)**

O 1-9 acres	O 50-99 acres	O 200-299 acres
O 10-24 acres	O 100-149 acres	O 300-499 acres
O 25-49 acres	O 150-199 acres	O 500 or more acres

4. Please indicate the primary type of forestland you own in Louisiana. **(Please fill in only one)**

O Natural Hardwood	O Natural Pine
O Planted Hardwood	O Planted Pine
O Mixed Hardwoods and Pine	O Other (please specify) _______________

5. Please choose the ownership category under which the majority of your Louisiana forestland holdings fall. **(Please fill in only one)**

O INDIVIDUAL (including joint husband, wife and family ownerships other than family corporations)

O PARTNERSHIP

O CORPORATION

O CLUB OR ASSOCIATION

O OTHER (please specify)________________________________

6. Have trees ever been harvested from your land, either by you personally or by someone else, during the time you have owned your forestland?

O NO

O YES ⟹ If YES, what year was the most recent harvest? _________

7. Over the past 5 years, which products have been produced from trees harvested on your forestland in Louisiana? **(Please fill in all that apply.)**

O FUELWOOD FOR YOUR OWN USE OR FOR THE USE OF FRIENDS

O OTHER PRODUCTS FOR PERSONAL USE (fence posts, lumber, etc.)

O FUELWOOD FOR SALE

O SAWLOGS FOR SALE

O PULPWOOD FOR SALE

O POSTS, POLES, AND PILINGS FOR SALE

O CHRISTMAS TREES FOR SALE

O CHIPS (IN WOODS)

O OTHER PRODUCTS (please specify) _________________________

8. Is there a written forestry management plan for your forestland in Louisiana?

O NO

O YES ⟹ If YES, who prepared the plan?

I prepared the plan O

Other O

If other, please specify _____________________________

9. Have you ever sought advice or assistance in managing your forestland?

O NO O YES

10. Are your forestlands in Louisiana certified by a third-party certifier?

O NO

O YES ⟹ If YES, please identify the certification program(s) **(Please fill in all that apply.)**

O Sustainable Forestry Initiative (SFI)

O Forest Stewardship Council (FSC)

O American Tree Farm System
O Green Tag
O Program for the Endorsement of Certification (PEFC)
O Other (please specify________________

11. Do you plan to harvest trees from your land for your personal use or for sale . . .

	Please choose only one in each column	
	Wood for own use	Wood for sale
In the next 10 years?	O	O
Possibly at some future date?	O	O
Never plan to harvest?	O	O

12. Please **RANK** the following reasons why you own forestland.
1= LEAST important reason …. 9= MOST important reason.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Land investment (hope to sell all or most of my forestland at a profit)	O	O	O	O	O	O	O	O	O
Recreation (hunting, camping, fishing, bird watching, etc.)	O	O	O	O	O	O	O	O	O
Timber production (growing timber or other forest products for sale)	O	O	O	O	O	O	O	O	O
Having forestland as a source of timber for my own use, e.g., firewood, fence posts, etc.)	O	O	O	O	O	O	O	O	O
Enjoyment of owning "green space"	O	O	O	O	O	O	O	O	O
Retirement Income	O	O	O	O	O	O	O	O	O
Donation to environmental group	O	O	O	O	O	O	O	O	O
For an estate to pass on to my children	O	O	O	O	O	O	O	O	O

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.

	Strongly Disagree	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
In my opinion, wood biomass is a viable energy alternative to fossil fuels.	O	O	O	O	O
I believe wood biomass used for energy production can help supplement our state’s energy needs.	O	O	O	O	O

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
In my opinion, economically viable technologies exist for converting wood to bioenergy.	O	O	O	O	O
I believe my state can achieve governmental mandates requiring a percentage of total energy production come from renewable resources.	O	O	O	O	O
I believe harvesting wood biomass negatively impacts wildlife habitat.	O	O	O	O	O
I believe harvesting wood biomass negatively impacts air and water quality.	O	O	O	O	O
I believe harvesting wood biomass negatively impacts soil quality.	O	O	O	O	O
I believe harvesting wood biomass will reduce growth production on standing timber.	O	O	O	O	O
I believe wood biomass harvesting and collection will not require extra men and equipment.	O	O	O	O	O
I believe wood biomass transportation can be done with traditional logging trucks.	O	O	O	O	O
I believe wood biomass storage can be easily stored for long periods.	O	O	O	O	O
I believe converting wood biomass to energy is a simple process that can be done at most pulp/paper and saw mills.	O	O	O	O	O
At this point in time, wood biomass is currently being utilized in our state for energy production.	O	O	O	O	O
I believe wood biomass requires utilizing whole trees as well as residual feedstock.	O	O	O	O	O
I would supply wood biomass to bio-refineries capable of producing energy for rural/local needs.	O	O	O	O	O
I would supply wood biomass to bio-refineries capable of producing energy for our State's needs.	O	O	O	O	O
I would supply wood biomass to bio-refineries capable of producing energy for our Nation's needs.	O	O	O	O	O

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

Extremely Negative	Somewhat Negative	Neutral	Somewhat Positive	Extremely Positive
O	O	O	O	O

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.

	Strongly Disagree	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
Residual wood waste from forest harvesting activities should be used for bioenergy production.	O	O	O	O	O
In my opinion, the health of my forestland can be improved by using wood biomass for bioenergy.	O	O	O	O	O
Chipping wood for biomass would harm the pulp and paper industry.	O	O	O	O	O
I believe wood biomass harvesting will help diversify the management activities of my timberland.	O	O	O	O	O

4. For each statement below, please fill in the appropriate response that **best describes your current** management activities regarding your forestland.

	Yes	**No**
Do you believe you practice sustainable forestry?	O	O
Do you think your forestland is currently overstocked?	O	O
Does part of your management costs involve burning/ removing slash piles or harvesting residues from harvesting activities?	O	O
Have you ever or do you currently use(d) prescribed burns as part of your management activities?	O	O
Have you ever or do you currently use(d) herbicide treatments as part of you management activities?	O	O
Would you be willing to participate in management activities specifically geared toward biomass production such as short rotation woody crops or slash/harvest residue removal?	O	O

Section III. Biomass Policy and Markets

*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.

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
Tax credits should be given to landowners, biomass harvesters and companies that utilize biomass intended for energy production.	O	O	O	O	O
Government subsidies should be provided as an incentive to companies for selling biomass residues (slash, chips, sawdust, etc.) from forestry and mill operations.	O	O	O	O	O
Government incentive programs should be provided to supplement the costs of establishing biomass tree crop species (fast growing poplar, willow and eucalyptus).	O	O	O	O	O
Grants should be awarded for research and development capable of advancing biomass production technologies.	O	O	O	O	O
Secured loans should be provided to develop and construct commercial scale bio-refineries.	O	O	O	O	O

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.

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
In my opinion, we should use wood biomass as feedstock for bioenergy markets.	O	O	O	O	O
I believe my parish is capable of supplying a wood biomass to bioenergy market.	O	O	O	O	O
I believe a bioenergy market will be competitive compared to the conventional energy market.	O	O	O	O	O

3. What prerequisites would it take for you to participate in a biomass to bioenergy market? (Select all that apply).

- O Profit
- O Does not harm wildlife habitat
- O Does not deplete the soil of nutrients
- O Does not cause erosion
- O It might upset existing sectors that use the same raw materials (e.g. chips for pulp/paper)
- O Knowledge and training
- O Other (Please specify)___________________

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? ____

3. Are you a resident or non-resident forestland owner in Louisiana?

- O RESIDENT
- O NON-RESIDENT

4. How long have you owned forestland in Louisiana?

O 0-9 years	O 20-29 years	O 40-49 years
O 10-19 years	O 30-39 years	O 50 or more 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 in 2009? (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)**

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

6. What is your gender?

- O MALE
- O FEMALE

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

O Some high school or less	O Some college	O Graduate degree (M.S./Ph.D., MBA, JD)
O High school graduate	O College graduate	

(B.A./B.S.)

8. What is your ethnic group?

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

THANK YOU!!!

Appendix B: Delta Region Agricultural Producer Survey

AGRICULTURAL LANDOWNER BIOMASS QUESTIONNAIRE

Section I. Agricultural Land Ownership

2. Do you own agricultural land in Mississippi or Louisiana? **(Please fill in the correct response)**

O NO ⇨ IF **NO**, PLEASE STOP HERE AND RETURN THE SURVEY IN THE POSTAGE PAID ENVELOPE.

O YES If yes, please identify the following about your agricultural land:

State where acres are located:

O LA

O MS

Please choose how much agricultural land you own currently. **(Please fill in only one)**

O 1-29 acres	O 140-249 acres	O 500-699 acres
O 30-79 acres	O 250-349 acres	O 700-999 acres
O 80-139 acres	O 349-499 acres	O 1000 or more acres

2. Please choose how much agricultural land you have acquired in the last 10 years. **(Please fill in only one)**

O 1-9 acres	O 50-99 acres	O 200-299 acres
O 10-24 acres	O 100-149 acres	O 300-499 acres
O 25-49 acres	O 150-199 acres	O 500 or more acres

3. Please choose how much agricultural land you have disposed of (sold or deeded to others) in the last 10 years. **(Please fill in only one)**

O 1-9 acres	O 50-99 acres	O 200-299 acres
O 10-24 acres	O 100-149 acres	O 300-499 acres
O 25-49 acres	O 150-199 acres	O 500 or more acres

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

O Sugarcane	O Hay	O Other (please specify)
O Rice	O Cotton	________________
O Soybeans	O Wheat	
O Corn	O Sweet Potato	

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

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

6. If your ownership has a business or other organization associated with it, what is the nature of the organization? **(Please fill in only one) (N/A means this does not apply to you)**

- O FOREST INDUSTRY (sawmill, pulp mill, etc.)
- O FARM INDUSTRIAL BUSINESS (manufacturing, mineral extraction, etc.)
- O REAL ESTATE NON-INDUSTRIAL BUSINESS (retail, sales, service industry, etc.)
- O SPORT/RECREATION CLUB OR ASSOCIATION
- O PUBLIC UTILITY
- O OTHER (please specify)____
- O N/A

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.

	Strongly Disagree	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
In my opinion, agricultural biomass is a viable energy alternative to fossil fuels.	O	O	O	O	O
I believe biomass used for energy production can help supplement my state's energy needs.	O	O	O	O	O
In my opinion, economically viable technologies exist for converting biomass to bioenergy.	O	O	O	O	O
I believe my state can achieve governmental mandates requiring a percentage of total energy production come from renewable resources.	O	O	O	O	O
I believe harvesting agricultural biomass for bioenergy negatively impacts wildlife habitat.	O	O	O	O	O
I believe harvesting agricultural biomass for bioenergy negatively impacts air and water quality.	O	O	O	O	O
I believe harvesting agricultural biomass for bioenergy negatively impacts soil quality.	O	O	O	O	O

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
I believe harvesting agricultural biomass for bioenergy will reduce growth production on agricultural crops.	O	O	O	O	O
I believe agricultural biomass harvesting and collection will not require extra men and equipment.	O	O	O	O	O
I believe agricultural biomass transportation can be done with traditional agricultural equipment.	O	O	O	O	O
I believe agricultural biomass can be easily stored for long periods using traditional storage methods.	O	O	O	O	O
I believe converting agricultural biomass to bioenergy is a simple process that can be done at most agricultural processing facilities.	O	O	O	O	O
At this point in time, agricultural biomass is currently being utilized in our state for energy production.	O	O	O	O	O
I believe agricultural biomass requires utilizing entire crop (e.g. corn, rice) as well as residual feedstock (e.g. corn stover, rice hulls).	O	O	O	O	O
I would supply agricultural biomass to bio-refineries capable of producing energy for rural/local needs.	O	O	O	O	O
I would supply agricultural biomass to bio-refineries capable of producing energy for our State's needs.	O	O	O	O	O
I would supply agricultural biomass to bio-refineries capable of producing energy for our Nation's needs.	O	O	O	O	O

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

Extremely Negative	Somewhat Negative	Neutral	Somewhat Positive	Extremely Positive
O	O	O	O	O

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.

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
In my opinion, agricultural residues from harvesting activities should be used for bioenergy production.	O	O	O	O	O
In my opinion, the health of my agricultural land can be improved by using biomass for bioenergy.	O	O	O	O	O
I believe agricultural biomass is a low value product compared to traditional commodity crops.	O	O	O	O	O

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
I believe biomass harvesting will help diversify the management activities of my agriculture land.	O	O	O	O	O

4. For each statement below, please fill in the appropriate response that **best describes your current** management activities regarding your agricultural land.

	Yes	No
Do you believe that you practice sustainable agriculture?	O	O
Does part of your management costs involve burning/ removing harvesting residues from harvesting activities?	O	O
Would you be willing to participate in management activities specifically geared toward biomass production such as short rotation energy crops (switchgrass, poplar, energy cane, sweet sorghum etc.)?	O	O

Section III. Biomass Policy and Market

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

4. For each statement below, please indicate **your level of agreement or disagreement** regarding

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
Tax credits should be given to landowners, harvesters and companies that utilize biomass intended for energy production.	O	O	O	O	O
Government subsidies should be provided, as incentives, to companies for selling biomass residues (e.g. hulls, stover, etc.) from agricultural operations.	O	O	O	O	O
Government incentive programs should be provided to defray the costs of establishing biomass crop species (switchgrass, poplar, sorghum, energy cane, etc.).	O	O	O	O	O
Grants should be awarded for research and development capable of advancing biomass production technologies.	O	O	O	O	O
Secured loans should be provided to develop and construct commercial scale bio-refineries.	O	O	O	O	O

5. 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.

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
In my opinion, we should use agricultural biomass as feedstock for bioenergy markets.	O	O	O	O	O
I believe my county/parish is capable of supplying biomass to bioenergy markets.	O	O	O	O	O
I believe a bioenergy market can be competitive compared to the conventional energy market.	O	O	O	O	O

6. Would you participate in a biomass to bioenergy market?

O NO

O YES

O NOT SURE

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.

3. 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

4. What is your primary occupation? ____

3. Are you a resident or non-resident agricultural landowner in Louisiana/Mississippi?

O RESIDENT

O NON-RESIDENT

4. How long have you owned agricultural land in Louisiana/Mississippi?

O 0-9 years	O 20-29 years	O 40-49 years
O 10-19 years	O 30-39 years	O 50 or more 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 in 2009? (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)**

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

6. What is your gender?

O MALE

O FEMALE

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

O Some high school or less	O Some college	O Graduate degree (M.S./MBA, Ph.D., JD)
O High school graduate	O College graduate (B.A./B.S.)	

8. What is your ethnic group?

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

THANK YOU!!!

Appendix C: U.S. Poultry Producer Survey

POULTRY FARM OWNER'S BIOMASS QUESTIONNAIRE

Section I. Poultry Farm Ownership

3. Do you own a poultry farm in United States? **(Please fill in the correct response)**

O NO ⇒ IF NO, PLEASE STOP HERE AND RETURN THE SURVEY IN THE POSTAGE PAID ENVELOPE.

O YES If yes, please identify the following about your poultry farm:

2. Please identify the following about the total production of your poultry farm:

Number of layers maintained in 2009 ____________________

Number of broilers finished in 2009 ____________________

Number of pullets produced in 2009 ____________________

3. Please choose the ownership category under which the majority of your poultry farm holdings fall? **(Please fill in only one)**

O INDIVIDUAL (including joint husband, wife and family ownerships other than family corporations)

O PARTNERSHIP

O CORPORATE

O CLUB OR ASSOCIATION

O OTHER (please specify)_________________________________

4. If your ownership has a business or other organization associated with it, what is the nature of the organization? **(Please fill in only one) (N/A means this does not apply to you or you are unaware of the answer)**

O FOREST INDUSTRY (sawmill, pulp mill, etc.)

O FARM INDUSTRIAL BUSINESS (manufacturing, mineral extraction, etc.)

O REAL ESTATE NON-INDUSTRIAL BUSINESS (retail, sales, service industry, etc.)

O SPORT/RECREATION CLUB OR ASSOCIATION

O PUBLIC UTILITY

O OTHER (please specify)____

O N/A

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.

	Strongly Disagree	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
In my opinion, converting poultry litter to bioenergy is a viable energy alternative to fossil fuels.	O	O	O	O	O
I believe poultry litter biomass used for energy production can help supplement our state's energy needs.	O	O	O	O	O
I believe technologies exist for converting biomass to energy.	O	O	O	O	O
I believe my state can achieve governmental mandates requiring a percentage of total energy production come from renewable resources.	O	O	O	O	O
I believe poultry litter biomass harvesting negatively impacts air and water quality.	O	O	O	O	O
I believe poultry litter biomass harvesting negatively impacts soil quality.	O	O	O	O	O
I believe poultry litter biomass harvesting will reduce growth production of poultry.	O	O	O	O	O
I believe poultry litter biomass harvesting and collection will not require extra men and equipment.	O	O	O	O	O
I believe poultry litter biomass transportation can be done with traditional poultry equipment.	O	O	O	O	O
I believe poultry litter biomass can be easily stored for long periods using traditional storage methods.	O	O	O	O	O
I believe converting poultry litter biomass to energy is a simple process that can be done at most agricultural facilities.	O	O	O	O	O
At this point in time, poultry litter biomass is currently being utilized in our state for energy production.	O	O	O	O	O
I would supply poultry litter biomass to bio-refineries capable of producing energy for rural/local needs.	O	O	O	O	O
I would supply poultry litter biomass to bio-refineries capable of producing energy for our state's needs.	O	O	O	O	O
I would supply poultry litter biomass to bio-refineries capable of producing energy for our nation's needs.	O	O	O	O	O

2. In general, what is your overall opinion of the viability of using poultry litter for bioenergy? **(Please fill in only one)**

Extremely Negative	Somewhat Negative	Neutral	Somewhat Positive	Extremely Positive
O	O	O	O	O

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.

	Strongly Disagree	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
I believe poultry litter should be used for bioenergy production.	O	O	O	O	O
Poultry litter as biomass is a low value product compared to traditional products (Collins and Basden).	O	O	O	O	O
I believe biomass sales will help diversify the management activities of my poultry farm.	O	O	O	O	O

4. Which of the following do you believe would be released into the environment if poultry litter was burned to produce electricity? **(Please choose all that apply)**

O Phosphorous

O Cadmium

O Copper

O Cyanide

O Arsenic

O Carbon

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

	Yes	**No**
Do you believe you practice sustainable poultry production?	O	O
Does a part of your management costs involve burning and/or removing residues from poultry activities?	O	O
Do you incorporate phytase into your ration?	O	O
Have you ever had the nutrient content of your litter tested for fertilizer value?	O	O
Have you ever incurred a financial loss from burning or removing poultry litter?	O	O
Would you be willing to participate in the sale of poultry litter as	O	O

	Yes	No
biomass for the production of bioenergy?		

Section III. Biomass Policy and Market

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

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

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
Tax credits should be given to landowners, biomass harvesters and companies that utilize biomass intended for energy production.	O	O	O	O	O
Government subsidies should be provided, as incentives, to companies for selling biomass residues (manures, bagasse, slash, sawdust, etc.) from agriculture, forestry and mill operations.	O	O	O	O	O
Government incentive programs should be provided to supplement the costs of establishing biomass crop species (switchgrass, poplar, willow, energy cane, etc.).	O	O	O	O	O
Grants should be awarded for research and development capable of advancing biomass production technologies.	O	O	O	O	O
Secured loans should be provided to develop and construct commercial scale bio-refineries.	O	O	O	O	O
Government incentives should be provided to help develop and construct non-commercial scale bio-refineries.	O	O	O	O	O

8. 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.

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
In my opinion, we should use poultry litter biomass as feedstock for bioenergy markets.	O	O	O	O	O
I believe my community is capable of supplying a biomass to bioenergy market.	O	O	O	O	O
I believe a bioenergy market will be competitive compared to the conventional energy market.	O	O	O	O	O

9. Would you consider participating 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 nd over

2. What is your primary occupation? ____

3. Are you a resident or non-resident poultry farm owner?

O RESIDENT

O NON-RESIDENT

4. How long have you owned a poultry farm?

O	0-9 years	O	20-29 years	O	40-49 years
O	10-19 years	O	30-39 years	O	50 or more 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 2009? (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)**

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

6. What is your gender?

O MALE

O FEMALE

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

O	Some high school or less	O	Some college	O	Graduate degree (M.S./Ph.D., MBA, JD)
O	High school graduate	O	College graduate (B.A./B.S.)		

8. What is your ethnic group?

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

THANK YOU!!!

Vita

Roger is a Graduate Research Assistant pursuing Master of Science degree in the Department of Renewable Natural Resources with an area of concentration in forest products and a minor in environmental sciences under the guidance of Dr. Richard Vlosky from Louisiana State University (LSU) via the LSU Agricultural Center in the College of Renewable Natural Resources. He recently earned a Bachelor of Science degree with a major in forest management and a minor in economics from Mississippi State University in the College of Forest Resources as well as an Associate of Arts degree with a major in forestry from Hinds Junior College. His work experience includes both basic forestry and managerial duties while working for one of the largest private hardwood producers in North America. He has also worked in the public sector helping to bridge the information gap between the public and private enterprises concerning public land utilization through environmental research studies in "Old Growth Forests", entomological damage, and hydrological issues. Roger Smithhart's memberships in professional societies include Xi Sigma Pi Forestry Honor Society, Society of American Foresters, Mississippi Forestry Association, Warren County Forestry Association, Southern Hardwood Forestry Association, Forest Resources Association, and the Forest Products Society. He has dedicated many hours to programs intended to strengthen community development through non-profit organizations.