

ABSTRACT

MORRIS, PRISCILLA RENEE. Non-Industrial Private Forest Landowners' and Agriculture Landowners' Perceptions and Knowledge of Biomass and the Bio-energy Industry in North Carolina and Tennessee. (Under the direction of Dr. Sudipta Dasmohapatra).

This thesis has been organized into three chapters based on potential publications. The first chapter focuses on forest landowner perceptions of biomass harvesting and bioenergy in North Carolina. The second chapter focuses on the perceptions of farm landowners on biomass harvesting and bioenergy in North Carolina. The third chapter of this thesis focuses on forest and farm landowners perceptions of biomass harvesting and bioenergy in Tennessee as well. Due to this organization, there could be some redundancies within the three papers.

The results of this study can be used to inform industry and policy makers about the landowner's knowledge about the industry, their willingness and interest in supplying biomass, and the barriers to the production and supply of bio-based feedstocks for the growing bioenergy industry.

Based on a response rate of 9.59% (n=144) from a mail survey to 1,500 forest landowners across North Carolina, we found that while almost half of the respondents indicate no interest in supplying biomass to the bioenergy industry, more than one-third of the total respondents indicated that they would like more information about production and economics before they would consider supplying biomass for energy. The results of a regression model showed that the interest and willingness to supply biomass increased by a factor of four as the level of information about economics and production pursued by

landowners increased. The three major barriers to supplying biomass for energy reported by landowners (in order) were a lack of knowledge of economics and markets, access to usable land, and poor profit margins. In addition to competing profit margins, landowners also indicated interest in tax incentive and cost-share programs from the government as incentives for supplying biomass to the bioenergy industry.

With a response rate of 6.9% (n=103) from farm landowners in North Carolina (from a mail survey of 1,500 landowners in Fall of 2013), we found that about one-third of farmers were interested in learning more about producing and supplying agricultural biomass to the bioenergy industry while about 57% indicated no interest in cultivating or providing biomass for the bioenergy industry. Among major barriers to producing and supplying agricultural biomass, lack of knowledge about production, an underdeveloped market and site restrictions were commonly cited (in that order). Farm landowners reported that factors that would motivate them to supply biomass include assistance on production of crops for bioenergy, better profit margins, tax breaks and supply contracts. Statistical analysis revealed significantly positive relationship between amount of land area owned and interest in supplying biomass as well as between land used for livestock and interest in supplying biomass for bioenergy.

The Tennessee landowner study gained a response rate of 13.0% (n=195) forest landowners and a rate of 7.4% (n=111) farm landowners from a mail survey to 3,000 landowners across TN. We found that competitive profit margins was the major factor that will create an incentive for landowners to supply biomass for bioenergy. Other key incentives include training on growing crops and better tax breaks and cost share programs.

Forest landowners indicated that lack of information about the production and economics was the major barrier for them to supply biomass while farm landowners reported prohibitive start-up and equipment costs as the major barrier. Over half of the forest landowners as well as half of the farm landowners in our study were not aware of biomass other than corn for the bioenergy industry. In addition, none of the forest landowners and only 10% of farm landowners were currently involved in supplying biomass for bioenergy industry. Most forest landowners were interested in supplying wood residues or thinned material from forests while farm landowners were mostly interested in supplying corn or switch grass.

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Non-Industrial Private Forest Landowners' and Agriculture Landowners' Perceptions and
Knowledge of Biomass and the Bio-energy Industry

by
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DEDICATION

To my amazingly strong mother who has always had faith in my abilities. Every ounce of determination and strength I have, has come from you. Thank you for pushing me, without you I would have never accomplished so much. To my father, thank you for teaching me the value of hard work and to have compassion for everything that I do; you have always believed in me even when I didn't. So much of my success has come from your support. To my sister for helping me through the rough times and providing me with the strength and confidence to grow into the person I am today. To my friends, those who have been there since day one, and those new to my life, thank you for your support and assistance. I would not be who or where I am today without the support of every one of you all. I am forever grateful. Much love.

BIOGRAPHY

Priscilla Renee Morris was born to Troy and Yvonne Morris III June 5, 1989 in Morehead City, North Carolina. Morehead City is a medium sized coastal town surrounded by rural communities, where much of her family is from. Priscilla developed an early love and appreciation of the natural environment due to her family's involvement in commercial fishing and other outdoor activities. Throughout Priscilla's life she has been involved in many sports activities including being a member of a club soccer team for over ten years before graduating high school. During her high school career, she was a member of the women's basketball and soccer teams, Junior Naval ROTC, the FFA, and the National Honors Society. After graduating high school, Priscilla enrolled at North Carolina State University as an undergraduate in the First Year College. The First Year College helped guide her love for the outdoors into a major in the College of Natural Resources. Within the department of Forestry and Environmental Resources, Priscilla became involved with the NCSU Forestry Club, as well as the Student Chapter Society of American Foresters. During the last semester of her undergraduate studies in Forest Management, Priscilla began to explore graduate opportunities in the Forest Biomaterials Department. Shortly after receiving her Bachelors of Science Degree in Forest management, Priscilla received notice of acceptance in the Forest Biomaterials Department where she signed on with Dr. Sudipta Dasmohapatra and the IBSS team to pursue her Masters of Science degree in Forest Biomaterials.

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I would also like to thank all of the staff and faculty in the department of Forest Biomaterials for allowing me such a unique and life changing experience in pursuing the requirements of this degree.

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Non-Industrial Private Forest Landowners' Perceptions and Knowledge of Biomass and Bio-energy

1. Introduction

The need for viable renewable energy sources has been a topic of discussion for several decades. Since 1978, in the U.S., the Energy Tax Act has granted monetary “exemptions from the federal gasoline excise tax for blended gasoline containing at least 10% ethanol” (Susaeta et al. 2010). While corn ethanol has helped reduce the nation’s dependence on fossil fuels, it has developed its own critics due to the potential impact of food prices and environmental concerns (Susaeta et al. 2012).

Criticism of corn ethanol, and the perception of increasing food cost due to the competition between feed and fuel has prompted a great deal of interest in producing fuels from nonfood biomass sources, including woody biomass. The use of domestically grown woody biomass for bioenergy will reduce dependence on the imports of crude oil from known politically unstable countries (Abt et al. 2010), reduce greenhouse gas emissions from the burning of environmentally friendly biofuels (Joshi and Mehmood 2011), and create a renewable and sustainable alternative to limited fossil fuel availability in the U.S. (Gruchy et al. 2012). Along with these factors, other societal benefits support the development woody-biomass for the biofuels including a higher “net energy balance” than food-based feedstock and reduction of the risk of wildfires and pest outbreaks (Shivan and Mehmood 2010). Given the advantages, public policies such as the Energy Independence and Security act of 2007,

the Energy Policy Act of 2005, and the Healthy Forests Restoration Act of 2003 all included provisions promoting bioenergy from cellulosic biomass, including woody materials (Shivan and Mehmood 2010).

Many studies have produced estimates on how much biomass exists within the United States and how much the current available land could produce in the future. The original “Billion Ton” report, and the more recent update, both concluded that more than 1 billion dry tons of sustainable biomass could be produced annually from both forest and farm sources. Studies specifically focused on woody biomass indicate that 10% of the nation’s energy requirement could be obtained from woody biomass; of that, 80% of the wood biomass could be provided by non-industrial private forest landowners (Paula *et al.* 2011). One third of private/commercial U.S. forests are located within the southern United States, of which 71% of the forested land is owned by non-industrial private forest landowners (Gruchy *et al.* 2012) (Fig. 1). This forested area has the potential to produce around 55 million tons of dry woody biomass annually (Foster *et al.* 2005). However, to better understand the supply potential from land owned by non-industrial private forest landowner’s (NIPF’s), an assessment of their willingness to supply woody-biomass should be established before concrete predictions can be made about the amount of woody-biomass that can be produced (Gruchy *et al.* 2012; Shivan and Mehmood 2010).

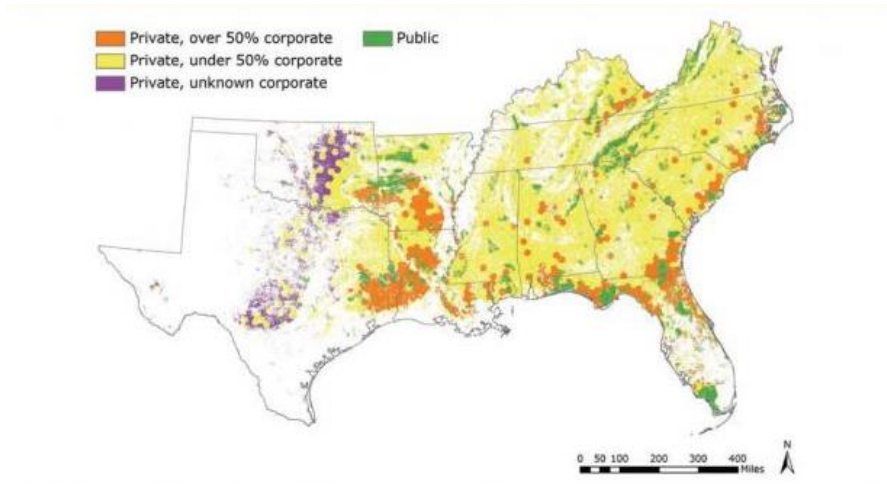


Figure 1. Forest Ownership in the Southern United States

(Source: Forest ownership (USDA Forest Service FIA, 2009), administrative boundaries ESRI Data and Maps 9.3.1, ESRI 2008).

Many studies have identified non-industrial private forest and farm landowners as important stakeholders, if not the most important ones, whose participation is vital to the success of the industry and the nation's ability to produce energy (Abt et al. 2010; Joshi and Mehmood 2011; Gruchy et al. 2012; Markowski-Lindsay et al. 2012; Monroe and Oxarart 2011; Paula et al. 2011). Without access to woody biomass resources and a positive attitude of forest landowners toward the bioenergy industry, the future goals of furthering the nation's sustainable energy productions will be difficult or even impossible to attain (Gruchy et al. 2012; Monroe and Oxarart 2011).

The importance of this particular stakeholder group to the future success of the industry has led to several recent studies on forest landowners' knowledge and awareness of the bioenergy industry. Overall, these studies show that nonindustrial and family forest landowners view the industry and the market with some skepticism, and hesitate to

participate in the supply chain. The following section presents a summary of the findings from previous studies on forest landowners' perceptions of bioenergy.

2. Literature Review

2.1 A Summary of Landowner Perceptions and Knowledge: Past Studies

Past studies on forest landowner awareness and knowledge of bioenergy indicate a lack of willingness to supply to bioenergy markets and the industry. Conrad et al. (2011) showed that 90% of forest landowners in the southern U.S. are willing to supply biomass for energy if proper economic incentives are provided. Conversely, a study of family forest landowners in Massachusetts shows very low willingness to participate in bioenergy markets (Markowski-Lindsay et al. 2012). This study also reports that the willingness to supply biomass has little or no correlation with the sales price of biomass.

Past studies also show that factors such as landowner age, management objectives, land area, and types of tree species on the land influence a landowner's awareness and willingness to harvest their land for bioenergy. A study by Joshi et al. (2013) suggests that elderly, male, and resident landowners are more likely to be aware of wood-based bioenergy as compared to female landowners having small tracts of land. Joshi and Mehmood (2011) showed that younger landowners with pine plantations or mixed species in their forestland or having larger tracts of land are more willing to supply biomass than others. Another study on willingness to harvest by non-industrial forest landowners in Mississippi indicated that, as opposed to standard clear-cutting options, most landowners preferred utilizing forest residues from harvesting operations for bioenergy (Gruchy et al. 2012). Older landowners and those

with large tracts of land were more interested in clear cutting for timber purposes, whereas younger landowners were more interested in removal and utilization of residuals for bioenergy. Shivan and Mehmood (2012) report that landowners who manage land for recreational or conservation purposes (wildlife or legacy for future) are not likely to provide biomass, whereas those that own large tracts with small-diameter trees are more likely to supply biomass for energy. Their study also found that a decent market price for woody biomass is more likely to influence willingness to supply by landowners. Furthermore, a study of landowners in Kentucky reported moderate interest from active private forest landowners to harvest biomass for energy in the future, even after outreach and educational materials were provided to inform the landowners about the industry (Leitch et al. 2013). In addition, lack of market and woodland access were cited as the most frequent barriers to supplying woody biomass to the energy markets, although only a small fraction of the total respondents responded to this question in the survey.

Clearly, the above studies provide evidence of a reluctance to participate in bioenergy markets by forest landowners and indicate the importance of socio-demographic characteristics in determining landowner willingness to harvest for bioenergy. However, not many of the studies show what will motivate landowners to supply to the bioenergy industry. Moreover, many studies focus on the important but narrow practice of collecting and utilizing residues. Few studies detailed the influence of current management practices, the impact of managing land for biomass, and important considerations such as government policies. In addition, most studies do not specify the type of bioenergy industry in focus (whether it is a more established market for pellets or electricity, compared to a brand new

liquid biofuels), which is likely to have an impact on landowner willingness to supply biomass. For example, the federal government provides credits for small-scale producers (classified as producing 60 million gallons or less of ethanol annually), which is likely to affect landowner perceptions. And many states have incentives for renewable electricity. Furthermore, many of the past studies have been conducted during the recent downturn in the economy, so the perceptions today could be varied or different from the landowner perceptions four to five years ago. For example, Conrad et al. (2011) indicate that while the biomass market was not an economically attractive option for forest landowners prior to the downturn in traditional timber markets, it could become more attractive to landowners seeking economic returns from their land during or following the downturn (Conrad et al. 2011).

This study seeks to add to the growing research in this important area with a focus on the perceptions of forest landowners in North Carolina to determine the awareness, knowledge, and attributes affecting motivations and barriers to supply biomass for bioenergy. This work specifically focused on the biofuels industry, including attributes such as economic, environmental, site management issues, policies, and markets. The results of this study will strengthen our understanding of the intent of the forest landowners in supplying biomass in an important state in the southern U.S. (North Carolina) as well as identify information sources that influence landowner motivation and that may change the barriers to supplying biomass for the energy industry.

2.2 North Carolina's Forest Industry

Currently 60 % (18.6 million acres) of the state of North Carolina is forested; the over-

all canopy is composed of 55% hardwoods (10.23 million acres), 28% pine (4.28 million acres), and 17% mixed stands (3.16 million acres). Approximately 79% (14.7 million acres) of these forested lands are owned privately. Sixty-four percent (9.4 million acres) of the privately owned land is owned by non-industrial private forest landowners, and while the remainder is owned by timber management investment companies. Publicly owned forests cover 14% (2.1 million acres) of the state's forest, and the remaining 7% (1.0 million acres) is owned by the forest products industry. Estimations show that there are approximately 500,000 non-industrial private forest landowners in the state (NC Forest Data, 2014). Among the three geographic regions in North Carolina (East or Coastal, West or Mountains, and Plains or Piedmont), the eastern part is largest in terms of forestland area (44%) (8.18 million acres), followed by the Plains (29%) (5.39 million acres) and then West (27%) (5.02 million acres) (FIA 2013).

The forest products industry is the largest manufacturing industry in North Carolina and contributes \$4.1 billion to North Carolina's Gross Product (Forest Products Industry in NC 2012). Historically, the forest products industry was composed of lumber and wood products, furniture, and pulp and paper; these three industries combined brought in \$19 billion dollars annually (Jahn 2002). In 2011 the forest products industry contributed \$23.1 billion in economic benefits, this is considerably lower than 2007 when the industry contributed \$30.3 billion in economic benefits ((Forest products industry in North Carolina 2012). With the loss in manufacturing, especially in the furniture and furnishings industry to foreign competitors, the bioenergy industry has the potential to create a new market for the state's forest resources. Although the most common biomass utilized for biofuels is corn, the

state has resources that can provide an abundance of other biomass feedstocks, such as pine, switchgrass, canola, and algae (Biofuels 2014). North Carolina currently imports 12.1 million gallons of gasoline while meeting 4% of its energy needs from biomass. Today, the potential available biomass from wood is estimated to be around 2.3 million dry tons of logging residues, 5 million dry tons of mill residues, and 833,000 dry tons of urban wood residues per year, just within the state (Jackson 2007). This diverse supply of renewable, non-food biomass led Chemtex to announce plans to build its first North American Proesa plant in Sampson County, North Carolina. This plant will be modeled after the 20 million gal/yr biofuels plant operating in Italy. Rich (2008) reported that if North Carolina could utilize the available biomass resources, the state could reduce its dependence on fossil fuels by approximately 14%. Furthermore, the study also suggested that if new dedicated energy crops such as canola, hulless barley, switchgrass, and hybrid poplar were grown, this percentage could increase (Rich 2008). More recently *Arundo Donax* and *miscanthus* have both been promoted as dedicated energy crops. Many of the studies mentioned in this section have estimated potential bioenergy production based on current measures of biomass available. However, none of these studies assessed landowner willingness to supply biomass and their perception of the industry.

3. Objectives

The goal of this study was to assess forest landowners' general perceptions about bioenergy, biomass resources, and biofuels for transportation in North Carolina. An

understanding of the knowledge, perceived value, and perceptions of forest landowners will provide extremely useful information to the bioenergy industry and policymakers about the motivations and barriers of this key stakeholder group. The results of this study will also be useful for the future development of educational tools and policies better targeted toward this group.

4. Materials and Methods

4.1 Sample Frame

To assess forest landowner perceptions about bioenergy, data were collected from a random sample of forest landowners stratified by the three different regions in North Carolina. The sample was stratified into the three regions of NC, due to the concentration of forested land within the regions. To create the sample frame, the amount of forestland within each county was first determined using data downloaded from the Forest Inventory and Analysis (FIA) database (FIA 2012). This database provides information on forested acres by county, forest type composition throughout the state, and ownership classification.

For this study, the NC counties were sorted from most to least forestland within each of the three regions of NC. For obvious reasons, the most urban counties were first eliminated from the population (we assume that the potential for a long-term supply of biomass from urban counties is low.) The urban counties were determined as those with the least acres of forested lands. Twenty-five counties were then randomly selected from across the three regions of the state, with the highest concentration of counties selected in the east followed

by the piedmont then the west (12 from the east, 7 from the piedmont, 6 from the west). A list of forest landowners was then generated from the county tax records, from which 1,500 landowners were randomly selected for data collection. The majority of the counties selected in the state classified their forest landowners within the current use program. This program only considers forest landowners as those who own 20 acres or higher of forested land. While the majority of counties selected for data collection in this study utilize this program, there were some counties that were able to provide contact information for landowners with smaller landholdings than 20 acres. Figure 2 shows the North Carolina counties used for data collection.

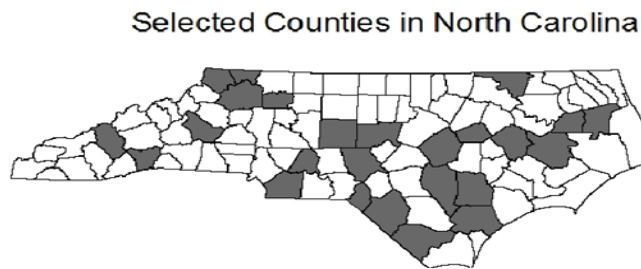


Figure 2. Randomly Selected Counties in NC for the Study

4.2 Data Collection

Traditional mail surveys were used for data collection from the forest landowners using the methods outlined in the Mail and Internet Surveys: The Tailored Design Method (Dillman 2000). Taking into consideration population characteristics and possible preferences for survey completion based on forest landowner demographic characteristics, we decided mail surveys was the best method for reaching out to the landowners (Gruchy et al. 2012; Joshi and Mehmood 2011; Markowski et al. 2012; Smithhart et al. 2014).

The mail survey contained three categories of questions, including 1) respondent demographic and ownership characteristics, 2) general bioenergy agreement statements, and 3) motivations and barriers to landowner involvement in the bioenergy industry. These questions included both fixed response, Likert scale, and open-ended response questions. The questions included in the survey were based on past studies focused on forest landowners as well as other stakeholders, in-depth review of past studies on landowner perceptions of energy, bioenergy, and bio-based feedstocks, as well as questions developed after discussions with researchers and industry professionals based on our study objectives (Anonymous undated, Jacobson undated, NC Cooperative Extension undated).

Before the surveys were mailed to landowners, a pilot study was conducted to test the effectiveness of the survey questions, interpretation of the survey questions, check question wording, and examine the survey length. A sample (n = 19) of forest landowners and forest products industry professionals responded to the pilot survey. The feedback from the pilot test was used to refine the survey instrument.

The final survey was mailed to the selected sample of 1,500 forest landowners in NC with a cover letter and a postage-paid return envelope in fall 2013. The cover letter specified the goal of the survey with emphasis on the voluntary nature of the survey and confidentiality of personal information in addition to the objectives of the survey. Three weeks after the initial survey was mailed, a reminder card was sent to the non-respondents to elicit a higher response rate. The reminder card included a link to an online version of the survey, to enable responses from contacts who found it more convenient to complete the survey online.

4.3 Overview of Factor Analysis and Logistic Regression

The survey included 35 agreement scale statements on different aspects of bioenergy industry, including economics, environmental attribute, information need, and biomass sources, among other issues. These statements were evaluated and reduced to a smaller number of related variables / latent concepts using factor analysis. This method is commonly used to analyze data from multivariate observations to find statistically significant trends within the data that are very difficult to connect without these analysis tools. Factor analysis can be viewed as a statistical method used to test the linear relationship between variables, using their correlation to organize variables into groups known as factors (Hair et al. 2009). These factors are interpreted as latent (unobserved) characteristics that represent commonality among the set of more complex, observed variables (Hardle and Simar 2012). A key objective of factor analysis is to reduce a large set of variables into meaningful factors. The resulting factors are uncorrelated or unrelated with each other (Haaf and Wilhelm 2000). This phenomenon is especially useful when using the reduced uncorrelated factors in advanced modeling (e.g., regression analysis). A factor analysis starts with a correlation matrix between variables included in the analysis. Using the intercorrelation matrix of the variables, a factor extraction method can be applied (Principal Component Analysis method was used in this case) to determine how the variables are related to unobserved factors. Factor loading is the correlation between a variable and the factors that have been extracted from the data using the Principal Component Analysis method. This information provides the analyst with a quantitative measure on how strongly each variable is related with the factors (Comrey 1992). A Varimax rotation method was used on the factor analysis results to allow better

interpretation of the factors (Hardle and Simar 2012).

We used Bartlett's Test of Sphericity to determine whether variables were factorable and the KMO (Kaiser-Meyer-Olkin) measure to determine whether it was beneficial to run a factor analysis with the given data or variables (Comrey 1992; Hair et al. 2006).

Once the factor analysis was completed, and a concise set of factors were produced, they were then used within a linear regression model. Linear regression is a statistical method that models the relationship between a dependent variable and one or more explanatory variables. In this study the dependent variable is landowner willingness to supply biomass, and the explanatory variables tested are all of the factors produced from the factor analysis, and all demographic aspects.

The logistic regression model predicts the logit, the natural log of the odds of having made one (value of 1 for interest in supplying biomass) or the other decision (value of 0 for interest in supplying biomass). The model is represented by:

$$\ln(\text{ODDS}) = \ln(\hat{Y}/1-\hat{Y}) = a + b X$$

where \hat{Y} is the predicted probability of the event which is coded with 1 (interest in supplying biomass) rather than 0 (no interest). $1 - \hat{Y}$ is the predicted probability of the other decision, and X is the predictor variable. The predictor variables are represented as X_1 and X_2 .

4.4 Response Rate

Overall, a total of 1,501 landowners were contacted and 180 responded for a total response rate of 11.99%. As shown in Table 1, 1501 landowners were contacted through the initial mailing. Of the total of 180 surveys 36 were unusable (incomplete on key questions and demographics), leaving 144 usable surveys for an effective response rate of 9.6%. The highest response was from the Piedmont region of NC, at 14% (Table 1).

Table 1. Distribution of Responses in North Carolina (n = 144)

Regions of NC	# of Counties	# of Contacts	# of Responses	% of Responses
West	6	250	27	11%
Piedmont	7	356	50	14%
East	12	895	66	7%
Total	25	1501	144	9.59%
*Undeliverable: 36 surveys (East = 23, Piedmont = 10, West = 3)				

4.5 Non-Response Bias

While it is difficult to unambiguously demonstrate non-response bias there are methods to test for this issue. Past studies have shown that non-respondents behave similar to the late respondents or respondents that respond after a reminder (Berg 2010). Early respondents are defined as those who responded before the reminder was sent, and late respondents are defined as those who answered after the reminder was mailed (Dillman 2000). Key questions were compared between the early and late respondents to determine if

there were significant differences between the two response groups. The variables included in the non-response bias analysis included landowner demographics and response to key questions (land area, objective of forestland ownership, percent of income from forestland, and attitudes towards bioenergy). An independent samples t-test between early and late respondents showed no significant difference between the two respondent groups on any variable.

5. Results

5.1 Respondent Profile

The respondent profile are shown in Table 2. About 89% of the respondents were older than 50. The respondents were mostly males (74%) and Caucasians (91%). Among respondents, 20% reported having less than a high school education, 11.7% reported having completed high school, 20.3% had some college experience, 28% completed a bachelor's degree, and 20.6% received an advanced degree. Approximately 60% of forest landowners reported their household incomes as over \$50,000 in 2012 (27% respondents had income between \$50K and \$100K, 15.3% between \$100K and \$150K, and 16.7% reported over \$150K).

Table 2. Demographic Profile of Survey Respondents (n= 144)

Demographics	Percentage of Respondents (n=144)
Age Class	
20-29	0.7%
30-39	2.1%
40-49	7.6%
50-59	20.8%
60-69	38.9%
70-79	20.8%
80+	9.0%
Gender	
Male	74.0%
Female	25.3%
Race/Ethnicity	
White	90.9%
African American/Black	2.8%
Native American	2.8%
Prefer not to answer	3.5%
Education	
Less than High School	19.4%
High School	11.7%
Some College	20.3%
Bachelor's Degree	28.9%
Advanced Degree	20.6%
Annual Household Income (2012)	
Under \$25,000	6.0%
\$25,000 to less than \$50,000	12.0%
\$50,000 to less than \$100,000	27.3%
\$100,000 to less than \$150,000	15.3%
\$150,000 and over	16.7%
Prefer not to answer	22.7%
Percentage of Household income from Forest Land (2012)	
0%	65.70%
1-10%	26.60%
11-20%	5.60%
31-40%	1.40%
41-50%	0.70%

Table 2. Continued

Education	
Less than High School	19.4%
High School	11.7%
Some College	20.3%
Bachelor's Degree	28.9%
Advanced Degree	20.6%
Annual Household Income (2012)	
Under \$25,000	6.0%
\$25,000 to less than \$50,000	12.0%
\$50,000 to less than \$100,000	27.3%
\$100,000 to less than \$150,000	15.3%
\$150,000 and over	16.7%
Prefer not to answer	22.7%
Percentage of Household income from Forest Land (2012)	
0%	65.70%
1-10%	26.60%
11-20%	5.60%
31-40%	1.40%
41-50%	0.70%
Primary type of forest land owned by respondents (2012)	
Mixed Hardwoods and Pine	43.8%
Planted Pine	32.6%
Natural Hardwood	12.5%
Natural Pine	5.6%
Planted Hardwood	1.4%
Other	4.2%
Type of ownership forest land is under	
Sole ownership	64.6%
Family-owned	28.5%
Partnership	2.10%
Corporation	2.80%
Other	2.10%

Not surprisingly a majority of respondents (65.7%) indicated that they received no income from their forest land in 2012, 26.6% reported that they received between 1% and

10%, and a very small proportion of respondents (7.7%) reported between 11% and 50% of their income from their forestland in 2012.

Respondents were also asked to indicate the primary type of species/forests in their forestland. The majority of respondent landowners (44%) reported having mixed hardwoods and pine forests while 33% landowners reported owning planted pine forests. Approximately 13% indicated natural hardwood forestlands, 6% indicated having natural pine forests and 5% indicated other (including planted hardwoods, mixed hardwoods only). An independent samples t-test was conducted to test the relationship between type of forest land owned and the amount of income respondents reported earning from their property. This test provided no significant difference between the type of forest owned and the amount of income earned in this study.

About 15% of forestland owners indicated that they followed a forest management program (e.g., FSC, American Tree Farm, NC Forest Service), and 18% indicated that they were involved in an applied cost-share fund or program (e.g., Pine Beetle Project, WHIP, CRP-Pine) by the government. In addition, 13% of forest landowners indicated that they had planted genetically improved trees in their forestlands. An independent samples t-test was conducted to test for significant differences between respondents who reported participating in forest management/certification programs and those who do not. It was found that there were no significant differences between respondents who participate in management/certification programs and those who do not. Similarly an independent samples t-test was conducted on respondents who reported their participation in cost share programs. This test reported a significant difference in the amount of forest acres owned (19% of

respondents participating in cost share programs own over 400 acres of forested land while those who do not participate did not report owning over 400 acres), the type of forest owned (69% own planted pine forest), and the percentage of their house hold income from their property was also significantly different from respondents who did not participate in cost share programs (11.5% reported earning between 11% and 50% of their income from their property). Variables tested in both scenarios include, the amount of forest acres owned, the type of forest owned, current production and or supply of biomass, gender, age, education, household income, ethnicity, and income from forest operations.

5.2 Willingness to Supply Biomass for Bioenergy Industry

Forest landowners were asked whether they were currently supplying or were interested in supplying or harvesting biomass for the bioenergy industry (any industry, including pellets, biofuels, and bio-based electricity) in the future. Table 3 shows the response to the question characterized by the amount of land owned (acres). Most respondents (n = 66) reported that they were not interested in supplying biomass for the bioenergy industry, while 35% (n = 46) indicated that they needed more information before they could harvest and supply biomass for bioenergy. Only 1.5% (n = 2) of landowners were currently supplying biomass for the bioenergy industry, and 7% (n = 9) were considering supplying or harvesting in the near future.

Table 3. Landowner Willingness to Supply Biomass by Land Area (n=133)

Forestland in acres	Currently supplying	Considering supplying	Not interested	Need more information before supplying	Other	Total # of Responses
1-30	0%	5.9%	58.8%	32.4%	2.9%	34
31-100	0%	6.1%	55.1%	30.6%	8.2%	49
101-200	0%	9.4%	46.9%	34.4%	9.4%	32
201- over 400	11.1%	5.6%	22.2%	44.4%	16.7%	18
Total Response Per category	2	9	66	46	11	133
Note: 11 landowners did not complete to this question. Other category specified includes:(Market conditions would not allow)						

Table 3 also shows that only landowners having very large holdings (over 200 acres) were supplying or harvesting for bioenergy currently among our respondents. Those who owned less than 200 acres mostly reported that they were not interested in supplying biomass for energy, and approximately one-third of respondents in any category of landownership (in acres) reported interest in learning or obtaining more information before supplying or harvesting for the bioenergy industry.

Note that among respondents, 13.5% of landowners owned more than 200 acres of land, 24% owned between 100 and 200 acres of land, 37% owned between over 30 but less than equal to 100 acres, and the rest (26%) owned 30 acres or less.

A t-test was also conducted of forest landowner’s willingness to supply biomass to see if landowner education, income, age, and regions of the state their property falls within had a significant effect on their willingness to supply biomass to the market. In this study, these variables had no significant effect on landowner willingness to supply.

5.3 Barriers and Motivations to Biomass Supply for Bioenergy Industry

Respondents were asked to indicate the major barriers to harvesting and supplying biomass to bioenergy industry (for pellets, biofuels, and electricity). This was an open ended question and responses were evaluated and condensed to the categories shown in Table 4. Note that respondents provided multiple answers to this question.

Table 4. Barriers to Supplying Feedstocks to the Bioenergy Industry (n=103)

Barriers	Percentage of Respondents
Lack of Knowledge about Bioenergy Economics and Markets	24%
Access to Usable Land	20%
Poor Returns/Low Profit Margins	19%
Lack of Knowledge on Woodlot Management (including: type of management required and regulations governing management)	11%
Lack of Market locally	11%
Other (Need family cooperation, other uses for woodlot including conservation and recreation)	7%
None (Not Interested)	13%
Don't Know	13%
(Note: Respondents provided multiple answers, total percentage exceeds 100%)	

The most frequent barrier reported by landowners (24% of landowners) was their lack of knowledge on the economics of forest-to-bioenergy system as well as the lack of information on potential size of markets (pellets, biofuels) they could target for their biomass. A closely related second barrier indicated by 20% of respondents include access to usable land to

harvest or supply biomass for bioenergy. Over 19% of the respondents indicate poor returns or low profit margins currently in the bioenergy industry compared to competing industries as a barrier and 11% of landowners indicated lack of available markets locally as a barrier. About 7% of respondents indicated barriers that were categorized into “other” including lack of family cooperation to harvest for bioenergy, and that their land was currently under other uses such as conservation or recreation. Interestingly, 13% of the landowners reported that they did not know of any barriers and an equal percentage indicated that they had no barriers and were just not interested in supporting the bioenergy industry.

In a separate question, the respondents were asked to indicate what would likely motivate them to consider bioenergy industry as a market for their biomass.

Table 5. Motivations for Considering Bioenergy Markets (n = 103)

Motivations	Percentage of Respondents
Competing and Better Profit Margins (compared to traditional markets)	49%
Government Incentives and Cost-Share Programs	29%
Information on Management of Forests for Bioenergy, Logistics, Harvesting	19%
Assurance about Environmental Benefits of Biofuels and other Bioenergy products	6%
If Critical National Need (or Reduce Imports of Oil)	6%
Don't Know	3%
(Note: Respondents provided multiple answers, total percentage exceeds 100%)	

A categorized form of the open-ended question is shown in Table 5. About half of the landowners indicated that they were looking for competing or better profit margins from the

bioenergy markets as compared to the traditional forest products markets. In addition, 29% of landowners indicated they would be motivated to consider bioenergy markets if they received government assistance in terms of incentives, tax breaks, and cost-share programs offered by the government to encourage participation in the bioenergy industry. Of the 29%, two-thirds of landowners (n=20) indicated a preference for tax-credits whereas one-third of landowners (n=10) indicated a preference for government cost-share programs. Approximately one-fifth (19%) of the respondents reported that they were interested in knowing more about the management, harvesting, and logistics of providing biomass to bioenergy facilities.

The next two categories reported by the respondents focused on biomass for transportation fuels. About 6% of respondents indicated that their motivation was more global in that, they were concerned specifically about biofuels and other bioenergy products being environmentally friendly. These respondents were looking for the assurance that bioenergy is environmentally beneficial compared to fossil energy. In addition, 6% of landowners reported that they would be motivated if there was a critical national need to produce biofuels or if we were sure that producing biofuels domestically would reduce oil imports.

5.4 Bioenergy and Biofuel Perceptions

Approximately 35 agreement statements on general bioenergy (defined to include pellets, biofuels, and bio-power) and attributes of biofuels for transportation were included to elicit landowner perceptions on a 5-point agreement scale (1=strongly disagree to 5=strongly agree). These statements ranged from awareness, knowledge-based, and perception questions.

Table 6 shows the top five (most agreed) and bottom five (least agreed) statements by mean agreement. On average, most forest landowners strongly agreed that biofuel production

could increase the demand for wood (mean agreement of 4.15). In addition, landowners agreed that a local bioenergy facility would help in the improvement of the local economy (mean agreement of 4.04). Furthermore, forest landowner respondents agreed that domestically produced fuel was important to national security (mean=4.03) and would reduce dependence on foreign oil (mean=3.85). The landowners also agreed that the use of pre-commercial thinning for bioenergy was a potential income opportunity.

Table 6. Top 5 and Bottom 5 Bioenergy Agreement Statements (n=144)

Top Five Agreement Statements	Mean	Std. Deviation
Biofuel production could lead to increase in the demand for wood	4.15	0.63
A local bioenergy plant/ facility will improve the employment in my local region.	4.04	0.72
Using pre-commercial thinning in forestlands for energy is likely a potential income opportunity	4.03	0.73
Bio-based fuels will reduce US dependence on foreign oil	3.85	0.88
Bottom Five Agreement Statements	Mean	Std. Deviation
I have heard of forest certification programs or BMP's for biomass production (to ensure renewable production)	2.88	1.16
It is more profitable to grow and sell small diameter wood to the bio-power industry (electricity) vs. other forestry markets (pulp)	2.84	1.29
Harvesting timber for energy will be detrimental to the site's productivity	2.75	1.19
Bioenergy produced from wood will have a negative environmental impact	2.6	1.27
I have sought professional advice about supplying woody biomass for energy	2.18	0.87
Domestically produced fuel is critical to the national security	4.02	1.06

The least agreed upon statement by the respondents indicated that they have not sought professional advice about supplying woody biomass for energy (mean agreement = 2.18). Respondents also do not agree on average, that bioenergy from wood would have a negative environmental impact (mean = 2.60) or harvesting timber for energy would be detrimental to the sites productivity (mean = 2.75). In other words, most respondents felt positive about the environmental benefits of bioenergy from wood as well as agreed that it would not affect the site's productivity. The other statement that was least agreed upon by the landowners included profitable production and supply of small diameter wood for bio-power vs. pulp markets. Most landowners also disagreed that they had heard about forest certification programs or BMPs for biomass production (mean = 2.88).

5.5 Factors Affecting Landowner's Willingness to Supply or Interest in Supplying Biomass: Dependent and Independent Variables

A logistic regression model was used to identify factors that affected the landowner's willingness to supply biomass. Willingness to supply biomass (dependent variable) was represented as a binary variable, with a value of "1" for all respondents who indicated that they were supplying or considering supplying or showed some interest in supplying biomass for bioenergy in the near future (42.5% of landowners) and a value of "0" for all respondents who indicated that they did not have any interest in supplying biomass or indicated they used their land for other uses (57.5% of landowners).

The predictors or independent variables used in the regression model (Table 8) were demographic variables such as age, education, gender, size of landholdings, types of species/forest type grown in the lands, and landowner perceptions (agreement statements on

bioenergy). Many of the bioenergy statements were strongly correlated with each other and thus, we used a factor analysis procedure to reduce the variables to a small number of factors that measured a common theme across the bioenergy statements. The factors or variables created from the factor analysis were used as inputs into the logistic regression model in addition to demographics for examining what factors predicted landowner's willingness to supply biomass for bioenergy.

The results of the factor analysis are shown in Table 7 with the factors (underlying latent variables in bold) and the original variables/questions. The overall variance explained by the factor analysis was 71.1%. Recall that the higher loading values indicate a higher correlation between the variable and the factor and thus, any loading greater than 0.50 is considered to be strongly correlated to the factor. Factor 1 represents five variables with loadings ranging from 0.76 to 0.83 and mean agreement scores from 3.18 to 3.65. The common theme across these variables is landowner interest in information about the production and economics of wood to energy systems. Similarly, Factor 2 represents positive and long-term viability of bioenergy represented by three variables with loadings from 0.48 to -0.78. In other words, the respondents strongly agree that biofuels and biopower is not likely to be more expensive than petroleum or electricity, respectively. Although, the third variable has a smaller loading (0.48), it is close to 0.50 and shows similarity with the other variables. The other five factors are represented as government support through cost share and tax breaks, profitability of bioenergy markets vs. alternative markets, profitability from planting trees for bioenergy, awareness and interest in professional outreach, and value of alternative woody biomass sources for bioenergy. Note that some variables that were not correlated with any factor, the

uncorrelated variables were eliminated from the factor analysis and will be included as independent variables into the regression. The percent of variance explained by each factor is also represented in table 7, this illustrates the amount of variance each factor contributes to the total factor analysis model.

Table 7. Factor Analysis of Bioenergy Agreement Statements

F1: Interest in Information about Production and Economics of Wood	Loading	Mean	% of Variance	St Deviation
I would like to know more about growing genetically modified trees for biofuels or biopower	0.83	3.46	20.10%	0.99
I would like to learn more about growing and harvesting wood for bioenergy (biofuels & biopower)	0.82	3.54		0.98
I am interested in field days (on site information) to learn more about growing trees for biopower/biofuels	0.80	3.52		0.91
I would like more information about the ECONOMICS of growing and supplying biomass for bioenergy	0.77	3.65		0.86
I am interested in supplying forest residues/trees to produce bioenergy	0.76	3.18		0.97
F2: Positive and Long Term Viability of Bioenergy	Loading	Mean	% of Variance	St Deviation
Bio-based fuels & biopower are likely to be more expensive than petroleum or electricity, respectively	-0.78	3.36	9.92%	0.74
I believe in the long-term viability (future) of the bioenergy industry	0.69	3.58		0.79
In my opinion, bio-based fuel is a better alternative to petroleum-based fuels	0.48	3.33		0.92
F3: Government Support Through Cost Share and Tax Breaks	Loading	Mean	% of Variance	St Deviation
In my opinion, the government should provide cost share programs for forest landowners willing to produce biomass for bioenergy	0.81	3.46	9.39%	1.14
In my opinion, the government should provide tax breaks for forest landowners willing to produce biomass for bioenergy	0.80	3.58		1.14

Table 7. Continued

F4: Profitability of Bioenergy Markets compared to Alternative Markets such as Pulp	Loading	Mean	% of Variance	St Deviation
I believe that it is more profitable to grow and sell wood for the biofuels industry vs.to other forestry markets (e.g., pulp)	0.77	2.92	9.00%	0.72
I believe that it is more profitable to grow and sell wood to the bio-power industry (electricity) vs. other forestry markets (pulp)	0.71	2.96		0.64
I believe it will be profitable to grow grasses in addition to timber in my forest land for energy purpose	0.50	3.01		0.72
F5: Profitability from Planting Trees for Bioenergy	Loading	Mean	% of Variance	St Deviation
I think it is profitable to grow short rotation woody crops for energy	0.82	3.23	8.90%	0.62
In my opinion, growing biomass for bioenergy is not profitable for landowners	-0.69	2.99		0.59
Growing wood for energy is a promising local option to improve rural economy	0.53	3.40		0.80
F6: Awareness and Interest in Professional Outreach	Loading	Mean	% of Variance	St Deviation
I have sought professional advice about growing woody biomass for energy	0.85	2.32	7.22%	0.83
I have heard of forest certification programs or BMP's for biomass production (to ensure renewable production)	0.65	2.93		0.81
F7: Value of Alternative Biomass Sources for Bioenergy	Loading	Mean	% of Variance	St Deviation
In my opinion, woody residues (left on forest site) when used for bioenergy purposes provides more value to the landowner than other uses	0.71	3.58	6.56%	1.14
I believe genetically modified trees are an important biomass source for producing biofuels or biopower	0.63	3.18		0.71

Variance Explained is 71.12%, Method used is PCA with Varimax, Rotation, KMO is 0.821, Bartlett's Test of Sphericity (Significant, p<0.0001)

5.6 Logistic Regression Model

A binary logistic regression model was utilized to analyze landowner's interest and willingness to supply biomass to the bioenergy industry. The dependent variable and the independent variables (covariates) included in the model are shown in Table 8. In addition to demographic variables, covariates included the seven factors from the factor analysis as well

as three additional specific survey questions having low correlation with the seven factors representing respondent agreement on the “environmental” aspect of bioenergy, “employment and rural economy,” and potential to create “national security.”

Table 8. Variables included in Binary Logistic Regression

Variables	Details
Dependent Variable	Interest and Willingness to Supply: <i>“1”</i> : Any interest in supplying biomass for bioenergy <i>“0”</i> : No interest in supplying biomass for bioenergy
Independent Variables	Demographics: <i>Age (<50, 50-59, 60-69, 70-79, 80+)</i> <i>Education (less than high school, high school, some college, 4 years college, advanced degree)</i> <i>Gender (male, female)</i> <i>Land area (1-30 acres, 31-100 acres, 100-200 acres, more than 200 acres)</i> <i>Species or type of forests (mixed hardwood and pine, planted pine, natural hardwood, natural pine, others)</i> Perceptions: <i>Factors (F1 to F7 shown in Table 7)</i> <i>Agreement statements standardized</i> 1. <i>Employment: A local bioenergy plant will improve employment in the local area</i> 2. <i>Environmental benefits: Compared to fossil fuels, biofuels are more environmentally friendly</i> 3. <i>National Security: Domestically produced fuel is critical to the national security</i>

A stepwise variable reduction procedure known as a backward elimination (conditional) binary logistic model was used to determine which variables would be best at predicting landowner interest in supplying biomass for bioenergy. Results indicated that only one factor (F1: Interest in Information about Production and Economics of Biomass for Energy) was significant in determining landowner interest and willingness to supply biomass in the future. Table 9 shows the parameter estimates of the final model with the significant variable- F1. The likelihood ratio chi-squared estimate for the final model was 28.656 ($p < 0.0001$).

Table 9. Regression Model

	β	SE	Wald	Sig	Exp(β)
F1: Interest in Information about Production and Economics of Biomass for Energy	1.441	0.3	18.354	0.000	4.227
Constant	-0.869	0.2	11.476	0.007	0.419

The table shows the model statistics with the first row in the table representing that the log odds of Factor F1 predicting interest in supplying biomass is 1.441. The Exp(β) value of 4.227 represents the exponentiated value for 1.441, which illustrates that the odds of landowner's willingness to supply could increase 4.227 times the current willingness to supply if the interest in information about production and economics of biomass for energy was increased by one unit.

5.7 Biomass Facility Proximity Effects on Landowner Perceptions

Given the nature of this study, an assessment of landowner perceptions based on the

regions of the state they were located in and their proximity to biomass facilities was conducted. This was done to determine the effect local biomass markets have on current landowner perceptions, and willingness to supply feedstocks. To do this landowner responses were separated based on their property location within the state of NC using zip codes. An independent samples t-test was conducted on landowner responses based on regions of the state, and their answers to key questions within the survey (all demographic, property based questions, and agreement statements). This test was run to see if there was a difference in landowners from the eastern part of the state compared to the west and the piedmont. Another independent samples t-test was conducted on respondents whose properties were located within 75 miles of a bio-energy facility to compare their responses to those whose properties were not located within 75 miles of a bio-energy facility (Fig. 3.). While there were some small differences in the regional and facility proximity assessment, there are currently no notable significant differences in landowner perceptions of the biomass industry and willingness to supply based on the region of the state they are located in or their proximity to bio-energy facilities, within this study.

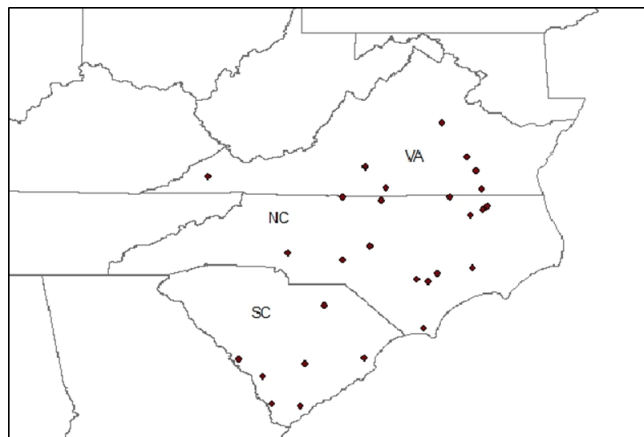


Figure. 3. Bio-energy Facility Locations within North Carolina and surrounding states.

6. Discussion and Conclusions

The results of this study showed that the majority of respondents owned their forested land independently and that the majority of the property owned consisted of a mixture of pines and hardwoods (Table 2). Although half of the respondents indicated no interest in supplying biomass to the energy industry, almost one-third of all landowners were interested in acquiring more information about the industry before harvesting or supplying biomass for energy purposes. Only two landowners in the study from 144 respondents were currently supplying biomass to the industry, and these landowners owned more than 200 acres of forest. This finding is similar to other studies that show marginal willingness among landowners to participate in the bioenergy industry (Minkowsky-Lindsay et al. 2011). A study of private forest landowners' intent to supply woody feedstocks for bioenergy production in Kentucky reported that approximately two-thirds of their survey respondents claimed they were planning on harvesting energy wood in the future (Leitch et al. 2013), whereas respondents in this study's consideration for producing or supplying biomass was considerably lower (6.7% of respondents). The reasoning for the difference in the results are unclear, but an assumption could be made about the proximity of biomass markets to landowners in Kentucky and the current publicity biopower is receiving in the state of Kentucky, specifically Hazard Biomass' proposal to build a facility in eastern Kentucky. A recent publication "Recommendations for the Harvesting of Woody Biomass" could have also raised interest in forest landowners in the state of Kentucky. Collaborators for this publications include the Kentucky Division of Forestry, Kentucky Department for Fish and Wildlife Resources, Kentucky Division of Water,

Kentucky Division of Conservation, etc. The state of Kentucky is also powered majorly by coal, and with the rise in environmental awareness, the possibility of burning biomass has become more attractive because it poses less of an environmental impact.

Among the major barriers for North Carolina forest landowner the lack of knowledge on economics and markets, and access to usable land were found to be key. Although most past studies indicated lack of profit margin for the bioenergy industry as the most important barrier to supply, our study found that to be the third most important barrier. The recent study by Leich et al. (2013) also indicated access to woodland as the most important barrier, in addition to lack of market. Our findings suggest the potential for extension and outreach to the forestland owners with respect to the management and economics of production and supply for bioenergy.

With respect to incentives for their participation in bioenergy industry, landowners indicated better profit margins as most important, closely followed by government cost-share programs and tax incentives. Almost 29% of landowners were interested in these different support programs. This information is vital for policymakers as they reflect on the needs of this important stakeholder group as they develop future policies toward meeting the renewable energy needs of states as well as the nation. Although tax incentives were more preferred by the landowners in this study, cost-share programs could also be important to encourage the participation of landowners. Our observations are consistent with the study by Markowski-Lindsay et al. (2012), who found that family forest landowners' enrollment in current taxation programs positively influence the decision to supply and produce biomass for bioenergy in Massachusetts.

Landowners in our study agreed that the bioenergy industry would likely help to increase the overall demand for the wood industry and would also improve jobs, improve national security, and increase employment opportunities in rural America. Thus, it is important that these aspects should be promoted locally when extension agents work with landowners.

Our regression model showed that none of the demographic variables representing the forest landowners such as gender, age, forestland area owned, or species/forest type affected the interest or willingness to supply biomass for bioenergy industry by the landowners. While this finding is similar to that of Leitch et al. (2013) for landowners in Kentucky, who did not find any demographic characteristics as important in landowners' decision to supply biomass, a majority of past studies found a positive relationship between size of forestland and age of landowners to the willingness to supply biomass (Gruchy et al. 2012; Joshi and Mehmood 2011; Shivan and Mehmood 2012). In other words, size of forestland and younger landowners are more willing to produce and supply biomass to the energy industry. The only predictor for the landowners' interest in supplying biomass was the level of information that they indicated they needed with regards to economics, production, and supply of the biomass. It makes intuitive sense that as the amount of information increases, there is an increase in willingness to supply biomass.

The results of the factor analysis model show the various latent aspects of bioenergy that need to be included during data collection from or information dissemination to landowners. Our findings suggest that the development of educational tools and programs to inform landowners the details of producing woody biomass for the bioenergy industry would peak

their interest in supplying to this industry. Instead of including many attributes and aspects targeting landowner knowledge and awareness, seven main factors or variables guide landowner perceptions. Note that these factors do not explain all of the variance in the variables (about 71% of the variance was explained). Nevertheless, the use of the factors could substantially reduce the data collection effort.

Our study also found that about 19% of landowners indicated interest in growing short rotation woody crops for bioenergy. Among them, 29% were large forest landowners (owning more than 200 acres of forestland), 43% were medium forest landowners (owning more than 100 acres but less than 200 acres of forestland), and the rest were small forest landowners (owning less than 100 acres of forestland). We found that landowners did not fully utilize available resources when it came to acquiring information about possible alternative uses and markets for their fibers. The effective dissemination of this information, provided by government agencies such as the Forest Service and Department of Energy or with private bioenergy industries, will have to develop a strategy for reaching out to these landowners. Landowners already believe using pre-commercial thinnings to produce biomass could be a possible income opportunity. Based on this information, providing landowners with a portfolio of economic alternatives that illustrate several management/harvesting options that they could pursue when producing woody biomass material would further their understanding of how biomass harvesting could contribute to their financial objectives.

Based on a 144 responses to a mail survey of landowners across North Carolina, we found that almost half of the respondents have no interest in supplying biomass to the bioenergy industry. However, there more than one-third would like more information about

production and economics to help them better understand the potential benefits of supplying biomass for energy.

Factor analysis was used to condense information from the 35 original questions into seven factors that could explain 71% of the respondent information. These factors, along with landowners demographic, were used to create a binary logistic regression model. This model showed that the interest and willingness to supply biomass increased by a factor of four as the level of information about economics and production pursued by landowners increased. The three major barriers to supplying biomass for energy reported by landowners (in order) 1) were a lack of knowledge of economics and markets, 2) access to usable land, and 3) poor profit margins. In addition to increased profit margins, landowners also indicated interest in tax incentive and cost-share programs from the government as incentives for supplying biomass to the bioenergy industry.

Landowners noted that increased assistance from the government would increase their participation in production of biomass for bioenergy markets. Within this study, landowners preferred tax credits above cost-share programs; however, a comprehensive assessment of their preference for the type of government assistance across the Southeast could also prove beneficial in the development of strategies to acquiring landowner interests.

6.1 Avenues for Future Research

The most difficult and time consuming part of this study centered on the acquisition of necessary information for contacting landowners in each county in North Carolina. The best avenue for gaining mailing addresses within the state was tax offices at the county level. However, the contact information of landowners in each county was available in varied

formats as well as quality of information and cost thus, requiring additional time and effort not expected before the study was conducted. Thus, future studies should allocate sufficient time, effort, and cost toward database generation for forest landowners in North Carolina and perhaps in other states.

While the past studies highlighted within this publication provide some information on regional similarities of landowners, there is still not enough substantial research done to make assumptions on landowners across the SE. To gain a better overall picture of how landowners perceive bioenergy and biomass supply across the South Eastern United States, studies should be conducted at a state level across different regions. Another factor that was important to landowners was the level of government involvement and the assistance they may gain from the government for their participation in biomass for energy programs. Within this study, landowners preferred tax credits above cost share programs, however, a comprehensive assessment of their preference for the type of government assistance across the SE can also prove beneficial in the development of strategies to acquiring landowner interests.

Also the effect of the structure of the supply chain from trees on the ground to the mill should be assessed. The supply chain's web like structure could be creating knowledge gaps for the landowner, who may not even realize that some of their fiber may be going to biomass facilities due to its complexity. With the current structure of the supply chain, landowners are usually not in contact with specific markets, and a possible assessment of the third party timber buyers knowledge and perceptions of the biomass industry could provide beneficial information that would allow the ability to regionally predict the amount of biomass that could be supplied to the bio-energy markets.

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North Carolina Farm Landowners' Perception about Biomass and Bio-energy

8. Introduction

With the current demand for alternative energy sources in the U.S., a great deal of research has been conducted to determine the nation's next steps toward a more sustainable and economically viable option for transportation fuels and energy. Cellulosic biofuels from agriculture resources is regarded as one of the nation's most promising alternatives to fossil fuels for obtaining its green energy goals (Smithhart and Darby 2011). The agricultural land area in the US has the potential to produce around 998 million tons of biomass from agriculture resources, annually (Perlack et al. 2005). This estimate is almost three times as much as the estimates of biomass available from forests (Figure 1), with the overall bioenergy cellulosic resource potential estimated at 1,366 million dry tons. About 98% of agricultural land in the United States is owned privately, either by a family or individual (Vilsack and Clark 2014). Figure 2 is a representation of the percent of farms operated by private landowners in the U.S., which also equates to approximately 896 million acres.

Researchers indicate that an assessment of landowner willingness to produce and supply cellulosic-biomass in their farmlands needs to be established before concrete predictions are made about the amount of cellulosic-biomass that can be produced and supplied for bioenergy (Wen et al. 2009, Paula et al. 2011, Smithhart and Darby 2011). Studies also report that without the acceptance and willingness to produce and supply biomass from farmlands, the success of the bioenergy industry cannot be ascertained (Paula

et al. 2011, Smithhart and Darby 2011). Furthermore, researchers indicate that policy directives tend to focus on geography or agronomic conditions rather than on who will produce these crops and what the consequences for society will be (Rossi and Hinrichs 2011). These authors also state that if we aspire for a sustainable bioenergy future for our nation, we cannot overlook the first-hand perspectives of the farming community about producing agricultural bioenergy feedstocks.

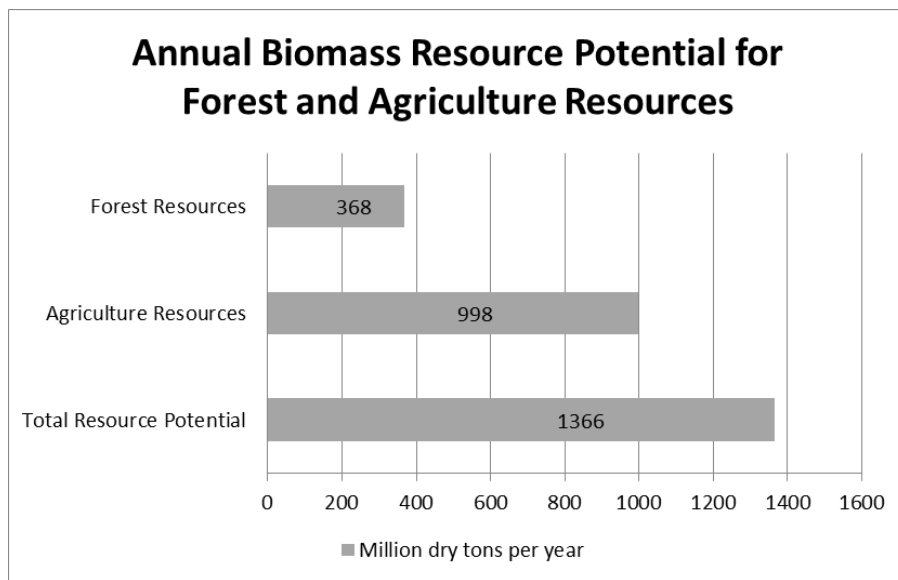


Figure 1. Annual Biomass resource potential for forest and agriculture resources (Source: (Perlack et al. 2005))

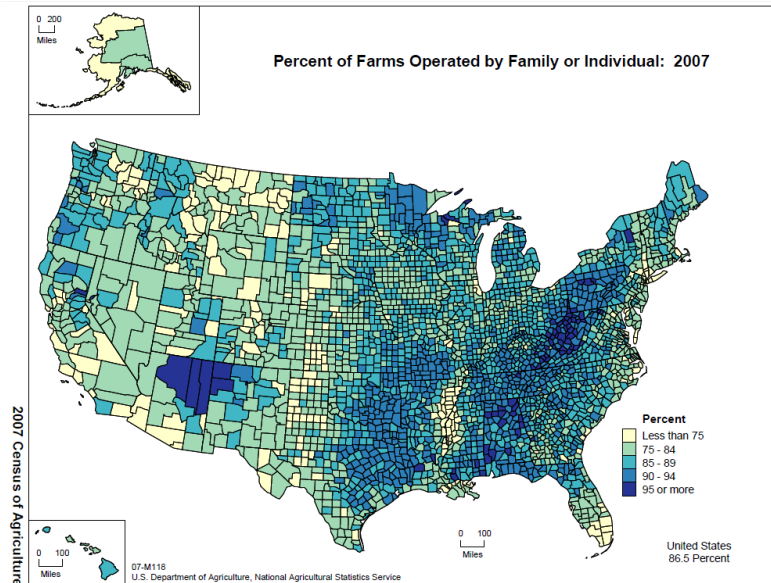


Figure 2. Farm Ownership in the United States (Category Archives, 2007)

9. Literature Review

9.1 Current Farmland Owner Perceptions and Knowledge of Biomass Production, Harvesting, and the Bioenergy Industry

Although, in the past decade most of the research on cellulosic biomass from farmlands is primarily centered around the breeding, conversion technologies, and logistics, researchers are recognizing the importance of understanding the perceived acceptance and willingness of farm landowners to produce and supply feedstocks to the bioenergy industry. In the last few years, although fragmented and narrow in scope, a few studies on farmers have shown that this stakeholder group is somewhat moderately interested and hesitant in producing and supplying biomass for the purpose of energy (Jensen et al. 2007, Mattison and Norris 2007, Wen et al. 2009, Qualls et al. 2012). An early study on landowner perceptions of bioenergy

focused on soybean producers in Tennessee which suggests considerable interest among the producers in selling their soybeans to a biodiesel production plant (Jensen et al. 2003). However, recently, most studies among the farming community for bioenergy have focused on switchgrass production and supply to the bioenergy industry. A survey of farmers' perspectives on switchgrass cultivation in the south-central and south-western Virginia showed that although 66% of respondents had heard about using switchgrass for bioenergy, only 43% are willing to cultivate it for bioenergy even if the enterprise was profitable (Wen et al. 2009). An underdeveloped market and lack of knowledge on cultivation of switchgrass was reported as the main reason for the hesitation in participation by the farmers. In another study, a survey of Tennessee farmers analyzing their willingness to supply switchgrass to the energy market found that the majority of farmers had not heard about using switchgrass for energy, and almost half were unsure about whether they would be willing to grow switchgrass (Jensen et al. 2007). The farmers were concerned about the underdeveloped bioenergy market and the lack of technical assistance for growing and managing switchgrass. The study also showed that farmer characteristics such as those with large off-farm incomes and with smaller farmland area were willing to convert more land area into switchgrass compared to their counterparts.

A study of switchgrass and miscanthus farmers in central France showed that farmers were interested in growing these biomasses for energy only when they were offered appropriate contractual arrangements for supply to convert to these crops (Bocqueho and Jacquet 2010). Furthermore, a study conducted in Alabama reported that 70% of respondents would be interested in supplying biomass feedstocks if a profit of \$100 per acre could be

obtained (Bransby 1998). Respondents also did not expect government assistance with growing biomass feedstocks if it was profitable (Bransby 1998). Qualls et al. (2012) analyzed the factors that influence interest among producers from 12 southeastern US states in growing switchgrass as a biomass feedstock, and showed that the lack of information on logistics, economics, and market availability are key factors. A key finding of the study was that almost two-thirds of the producers in the region show moderate interest in growing switchgrass. This interest is tempered with concerns about potential conflicts with planting and harvesting times for other crops. The study also showed that producers are motivated by the possibility of contribution to the nation's energy security, contribution to rural employment, and the benefits of bioenergy to the environment. Rossi and Hinrichs (2011) also confirm the aforementioned findings with their qualitative interviews of 48 farming and non-farming participants in two switchgrass bioenergy projects in Iowa and Kentucky). The participants in their study expressed both positive and negative impacts of the agricultural bio-economy with local and regional revitalization as the most important benefit of bioenergy industry in rural areas. Fewell (2013) surveyed a sample of farmers in Kansas in 2011 and found that farmers whose primary enterprise was livestock were less inclined to grow switchgrass, while factors such as shorter contracts, greater harvest flexibility, crop insurance, and cost-share assistance increased the likelihood of farmers to grow switchgrass. In addition, this study showed that farmers are indifferent towards adopting new bioenergy cropping enterprises when traditional crop production is profitable and more certain.

Most of the above studies above have usefully assessed landowner interest, the studies have almost always focused on landowner willingness to produce switchgrass as a potential

biomass. Although perception studies examined landowner's perspective on this important biomass from several parts of the southeast US there are no previous studies of farmer's interest in supplying to bioenergy industry in NC. The objective of this study is to fill this gap, focus on agricultural biomass overall, and to identify farmer-driven constraints and motivations required in development of a viable and sustainable biomass enterprise in the state.

9.2 North Carolina's Agriculture Industry

There are currently 5.4 million acres of agricultural land within the state of North Carolina. Jackson (2007) estimates that this land has the potential to produce approximately 1.5 million dry tons of crop residue biomass annually. North Carolina is known to be a diversified agricultural state, having more than 52,400 farmers who grow over 80 different agro-commodities. Within the state Including food, fiber, and forestry, the agriculture industry contributes \$70 billion dollars annually to the State's economy and employs over 17% of the work force (NCDACS 2013). Among, the three primary regions of the state, the eastern region accounts for 68% of the farmland area followed by 25% farmland in the Piedmont and the remaining (7%) in the western part of the state (Vilsack and Clark 2014). The state produces 3.5 million tons of corn, which is the most common biomass resource for bioenergy today but has the potential to provide an abundance of other agricultural crops and grasses as feedstocks (Jackson 2007, NCBC undated). North Carolina currently imports 12.1 million gallons of gasoline while meeting 4% of its energy needs from biomass. Rich (2008) indicates that if the state could utilize its current biomass resources for energy, it could decrease its current dependence on fossil fuels by a total of 14%. Furthermore, as new, dedicated, energy

crops such as canola, hull-less barley, industrial sweet potato, switchgrass, and hybrid poplar are grown, this percentage could increase substantially. In this study, we focused on the farmers' knowledge and awareness, perspective of the overall bioenergy industry, and the potential barriers to produce and supply biomass in North Carolina.

According to the Biofuel Center of North Carolina (2014), more than 40 biofuels companies are currently operating in the state. Although the most common biomass utilized for biofuels is corn; the state has resources that can provide an abundance of other biomass feedstocks such as Pine, Switchgrass, Canola, Algae, and Kudzu (Biofuels 2014).

10. Objectives

The overall goal of this study was to assess farm landowners' general perceptions about bioenergy, biomass resource, and biofuels for transportation in North Carolina. We specifically focused on their willingness to produce and supply biomass for the bioenergy industry as well as the potential barriers that they perceived for their participation in the growing biomass to energy system. An understanding of the knowledge and perceived value and impact of this industry will provide extremely useful information to the industry and policymakers about strategies to reach out to this key stakeholder group.

11. Materials and Methods

11.1 Sample Frame

To collect data from farm landowners in North Carolina (NC), we examined the amount

of farm land within each county using the county fact sheets (Vilsack and Clark, 2014). The NC counties were sorted from most to least farm land within each region and twenty-five counties were randomly sampled from across the three stratified regions of the state. The most urban counties were eliminated from the sample frame (due to their low level of biomass contribution potential.) Figure 3 represents the distribution of the counties selected for data collection within North Carolina. The darker shaded counties were those selected for data collection, a database of farm landowners contact information from the twenty five counties was then created from each of the county's tax records. From the database, 1,500 landowners were randomly selected for data collection.

Selected Counties in North Carolina



Figure 3. Randomly Selected Counties in NC for the Study

11.2 Data Collection

Traditional mail surveys were used for data collection from the farm landowners using the methods outlined in the Mail and Internet Surveys: The Tailored Design Method (Dillman 2000). Taking into consideration population characteristics and possible preferences for survey completion based on farm landowner demographic characteristics, we decided mail

surveys was the best method for reaching out to the landowners (Smithhart et al. 2014) Before the surveys were mailed to landowners, a pilot study was conducted to test the effectiveness and interpretation of the survey questions, check question wording, and examine survey length. A sample (n = 19) of landowners responded to the pilot survey. The feedback from the pilot test was used to refine the survey instrument.

The final survey was initially mailed to the selected sample of 1,500 farm landowners in NC with a cover letter and a postage-paid return envelope in fall of 2013. The cover letter specified the goal of the survey with emphasis on the voluntary nature of the survey and confidentiality of personal information. Three weeks after mailing the initial survey, a reminder card was sent to the non-respondents to elicit a better response rate. The reminder card also included a link to an online version of the survey, in the case that respondents found it more convenient to complete the survey online. The mail survey contained three categories of questions, including respondent demographic and ownership characteristics, general bioenergy agreement statements, and motivations and barriers to the landowner willingness to produce and supply biomass to the bioenergy industry. These questions ranged from fixed response, five-point Likert scale, and open-ended questions. The questions included in the survey were based on prior studies focused on farm landowners as well as other stakeholders related to the bioenergy industry in addition to questions developed after discussions with researchers and industry professionals based on our study objectives (Anonymous undated, Jacobson undated, NC Cooperative Extension undated, Jensen et al. 2003). The survey included 24 agreement statements on a five-point Likert scale of agreement about difference aspects of bioenergy industry including economics, environmental benefits, interest in

information on growing biomass, and biomass sources.

11.3 Response Rate

Overall, we received a response rate of 6.9% (n =103) following the data collection, with the highest response from the western region of North Carolina. Table 1 presents the response rate for the data collected from the farm landowners in NC by region. As shown in the table, initial contacts were made with 1,498 landowners. One hundred and thirty nine surveys were returned by the respondents, 36 of which were unusable, giving us 103 completed usable surveys.

Table 1. Distribution of Responses in North Carolina

Regions of NC	# of Counties	# of Contacts	# of Responses	% of Responses*
East	12	921	36	3.9%
Piedmont	7	488	48	9.8%
West	6	89	19	21.3%
Total	25	1498	103	6.9%
Undelivered Surveys*: East = 26, Piedmont = 10, West = 0 Total = 36				

11.4 Non-Response Bias

A non-response bias analysis was conducted to examine whether respondents of the study were different from non-respondents. Past research has shown that non-respondents behave similarly to the late respondents or respondents that respond after a reminder (Dillman et al. 2009). Early respondents in this study (n= 78) are defined as those who responded before

the reminder was sent and late respondents (n=27) are defined as all those who answered after the reminder was mailed (Dillman 2000). Key questions including demographics and land ownership characteristics (e.g., type of crops grown, willingness to produce and supply biomass) were compared between the early and late respondents using an independent samples t-test (continuous variables) and chi-squared test (nominal variables). The tests revealed no significant difference between the two respondent groups (early vs. late) on any of the demographic variables except for gender. The early respondents primarily had a higher percent of males (82%) vs. 56% for the late respondents. We then tested differences among early and late respondents on their response to the bioenergy and biomass awareness, knowledge and attributes and found no significant difference between the two groups.

12. Results

12.1 Respondent Profile

A demographic profile of the survey respondents showed that approximately 7.5% of farm landowners were less than 50 years of age, while 62% were within the age group of 60 to 79 years (Table 2). Respondents in this study were primarily male (76%) and White/Caucasian (95%). With regards to education, 27% of landowners had a 4-year college degree or higher, while about 46% reported having attained high school or less. As shown in Table 2, more than 20 percent of landowners did not report their annual household income for 2012 and approximately 56% of respondents reported a household income of over \$50,000 (32.6% respondents had income between \$50K and \$100K, 12.6 % between \$100K and \$150K, and 10.5% reported making over \$150K, in in 2012).

Table 2. Demographic Profile of survey respondents (n= 103)

Demographics	Percentage of Respondents (n=103)
Age Class	
Less than 50	7.5%
50-59	14.9%
60-69	29.8%
70-79	31.9%
80 and over	16.0%
Gender	
Male	75.8%
Female	24.2%
Race	
White/ Caucasian	94.8%
Black /African American	1.1%
Prefer not to answer	4.1%
Education	
Less than High School	19.8%
High School	26.0%
Some College	27.1%
Bachelor's Degree	18.8%
Advanced Degree	8.3%
Annual Household Income (2012)	
Under \$25,000	8.4%
\$25,000 to less than \$50,000	14.7%
\$50,000 to less than \$100,000	32.6%
\$100,000 to less than \$150,000	12.6%
\$150,000 and over	10.5%
Prefer not to answer	21.1%
Percentage of Household income from Farm land (2012)	
0	25.5%
1-10	49.0%
11-20	10.5%
21-50	5.0%
51-80	4.0%
81-100	6%

Table 2 Continued

Ownership Type	
Sole Ownership	64.4%
Family-Owned	26.9%
Partnership	1.0%
Corporation	1.0%
Other	6.7%
Farm Land Acres Currently Owned	
1-9	6.73%
10-30	24.04%
31-49	9.62%
50-100	29.81%
101-149	9.62%
150-200	4.81%
201-299	7.69%
300-400	4.81%
Over 400	2.88%

Of the landowner respondents, 25.5% of respondents indicated that they received no income from their farm land, almost half (49.0%) reported receiving between 1% and 10% of their household income from their land, and 10.5% of respondents received between 11 and 20% of their income from their farm land. About 10% of respondents reported receiving over 50% of their household income from their farm land. About 64% of respondent farm land was under sole ownership and 27% was family-owned (2% under partnership and 7% leased or other). When asked about the land area under farming, 31% of respondents indicated owning or managing 30 acres or less of land area, 10% reported owning or managing between 31 and 50 acres, 30% reported owning or managing between 50 and 100 acres, 14% respondents reported 101 to 200 acres of land area, and about 16% reported owning and managing over 200 acres of land area. Approximately, 75% of respondent farmers owned some forest land in addition to farm land.

When asked about the primary use of farm lands or primary crop in their farmland, 47% indicated that their farm land was dedicated to hay or pasture, 24% farmers primarily grew soybean, 21% grew corn and 4% grew sweet potato (Table 3). As shown in Table 3, the primary crop for 2% of respondents was cotton, and wheat or tobacco were the primary crops by 1% respondents, each.

Table 3. Primary Crops in Farmlands

Crops	Percent of Respondents
Hay/Pasture	47%
Soybean	24%
Corn	21%
Sweet Potato	4%
Cotton	2%
Wheat	1%
Tobacco	1%

Respondents were also queried whether they grew genetically modified (GM) crops in their farmland. About 23% of respondents reported that they grew GM crops whereas, 10% indicated that they were unsure whether their crops were GM.

12.2 Awareness of Biomass for Bioenergy

When asked about whether they were aware of various bioenergy feedstocks from farm lands and forest lands, 64% of respondent farmers indicated that they were aware of corn feedstocks for bioenergy (Figure 4). About 40% farmers were aware of wood or wood residues from forests as biomass feedstocks, followed by 30% who had heard about grasses, 27% who had heard about mill residues as feedstocks, and 23% who had heard about crops other than corn. As shown in Figure 4, nineteen percent of farmers had heard about GM

agricultural crops, 16% had heard about crop residues and 11% were aware of GM trees or short rotation trees as biomass feedstocks.

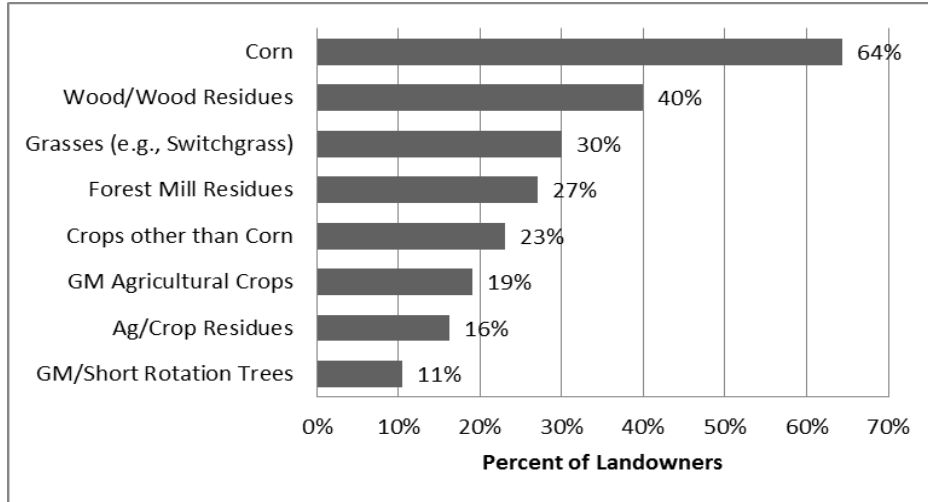


Figure 4. Landowner Awareness of Bioenergy Feedstocks from Forest and Farms

12.3 Willingness to Produce or Supply Biomass for Bioenergy Industry

Farm landowners were asked whether they were currently producing and supplying or were interested in producing/supplying biomass to the bioenergy industry. Table 4 shows the response by the amount of land owned by the landowners (acres). None of the respondents indicated that they were currently producing or supplying biomass to the bioenergy industry. Most respondents (n=61) were not interested in supplying or producing biomass for the bioenergy industry or provided other reasons (n=7) for not being able to grow or supply biomass for bioenergy industry. About 33% (n=34) farm landowners indicated that they needed more information before they would produce and supply biomass for bioenergy.

Table 4. Landowner willingness to produce biomass

	Are you currently producing / supplying or considering or have an interest in producing/ supplying agricultural biomass from your farmland for bioenergy purposes?				
Acres	Considering producing/supplying	Not interested	Need more information for producing/ supplying	Other (Unusable land)	Total # of Responses
1 -30	3.0%	75.8%	18.2%	3.0%	32
31-100	0.0%	65.9%	26.8%	7.3%	41
101-200	0.0%	46.7%	33.3%	20.0%	15
Over 200 acres	0.0%	18.8%	75.0%	6.3%	15
Total	1	61	34	7	103
Note: Other includes land used for other purposes such as animal waste production (n=3) or land leased to another farmer (n=4)					

The majority of landowners in all land area categories indicated that they were not interested in producing or supplying biomass for bioenergy. The largest (75%) landowner category reporting no interest included those owning 30 acres or less of land area. Three-fourths of respondents owning more than 200 acres of farmland indicated that they were interested in learning or obtaining more information about producing or supplying crops for bioenergy compared to respondents from any other category of land area owned. A chi-squared test was run to determine if the amount of land area (in acres) was related to the interest in information for producing and supplying biomass. All respondents who reported not interested or other (Table 4, n = 70) were categorized into the not interested group, and those who indicated need more information for producing/supplying and consider producing supplying (n = 35 from Table 4) were categorized into a second group. The chi-squared test revealed a significant relationship between the land area owned and interest groups (Pearson

chi-squared = 15.46, significance = 0.001) at a 0.05 level of significance.

We also performed a chi-squared test to examine if there was a significant relationship between the interest in producing or supplying biomass with the primary system of enterprise or primary crops in the farmlands. Farmers who used their lands for pasture or livestock (47% respondents) were in one group and all other farmers were grouped into another category for this analysis. The chi-squared test showed a significant relationship between the two variables (Pearson chi-squared = 4.35, significance = 0.037) at 0.05 level of significance. Only about 22% of farmers who were managing their land for livestock (pasture/hay) indicated an interest in learning about producing or supplying biomass for bioenergy compared to 43% of farmers who managed land for other than livestock.

A Pearson's correlation and independent samples t-test was run to determine any significant differences between willingness to supply, and demographic characteristics as well as differences between regions of the state respondents belonged to. After running these tests it was found that there is no differences between respondent's demographic characteristics such as age, education, income and ethnicity and their willingness to supply biomass to the bio-energy industry. It was also determined that there is no regional effect within North Carolina on landowner's willingness to supply biomass.

When asked to report which crops the landowners would be willing to grow or supply as biomass for the energy industry; soybeans and trees were indicated by approximately 24% of respondents each (Fig. 5). About 23% of landowners indicated interest in growing corn while interest in growing switchgrass and miscanthus was reported by 7% of respondents, each. Interest in growing or supplying sorghum and crop residues were each reported by 6% of

respondents. Our study found only a slight interest among the respondents to plant and supply genetically modified crops for bioenergy (3% of respondents) (Fig. 5).

While almost all landowners in this study responded to this question, those that indicated interest in learning about producing or supplying crops (n = 34) did not choose corn as a bioenergy crop for bioenergy. More than a quarter of landowners who indicated interest in learning more about biomass for bioenergy reported their interest in growing or supplying soybean and a quarter of landowners from this category indicated interest in growing or harvesting trees for bioenergy. More than a quarter of landowners who indicated interest in learning more about biomass for bioenergy reported their interest in growing or supplying soybean and a quarter of landowners from this category indicated interest in growing or harvesting trees for bioenergy.

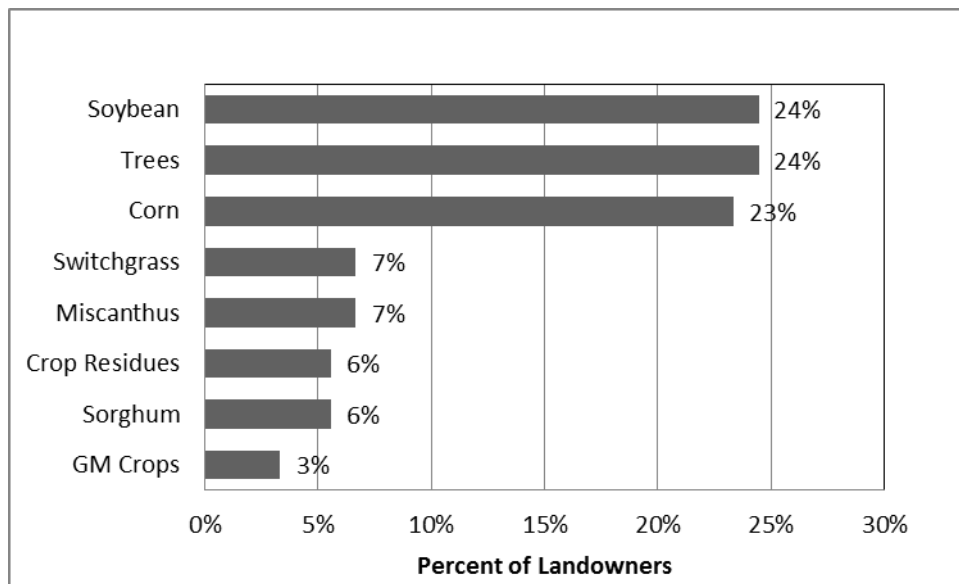


Figure 5. Types of Crops willing to grow

12.4 Barriers and Motivations to Biomass Production and Supply

Respondents were asked to indicate key barriers for production and supply of agricultural biomass for the bioenergy industry in an open-ended question. The responses

were grouped into a few major categories. A majority of farm landowners (43%) reported the lack of knowledge about production as the key barrier to produce and supply feedstocks (Figure 6). Interestingly, 18% of landowners reported that they have no barrier to supplying and they were not interested in producing and supplying crops for bioenergy industry. Approximately, 16% of respondents indicated lack of a developed market as a key barrier, followed by 9% who indicated site restrictions on their land, 6% who indicated low profit margins in their land, and 6% reported managing farm for livestock, and 5% of landowners reported no government support for producing and supplying biomass for bioenergy. About 16% of respondents also reported other reasons such as old age, family issues, lack of man power, or small operation that were categorized into an “other” category of barriers.

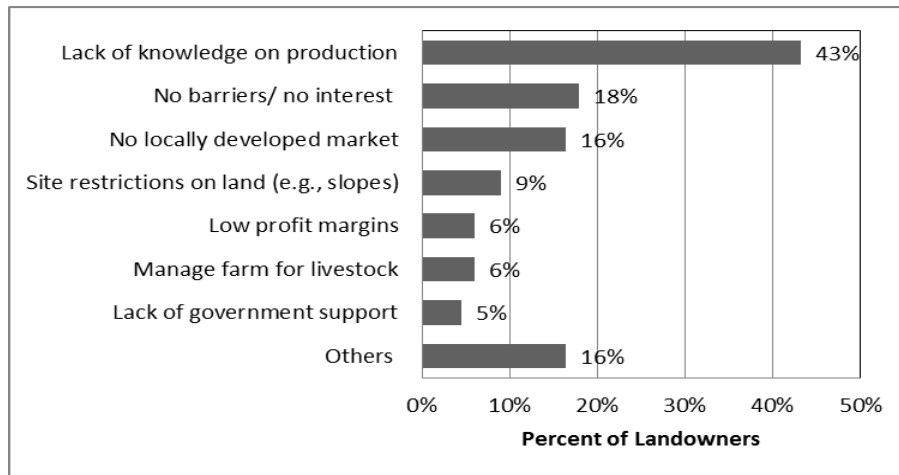


Figure 6. Barriers to Produce and Supply Biomass
Note: Other includes old age, lack of man power, small operation, etc.

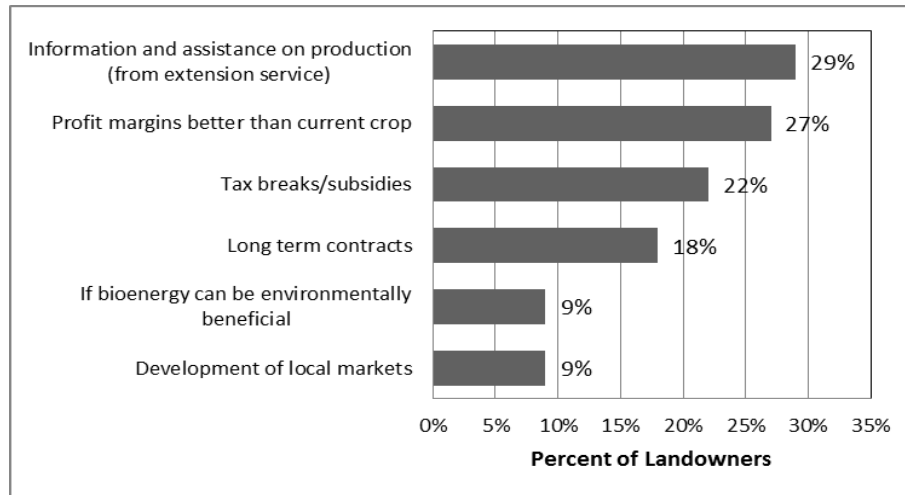


Figure 7. Motivational Factors for Production and Supply of Biomass

In another open ended question, we asked landowners to respond to the factors or incentives that will motivate them to produce and supply crops for the bioenergy industry. The responses from this question were evaluated and condensed to the categories shown in Figure 7.

Approximately 29% of landowners stated that they would like more information and assistance from extension service on production of crops for energy, while 27% reported that they need better profit margins for the feedstocks than the profits from current crops. In addition, 22% of landowners reported that they were looking for government assistance in the form of tax breaks and subsidies and 18% who indicated the availability of long-term contracts for growing crops for bioenergy. About 9% of landowners reported that the availability of local markets would motivate them to produce and supply crops for bioenergy and an equal percent (9%) of landowners indicated that they would like to be convinced that bioenergy is environmentally beneficial.

12.5 Bioenergy and Biofuel Perceptions

To determine farm landowner perceptions of various aspects of the bioenergy industry, several (24) bioenergy statements were included in this survey. These statements focused on the national needs, environmental aspects of bioenergy, profit vs. costs for growing biomass for bioenergy, information needs and benefits bioenergy. Table 5 illustrates relative agreement (mean) of the landowners on bioenergy statements (on a five-point Likert agreement scale, 1=strongly disagree and 5=strongly agree). Most farm landowners agreed that domestic biofuel production could increase the demand for agriculture crops and residues (mean agreement= 4.1). Landowners also strongly agreed that current government policies were not helpful to grow or supply agricultural crops for bioenergy (mean=4.0). In addition, landowners agreed that costs for biomass production for energy is more than the returns from the market (mean=4.0). Furthermore, landowners agreed that domestic production of fuels was critical to the national security (mean=3.9).

Table 5. Landowner Relative Agreement on Bioenergy Statements

	Bioenergy Agreement Statements	Mean*	Std. Dev.
1	Domestic biofuel (for transportation) production has the potential to increase the demand for agriculture crops and residues	4.1	0.78
2	Current government regulations/policies are not helpful to me for growing and supplying agricultural crops/residues for the bioenergy industry	4.0	0.61
3	The cost of growing biomass for energy purposes is more than the returns from the market (not profitable)	4.0	0.5
4	Domestically produced fuel is critical to the national security	3.9	1.08
5	A local bioenergy plant/ facility is likely to improve the employment in my region	3.8	1.04
6	Domestically produced biofuels for transportation are very important in meeting our national energy needs	3.8	0.95

Table 5. Continued

7	The government should provide tax breaks for farmland owners willing to produce biomass for bioenergy	3.8	0.93
8	Compared to fossil fuels (petroleum), bio-based fuels are more environmentally friendly	3.6	1.15
9	Bio-based fuels will reduce US dependence on foreign oil	3.5	0.84
10	I believe in the long-term viability (future) of the bioenergy industry	3.5	0.95
11	Growing agriculture crops for biofuels or biopower has the potential to improve the local economy in my region	3.5	0.78
12	I would like more information about the economics of growing and supplying crops for bioenergy	3.5	1.00
13	Agricultural energy crops can be grown in areas that are not suitable for food crop production	3.4	0.64
14	I am interested in field days (on site information) to learn more about growing crops for biopower & biofuels	3.4	0.57
15	Bio-based fuels & biopower are likely to be more expensive than petroleum/electricity	3.3	0.97
17	I believe genetically modified crops are an important biomass source for producing biofuels or biopower	3.3	0.97
18	In my opinion, agriculture residues when used for bioenergy purposes provide better value than current uses	3.3	0.88
19	Increase in production/ distribution of bio-based energy will increase the cost of growing & supplying agriculture crops to the market	3.3	0.77
20	It will be profitable to grow grasses in addition to crops on my farmland for energy purposes	3.2	0.92
21	Harvesting agricultural biomass for bioenergy will reduce the necessary nutrients in the soil	3.1	0.83
22	Bioenergy/biofuels are more likely to be successful when produced & distributed at a small/ local scale & not at a large/ commercial scale	3.0	0.84
23	It is more profitable currently to grow and sell crops for bio-energy industry vs. other agriculture markets	2.5	0.76
24	I am worried that bioenergy produced from agriculture crops will have a negative environmental impact	2.1	0.66

Table 5 shows that landowners strongly disagreed with the statement “I am worried that bioenergy produced from agricultural crops will have a negative environmental impact” with mean agreement of 2.1. They also disagreed that it was currently more profitable to grow and

sell crops for the bioenergy vs. other agricultural markets (mean=2.5).

12.6 Biomass Facility Proximity Effects on Landowner Perceptions

Given the nature of this study, an assessment of landowner perceptions based on their proximity to biomass facilities was conducted. This was done to determine the effect local biomass markets have on current landowner perceptions, and willingness to supply feedstock's. To do this landowner responses were separated based on their property location within the state of NC using zip codes. An independent samples t-test was conducted on respondents whose properties were located within 75 miles of a bio-energy facility to compare their responses to those whose properties were not located within 75 miles of a bio-energy facility (Fig. 8). While there were some small differences in the facility proximity assessment, there are currently no notable significant differences in landowner perceptions of the biomass industry and willingness to supply based on the region of the state they are located in or their proximity to bio-energy facilities, within this study.

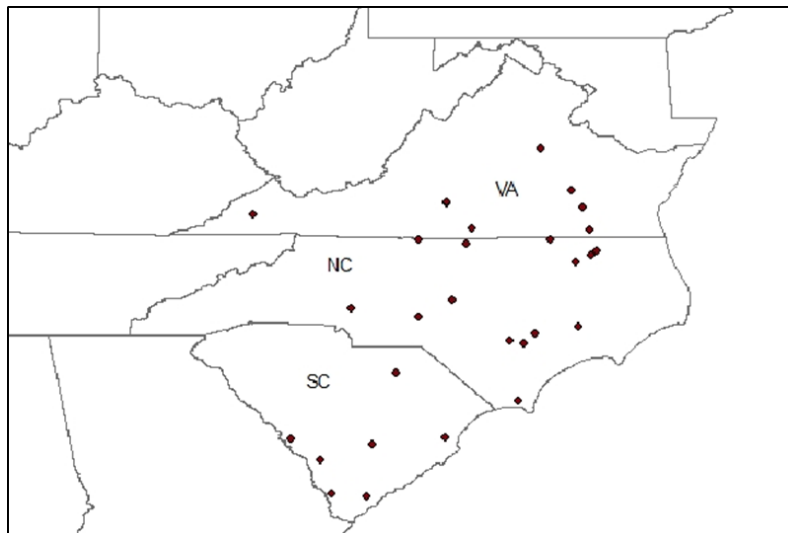


Figure. 8. Bio-energy Facility Locations within North Carolina and surrounding states.

13. Discussion and Conclusions

The primary findings from our study showed that a small percent of the farmers in NC were aware of biomass sources other than corn for bioenergy. About 64% of farmers were aware of corn biomass; however, only about 30% of the farmers reported that they were aware of grasses and 40% of trees or wood residues as sources of biomass for bioenergy. None of the farm landowners in our study were currently supplying biomass to the bioenergy industry and only one respondent reported that they were considering producing or supplying biomass for bioenergy. This could be due to the lack of agriculture biomass facilities within the state. About one-third of respondents showed an interest in learning about producing and supplying agricultural biomass for bioenergy while more than 57% reported no interest. Our findings are similar to those found in past studies where farmers indicated only moderate interest in converting their land to switchgrass (Jensen et al. 2007; Qualls et al. 2012; Wen et al. 2009).

In addition, our study results showed that those farmers who own large tracts of land were more interested in gaining information about producing and supplying biomass but those whose primary land use was for livestock were less interested than others in information about producing and supplying biomass for bioenergy. Among biomass crops that landowners were willing to grow or interested to grow in their land for bioenergy, soybean, trees, and corn were the most popular reported by almost 25% of respondents each. Interest in trees as a crop for bioenergy was not surprising given that almost two-thirds of farm landowners in this study also owned forestlands. Although almost all of the previous studies on farm landowner interest in biomass for bioenergy focused on switchgrass, interest in this crop was only

reported by 7% of the farmers from NC. With respect to farmers' perception of barriers to grow and supply biomass for bioenergy, lack of knowledge on production, an underdeveloped market, and site/land issues topped the list, in that order. Interestingly, 18% of respondents indicated they had no barriers and were not interested in producing or supplying biomass. Farmers indicated that they would be motivated to produce or supply biomass if they received information and assistance about growing the biomass (29% respondents). Better profit margins than current crops and tax subsidies were the second and third most important factors, respectively, as motivation to grow biomass for bioenergy. Again, these results confirmed findings from other studies in the past that show economics and interest in learning more about cultivation as the factors that increase the likelihood for farmers' willingness to produce switchgrass for bioenergy (Jensen et al. 2007; Wen et al. 2009).

Responses to several bioenergy statements showed that respondents agreed most that domestically produced biofuels and bioenergy would be likely to increase the demand for agricultural crops and is critical to national security. In addition, they agreed that low profit margins and current government policies are not helpful to grow and supply biomass. Respondents also agreed that bioenergy plants would be likely to have a positive impact on increasing employment in the rural areas. Some of these results confirmed a recent finding on switchgrass acceptance across southeastern US that shows national security and rural employment as important issues that could generate landowner interest (Qualls et al. 2012).

We also conducted a logistic regression analysis to identify variables that would predict respondent landowner's interest in information for producing or supplying agricultural biomass for bioenergy based on demographic (age, land area owned, education, primary use

of farmlands and crops primarily grown, and percent of household income from farmlands) as well as relevant bioenergy agreement statements. However, our model did not result in any significant variables that predicted the landowner's interest in growing or supplying crops for bioenergy. Past studies have shown that farmers with large off-farm incomes and small land area are more willing to convert land area into switchgrass in Tennessee (Jensen et al. 2007). Despite of the non-significant results from our regression model, we found a fairly significant relationship between interest in information for producing/ supplying biomass to bioenergy and amount of land area. We found that farmers owning larger tracts of land were significantly more interested in growing and supplying biomass than those with smaller land area. Note that our study did not focus just on switchgrass and included a broader definition of the biomass feedstock (agricultural crops) for bioenergy. Other prior studies have shown that economics, contractual agreement on supply, and potential conflicts with harvesting times for current crops are other factors that influence farmers' willingness to convert land for switchgrass cultivation. Our model did not specifically include the contractual agreement variable as a predictor; however, our study results showed that 18% of farmers were looking for contractual agreement for supply as a motivational factor for producing and supplying biomass to the bioenergy industry, in addition to better profit margins.

It is clear from the above results that education and assistance about growing crops for bioenergy is key to the beginning of a successful acceptance and adoption strategy by the farm landowner population in North Carolina. Thus, extension agents should be well equipped with information on the cultivation, economics, and logistics of the biomass as well as be able to quickly disseminate that knowledge to the farmer population. Educational programs should be

tailored to farmers with larger land area under cultivation and those not currently utilizing their land for livestock (pasturelands), initially. Furthermore, farmers will not be interested unless they can find better profit margins for their biomass than current crops. Thus, the economics for the production and supply should make sense before successful adoption is possible. Cost-share programs and tax breaks could help in a quicker adoption rate. In addition, educational programs promoting bioenergy could focus on bioenergy's contribution to the national security and lead to rural employment to generate more interest from farmers in North Carolina.

13.1 Avenues for Future Research

Although comparable to other studies, we had a small response rate with 103 farmers. This did not allow sufficient data points to be compared among farmer respondents across the three regions of the state. In the future, studies could target a higher sample size to help with this comparison. In addition, cost and time constraints of the project did not allow us to reach the farmers who leased land from farm landowners for their livelihood. Efforts should be made to reach out to these farmers in the future for a better representation of the farming community. Our study showed farmer interest in cost share programs, tax breaks, and supply contracts. Future studies on farm landowners could focus on various types of cost share programs that farmers would be interested in as well as duration and type of supply contracts that would generate interest and lead to faster adoption of biomass crops in their farmland. Similar studies could also be conducted in other states in order to gain a better overall picture of the perceptions of farm landowners across the Southeastern US., especially if there is consideration for a broader spectrum of feedstocks, such as sorghum, crop residues, short

rotation woody crops, genetically modified crops, and trees.

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Non-Industrial Private Forest and Farm Landowners’ Perceptions and Knowledge of Biomass and Bioenergy in TN

15. Introduction

The use of biomass feedstocks from forest and agricultural lands has the capability to displace our nation’s petroleum imports, and produce bioproducts and biopower, thus, enhancing energy security, reducing environmental impact, and furthering economic development. The US billion-ton study update estimates the feedstock potential from forest biomass and waste resource at 102 million dry tons and the agricultural biomass and waste resource at 265 million dry tons by 2030 (DOE 2011). In addition, the study estimates the potential of new forest and agricultural energy crops at 400 million dry tons (energy crops are assumed to be planted starting in 2014) in 2030. Much of this resource potential is estimated to be sourced from the southeast US. One of the key southeastern states is Tennessee, which has a rich forest and agricultural base.

The state has about 14 million acres of forestland and 10.8 million acres of farmland (TN Department of Agriculture 2009, USDA 2009). Approximately 53% of the land area in TN is represented by forests while 16% is covered by farmlands (Figure 1). In 2011, agriculture and forestry together contributed \$66.4 billion to Tennessee’s economy which accounts for 13.3% of the economic activity within the state (Menard et al 2013). Forest resources account for about half of the biomass resources currently used for renewable energy production in the state, followed by a quarter each from crop, mill and urban wood residues, and biofuel crops (biogas also account for a small percent) (SAFER 2010). By 2010, TN had of more than 13 ethanol and biodiesel plants across the state and three

biomass-fueled combined heat and electric power plants (SAFER 2010). Guo et al. (2009) project that the EIA estimate of 5.2% annual growth in energy generation from wood and other biomass is likely to increase the forest biomass demand to over 5 million green tons in TN by 2030. Estimates also show that the state has the potential to produce 1.5 million dry tons of agricultural residue biomass annually with an additional 6.6 million dry tons of dedicated agricultural energy crops at \$40/dry ton (Walsh et al. 1999).

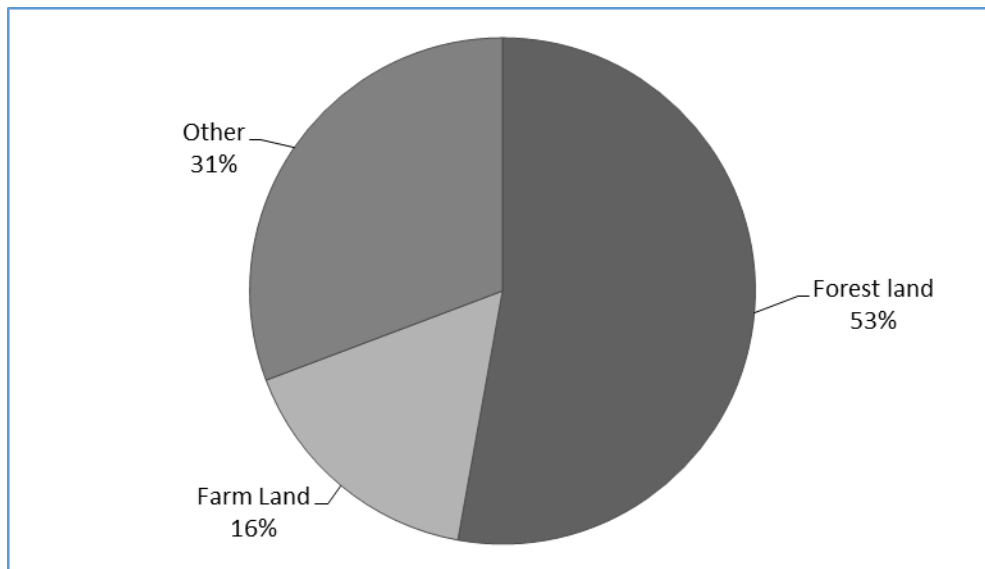


Figure 1. Land Classification in Tennessee
Source: US Census Bureau (County Fact Sheets), 2012

The Census of Agriculture estimates approximately 79,280 farms in the state of TN (USDA 2009), most of which are privately owned and eighty percent of timberland in TN is estimated to be owned by non-industrial private landowners (TN Department of Agriculture 2009). The perception of these private landowners (both forest and farm) about the bioenergy industry, in general, and their willingness to supply or produce energy crops is key to the

success of the bioenergy industry (Dwivedi and Alavalapati 2009, Abt et al. 2010, Joshi and Mehmood 2011, Paula et al. 2011, Gruchy et al. 2012). Wen et al. (2009) indicate that most of the research in the area of bioenergy is focused on production, economics and environmental aspects which are important, however, the major component missing in the overall development of this bio-based enterprise is the stakeholders opinion among which landowner's perspectives are most important. Furthermore, researchers indicate that without the support of the landowners and their willingness to grow and supply biomass, the sustainable bioenergy targets are impossible to attain (Monroe and Oxarart 2011, Smithhart and Darby 2011, Gruchy et al. 2012).

The need to understand landowner perceptions has led to a number of research studies in the past few years focused on forest and farm landowners. Overall, these studies show that most forest and farm landowners have moderate interest and are hesitant to participate in supplying biomass to bioenergy markets (Jensen et al. 2007, Wen et al. 2009, Joshi and Mehmood 2010, Markowski-Lindsay et al. 2012, Gruchy et al. 2012, Qualls et al. 2012, Fewell 2013, Leitch et al. 2013). The landowner hesitation results from a lack of understanding about the biomass to bioenergy market (Wen et al. 2009, Joshi and Mehmood 2011, Markowski-Lindsay et al. 2012, Qualls et al. 2012), an underdeveloped market (Jensen 2007, Conrad et al. 2011, Fewell 2013, Leich et al. 2013), and restrictive site conditions (Leich et al. 2013). Some studies also show that younger landowners are more likely to be interested in supplying biomass, and those that manage lands for conversation, recreation or livestock are less likely to be interested in supplying biomass (Jensen et al. 2007, Joshi and Mehmood 2011, GC and Mehmood 2012, Fewell 2013, Leich et al. 2013). In addition,

presence of supply contracts, inspite of competitive prices for bioenergy, generated landowner interest in supplying biomass to the bioenergy industry (Jensen et al. 2007, Fewell 2013).

15.1 Past Studies on Landowner Perceptions of Bioenergy in TN

Past bioenergy stakeholder studies in TN have primarily focused on farm landowner's perspectives of bioenergy from agricultural biomass as alternative markets. A survey of TN farmers on their willingness to supply switchgrass for bioenergy found low awareness about growing switchgrass for energy production and a hesitation for producing this biomass (Jensen et al. 2007). Demographic and farmer characteristics such as younger farmers with higher education and larger off farm incomes were more willing to convert land to switchgrass whereas those with large farm size were less willing to convert land to switchgrass for bioenergy. This study also found that a better market for bioenergy and supply contracts were issues that are likely to increase participation of farmers in converting their land to switchgrass production. Jensen et al. (2003a) surveyed soybean producers about their views on biodiesel and found that producers were optimistic about the growth prospects of the biodiesel market. The producers also agreed, on average, that they would be interested in using biodiesel from soybeans in a 20% blend on their farming operation if it were competitively priced with conventional biodiesel. Qualls et al. (2012) analyzed factors that influence interest among farm landowners from 12 southeastern US states including TN in growing switchgrass as a biomass feedstock, and show that the lack of information on logistics, economics and market availability were key factors. The interest in supplying switchgrass was tempered with concerns about potential conflicts with planting and

harvesting times for other crops. This study looked at the influence of region (TN and OK were included as a region) on interest in converting land to switchgrass and found no significant relationship among the two variables. Conrad et al. (2011) surveyed 21 forest landowners in each state in the southern US including TN and found that ninety percent of landowners were willing to sell timber to an energy facility if the right price was offered. However, the willingness to sell was based on the presence of a vibrant wood-energy market and the main constraint was reported to be a competitive traditional forest products industry market. Since each state had only a small number of responses, a state state-based analysis of forest landowners was not possible in this study.

In another study, residential consumers surveyed on their perceptions on electricity from renewable resources suggests slightly lower preference for electricity from crops or forest wastes compared to that from solar or wind sources (Jensen et al. 2003b). While this study did not focus on landowners in TN, it provides an indication on the possible market acceptance for crop and forest biomass.

While the above studies are vital and indicate the direction of landowner's views on acceptance of bioenergy markets from possible crops and forests, they are primarily narrow in scope and focus or broadly include a regional sample. Our study attempts to fulfil this gap and will provide a broader examination of landowner (both forest and farm) perceptions and interest in participation in production and supply of biomass in the state of TN. TN is similar to other states in terms of its agricultural land use but slightly different from the rest of the southern states with regards to its forest species composition, in that it primarily consists of hardwood forests (TN Department of Agriculture 2009).

16.Objective

The goal of this study is to assess forest and farm landowners' general perceptions about bioenergy, biomass resource, and biofuels for transportation in the state of Tennessee. An understanding of the knowledge and perceived value / impact of this industry will provide extremely useful information to the industry and policymakers about motivations and barriers for the involvement of this key stakeholder group within the growing bioenergy landscape. The results of this study will be useful for the future development of educational tools and policies better targeted toward this group.

17.Methods

17.1 Sample Frame

To assess forest and farm landowner perceptions, data was collected from a random sample of landowners. For generation of the sample frame for forest and farm landowners, the amount of forest or farm land within each county was first determined. For forest lands, data was based on the Forest Inventory and Analysis (FIA) database (FIA 2012). This database provides information on forested acres by county, forest type composition throughout the state, and ownership classification. The amount of farm land area by county was determined by downloading county fact sheets from the US Department of Agriculture (US Census Bureau, 2012).

For obvious reasons, the most urban counties were first eliminated from the population

(we assume that the biomass contribution potential is low in urban counties.) The TN counties were then categorized from most to least forest land and farm land. Twenty-five counties were then randomly sampled from across the three regions of the state. Once the counties were determined, a list of forest and farm landowners was generated from the county tax records and 3,000 landowners were randomly selected for data collection (1,500 for each landowner type). Figure 2 illustrates the distribution of the counties selected for data collection with the darker shaded counties representing the selected counties.

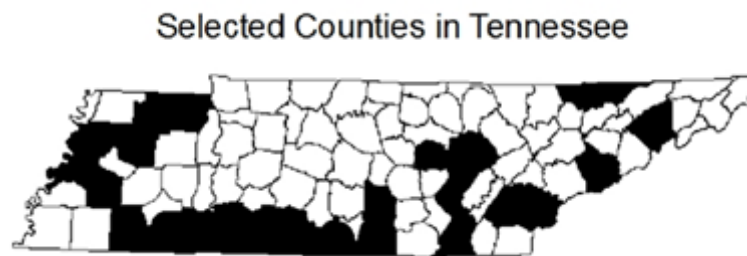


Figure 2. Randomly Selected Counties in Tennessee for Data Collection

17.2 Data Collection

Data was collected from the landowners using mail surveys. Before the surveys were mailed, a pilot study was conducted to test the effectiveness and interpretation of the survey questions, check question wording, and examine survey length. A sample (n=19) of landowners responded to the pilot survey. The feedback from the pilot test was used to refine the survey instrument.

Data for this study was collected based on the methodology outlined in the Tailored Design Method (Dillman 2000). The final survey was initially mailed to the selected sample of 1,500 forest and 1,500 farm landowners in TN with a cover letter and a postage-paid return

envelope in November of 2013. The cover letter specified the goal of the survey with emphasis on the voluntary nature of the survey and confidentiality of personal information. Three weeks after mailing the initial survey, a reminder card was sent to the non-respondents to elicit a better response rate. The reminder card also included a link to an online version of the survey, in the case that respondents found it more convenient to complete the survey online. The mail survey for each of the landowners contained four categories of questions, including respondent demographic and ownership characteristics, general bioenergy agreement statements, and motivations and barriers to the landowner willingness to produce and supply biomass to the bioenergy industry. These questions ranged from fixed response, five-point likert scale, and open-ended questions. The survey included xx agreement statements for forest landowners and xx statements for farm landowners on a five-point Likert scale of agreement about difference aspects of bioenergy industry including economics, environmental benefits, interest in information on growing biomass, and biomass sources. The questions included in the survey were based on prior studies focused on landowners as well as other stakeholders related to the bioenergy industry as well as questions developed after discussions with researchers and industry professionals based on our study objectives (Anonymous undated, Jacobson undated, NC Cooperative Extension undated, Jensen et al. 2003a). Some of the questions including the demographics, awareness and the bioenergy agreement statements remained the same for both landowner group, however, a majority of questions for the forest and farm landowners were different for the two groups (for forest landowners questions focused on wood and wood residues whereas, for farm landowners the feedstock focus was on agricultural crops and residues). Three versions of each of the

landowner surveys were created with question and option randomization to avoid any bias in question order.

17.3 Response Rate

Overall, we received a response rate of 10.1% (n =306) following the data collection from the landowners in TN (Table 1). As shown in Table 1, a response rate of 13% (n=195) was obtained from forest landowners and 7.4% (n=111) was obtained from farm landowners in TN.

Table1. Response Rate by Landowner Type

Type of Landowners	# of Contacts	# of Responses	Response Rate
Forest	1,500	195	13.0%
Farm	1,500	111	7.4%
Overall	3,000	306	10.2%

17.4 Non-Response Bias

A non-response bias analysis was conducted to examine whether respondents of the study were different from non-respondents. Past research has shown that non-respondents behave similar to the late respondents or respondents that respond after a reminder (Dillman et al. 2009). Early respondents (n=246) in this study are defined as those who responded before the reminder was sent and late respondents (n=57) are defined as all those who answered after the reminder was mailed (Dillman 2000). Key questions including demographics and land ownership characteristics (e.g., type of crops grown, willingness to produce and supply biomass) were compared between the early and late respondents using an independent

samples t-test (continuous variables) and chi-square test (nominal variables). The tests revealed no significant difference between the two respondent groups (early vs. late) on any of the variables.

18. Results

18.1 Respondent Profile

A demographic profile (Table 2) of the survey respondents shows that most landowners who responded to the survey were over the age of 50 years with the highest percent of respondents in the 61-70 year age category for both forest (39%) and farm (40%) landowners. A majority of landowners were white males with a 4 year college degree. As shown in Table 2, approximately 45% of forest landowners had a 4-year degree compared to 43% of farm landowners. The highest household income category in 2012 for both the landowner groups was \$50,000-100,000 with about 27% of forest landowners and 34% of farm landowners belonging to this category. Respondents were asked to indicate the proportion of income they derived from their lands in 2012. More than 80% of forest landowners reported receiving no income from their forest lands in 2012, 17% reported having received between 1 and 10% and only 1% reported more than 10% of income that they received in 2012 from their forests. Among farm landowners, 27.5% indicated having received no income from their farm lands in 2012. About 35% of farm landowners reported they received between 1-10% of their income in 2012 from farm lands, 10% reported having

received 11-20% of their income and 16% reported they received between 21 and 50% of their income and 12% received over 50% of their income from their farm land in 2012.

Table2. Demographic Profile of Survey Respondents

Demographics	Forest Landowners (n=195)	Farm Landowners (n=111)
Age Class (years)		
50 and less	9.2%	10.8%
51-60	25.6%%	22.5%
61-70	39.0%%	39.6%
71-80	18.5%	18.0%
Over 80	8.4%	9%
Gender		
Male	81.0%	85.6%
Female	19.0%	14.4%
Race/Ethnicity		
White	88.2%	91.0%
African American/ Black	0.5%	0.9%
Other	3.6%	1.8%
Prefer not to answer	7.7%	6.3%
Educational Attainment		
High School or Less	24.6%	27.9%
Some College	20.9%	23.4%
Bachelor's Degree	45.5%	43.2%
Advanced Degree	9.1%	5.4%
Annual Household Income (2012)		
Under \$25,000	5.6%	7.2%
\$25,000 to < \$50,000	10.8%	17.1%
\$50,000 to < \$100,000	28.7%	33.39%
\$100,000 to < \$150,000	11.3%	10.0%
\$150,000 and over	19.5%	14.4%
Prefer not to answer	24.1%	18.0%

Table 2. Continued

% of Income from Land (2012)		
0%	81.7%	27.5%
1-10%	17.3%	34.9%
11-20%	1.0%	10.1%
21-50%	0%	15.6%
Over 50%	0%	11.9%

Respondents were asked to indicate the amount of forest land area (for forest landowners) or farm land area (from farm landowners) owned by them. Table 3 shows the distribution of land area by the landowners. As shown in Table 3, about 25% of forest landowners owned 30 acres or less, followed by 16.8% between 31-50 acres, 24.6% forest landowners had 51-100 acres of land and over one-third owned more than 100 acres of forest land. In comparison, a majority (32.4%) of farm landowners owned more than 200 acres of farm land and about a quarter of respondents, each, owned less than 50 acres and 51-100 acres of farm land (Table 3).

Table3. Total Forest/Farm Land Area Owned by Respondents

Land area in Acres	Forest Landowners (n=195)	Farm Landowners (n=111)
30 acres and less	25.1%	12.6%
31 to 50 acres	16.8%	11.7%
51-100 acres	24.6%	25.2%
101-200 acres	16.2%	18.0%
More than 200 acres	17.3%	32.4%

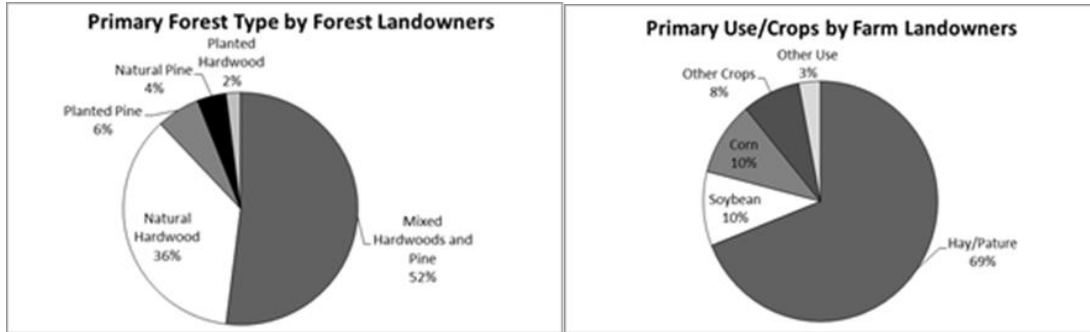
Respondents were also asked what type of ownership their land was under. About 69% of forest landowners reported that their land was under sole ownership while 23% of reported family-owned land and 8% of forest landowners reported that their land was managed under a partnership or a corporation. Among farm landowners, about 62% reported that they were sole owners whereas, 32% reported family ownership and 6% reported that their land was managed under a partnership or corporation.

About 47% of forest landowner respondents indicated that they also owned farm lands however, they owned more forest land than farm land. Among farm landowners about 78% indicated that they owned forest lands as well however, the amount of forest land owned was small compared to their farm lands (as a result they are classified as farm land owners).

18.2 Major Types of Crops Grown

When asked to report primary species in their forest lands, 52% indicated mixed hardwoods and pine followed 37% who indicated natural hardwoods. About 4% respondents indicated natural pine, 6% indicated planted pine and 2% indicated having planted hardwood in their forests (Figure 3). Also approximately, 11% of forest landowners reported that they had a forest management plan (landowners indicated American Tree Farm, TN Forest Tax Reduction and State Program) and 6% indicate participating in a cost-share program (landowners indicated Greenbelt, WHIP, Pine Beetle Project, etc.). When asked about genetically modified (GM) trees, about 8.5% of forest landowners indicated that they had planted GM trees (seedlings) and 7% indicated that they were unsure about planting GM trees. About a quarter of farm landowners indicated that they planted GM crops in their

farmlands and 29% participate in applied government cost share programs or funds (landowners reported NRCS, Conservation Reserve, TAEP).



Note: Other crops indicate crops other than soybean and corn and include cotton, sugarcane, wheat, sweet potatoes, etc.; Other use indicates turf grass lands and unspecified.

Figure 3. Types of Primary Forest Land or Crops and Land Use for Farms

18.3 Awareness of Bioenergy Sources

When asked about whether they were aware of various bioenergy feedstocks from farm lands and forest lands, a majority of landowners (76% forest and 60% farm landowners) indicated that they were aware of corn feedstocks for bioenergy (Figure 3). About 47% of forest landowners and 48% of farm landowners were aware of grasses, particularly switchgrass for bioenergy. As shown in Figure 3, approximately, 40-43% of landowners had heard of wood/wood residues and mill residues as sources of bioenergy. Surprisingly, more forest landowners (39%) reported that they were aware of food crops other than corn as biomass compared to farm landowners (26%) and more farm landowners (29%) indicated having heard about GM trees /short rotation trees compared to forest landowners (13%).

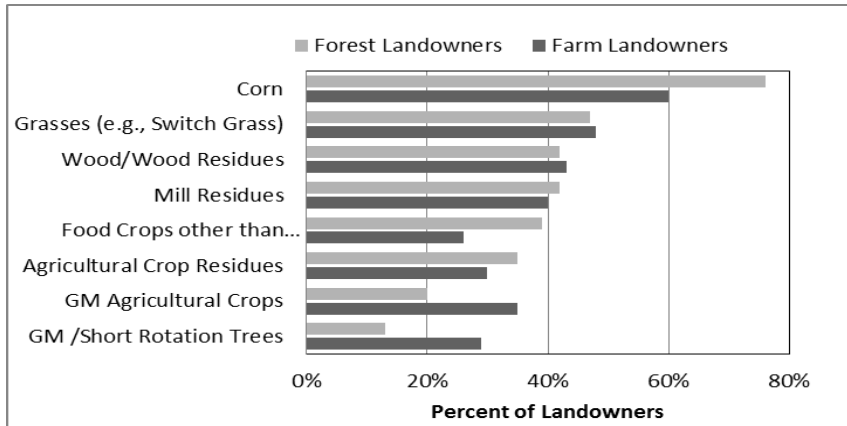


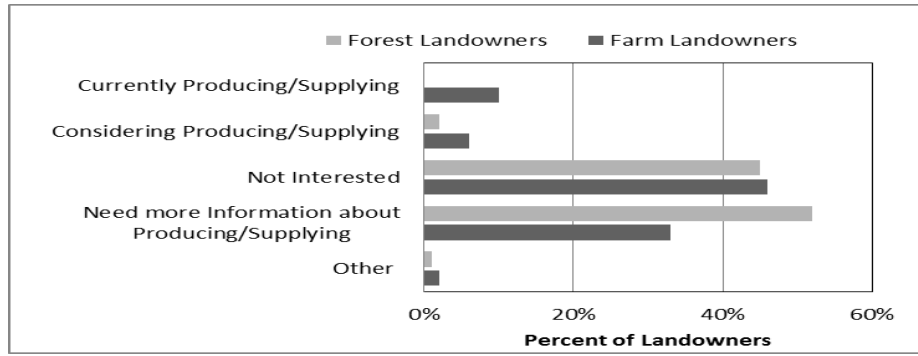
Figure 4. Landowner Awareness of Various Bioenergy Feedstocks

18.4 Willingness to Produce or Supply Biomass for Bioenergy Industry

Tennessee landowners were asked whether they were currently producing and supplying or were interested in producing/supplying biomass to the bioenergy industry. Figure 4 shows that while 10% of respondent farm landowners reported they were currently producing or supplying biomass for bioenergy, none of the forest landowners were currently producing or supplying biomass. Of these 10% of farm landowners, most are supplying corn (7%) followed by switchgrass (2%) and soybeans (1%) to the bioenergy industry.

About 6% of farm landowners and 2% of forest landowners were considering producing or supplying biomass and 33% of farm and over half of forest landowners were interested in more information about producing and supplying biomass for bioenergy. Furthermore, more than 45% of landowners from each of the groups (forest and farm) indicated that they were not interested in supplying or producing for bioenergy industry.

About 2% of farm landowners and 1% of forest landowners indicated “other” reasons for not being able to supply biomass including site access issues (farm landowners) and restrictions on forest biomass sale (green belt conservation).



Note: Other includes site access issues (farm landowners) and restrictions on forest biomass sale (forest landowners)

Figure 5. Landowner Willingness to Produce Biomass

Forest and farm landowner respondents who indicated considering supplying biomass to bioenergy industry or indicated an interest in information about producing or supplying biomass, also reported their crops of interest. Eighty-seven forest landowners responded to this question. About 24% of the forest landowners indicated interest in supplying forest residues or thinned material from timber lands whereas 14% reported interest in growing short rotation tree species in their lands. About 8% were interested in GM trees and 43% reported that they had no knowledge about the types of biomass that they can supply to the bioenergy industry from their forest lands.

Of the farm landowners (n=43) who reported considering or interest in information about producing and supplying biomass to the bioenergy industry, 37% were interested in corn, 30% in switchgrass, 24% in soybeans, 22% in trees/wood residues, 16% each in miscanthus and sorghum, and 8% in crop residues. About one-third of farm landowners indicated that they did not have any knowledge about specific biomass to grow and harvest for bioenergy industry. Note that 78% of farm landowners also owned forest lands thus, their interest in wood or wood residues was not surprising.

Table4. Types of Crops of Interest as Biomass from Landowners

Forest Landowners (n=87)		Farm Landowners (n=43)	
Crops of Interest	% of Landowners	Crops of Interest	% of Landowners
Forest Residues/Thinning Material from Timber	24%	Corn	37%
Short Rotation Tree Species	14%	Switchgrass	30%
GM Trees	8%	Soybean	24%
Have no Knowledge about Types of Biomass to Supply	43%	Wood/Wood Residues	22%
		Miscanthus	16%
		Sorghum	16%
		Crop Residues	8%
		Have no Knowledge about Type of Biomass to Supply	32%

Note: Numbers do not add to 100% as respondents could choose multiple crops

An analysis of the supply consideration or interest in information about production and supply of biomass for bioenergy by land area indicates that forest landowners who indicated interest in information about producing and supplying biomass for bioenergy belonged mostly (29%) to the 30 acres and less forest land area category (Table 5). About 38% of landowners who indicated interest in information about producing and supplying biomass had over 100 acres of forest land area. Among those who indicated no interest, most landowners owned between 50 and a 100 acres of land area, followed by 30 acres or less land area (23% of landowners).

Table5. Landowner Supplying or Interest in Information for Biomass Supply by Land Area

Land Area (in acres)	Currently Supplying		Considering Supplying		Interest in Information		Not Interested	
	Forest (n=0)	Farm (n=11)	Forest (n=2)	Farm (n=7)	Forest (n=89)	Farm (n=37)	Forest (n=101)	Farm (n=51)
30 and Less	0%	0%	0%	0%	29%	16%	23%	19%
31-50	0%	0%	0%	17%	12%	6%	20%	17%
51-100	0%	11%	50%	17%	21%	26%	25%	28%
101-200	0%	0%	25%	33%	17%	23%	16%	15%
Over 200	0%	89%	25%	33%	21%	29%	16%	21%
		100%	100%	100%	100%	100%	100%	100%

About 89% of farm landowners currently supplying biomass for bioenergy owned over 200 acres of farm land (Table 5). In addition, most farm landowners considering production and supply of biomass and those who indicated interest in information about production and supply of biomass had over 100 acres of farmland. Among those who indicated no interest in supplying biomass, most landowners (28%) had between 51-100 acres of farmland.

We also analyzed the primary land use for the farm landowners and their supply consideration and found that about 54% of landowners who currently used their land for livestock breeding or as pastureland indicated they were not interested in supplying biomass and 36% indicated that they were interested in learning more about producing and supplying biomass for bioenergy. A majority of corn producers (44%) were already supplying to the bioenergy industry and an equal percentage (44%) indicated that they were interested in information about producing and supplying biomass. In contrast, most of the soybean producers (38%) indicated no interest in supply of biomass while 25% of soybean producers indicated they were currently supplying and the same percent were considering supplying to the bioenergy industry.

18.5 Barriers and Motivations to Biomass Production and Supply

Respondents were asked to indicate key barriers for production and supply of forest or agricultural biomass for the bioenergy industry in an open ended question. The responses were grouped into a few major categories. A majority of forest landowners (37%) reported the lack of knowledge about market as the key barrier to produce and supply feedstocks, while almost half of farm landowners indicated prohibitive start-up costs and lack of necessary equipment as the key barrier to produce and supply biomass (table 6). Table 6 also shows that 17% of

forest landowners and 24% of farm landowners indicated lack of an established market and low profit margins as another major barrier. Restrictive site conditions and environmental concerns were some of the other barriers reported by both these groups of landowners. Lack of a local processing facility was found to be a more important barrier to farm landowners (22%) compared to the forest landowners (8%). While only 1% of forest landowners indicated lack of supply contracts for biomass as a barrier, about 7% of farm landowners indicated this reason as a barrier to supply biomass. Disturbance to wildlife habitat and poor tax structure was mentioned as barrier by 8% and 1% of forest landowners only. Interestingly, 20% of forest and 13% of farm landowners reported that they have no barriers, however, they were not interested in producing and supplying crops for the bioenergy industry.

Table 6. Barriers to Bioenergy Supply by Forest and Farm Landowners

Barriers Proposed	Forest Landowners (n=145)	Farm Landowners (n=80)
Lack of adequate knowledge about the market	37%	26%
Lack of established market/ competitive profit margins	17%	24%
Site issues (rolling hills, insufficient land area, no access to road (forest landowners), poor soil quality (farm landowners))	15%	11%
Prohibitive start-up cost/ lack of necessary equipment	12%	49%
Environmental concerns (Depletion of soil quality, cause problems to protection of woodlands (forest landowners))	8%	10%
Lack of local processing facility	8%	22%
Disturbance to wildlife habitat	8%	-
No supply contracts	1%	7%
Poor tax structure	3%	-
No barrier/ no interest in bioenergy	20%	13%

Table 7. Motivations / Incentives for Supplying Biomass for Bioenergy

Motivational Factors	Forest Landowners (n=131)	Farm Landowners (n=67)
Competitive profit margins vs. current crops/timber	34%	45%
Assistance/workshops on economics and production	26%	19%
Tax credits/ cost-share programs	18%	30%
Guarantee that forests/woodland be protected	7%	-
Local processing facility	5%	14%
Dependable/established market	5%	5%
Long-term supply contracts	2%	14%
Nothing (Maintain land in its current use)	5%	13%

In another open ended question, we asked landowners to respond to the factors or incentives that will motivate them to produce and/or supply agricultural crops (farm landowners) or forest products (forest landowners) to the bioenergy industry. The responses from this question were evaluated and condensed to the categories shown in Table 7.

We found competitive profit margins with bioenergy versus current crops or market as the most important incentive that will motivate forest (34%) and farm (45%) landowners to participate in the bioenergy industry as a feedstock supplier. As shown in Table 7, assistance or workshops on feedstock production and economics was reported as a motivational factor by 26% of forest and 19% of farm landowners in TN. While almost 30% of farm landowners were interested in tax breaks or cost share programs, only 18% of forest landowners expressed that this factor was an incentive in growing and supplying feedstocks. Note that most landowners (60-65%) who indicated tax breaks or cost share in both groups (farm and forest) were interested in tax breaks vs. (40-35%) interested in cost-share programs. Table 7 also

shows that 7% of forest landowners were interested in maintaining and protecting their wood lots as an incentive. Similar to barriers to supply, we found that landowners considered a local processing facility (7% of forest landowners and 14% of farm landowners), an established market (5% of forest and 5% of farm landowners), and long-term supply contracts (2% forest and 14% farm landowners) as the other factors that would motivate their participation in the biomass to bioenergy industry.

18.6 Bioenergy and Biofuel Perceptions

To determine forest landowner perceptions of the bioenergy industry, respondents were asked to indicate their agreement with several bioenergy statements (on five-point Likert scale of agreement, 1=strongly disagree and 5=strongly agree). Tables 8 and 9 illustrate the forest landowner and farm landowner response to the statements (mean agreement and standard deviation shown). The common statements asked to both groups of landowners are italicized in each table for comparison.

Tables 8 and 9 show that both forest and farm landowners agreed that domestically produced fuel was critical to the national security (mean agreement forest landowner =4.2; mean agreement farm landowner=4.0). In addition, the second most agreed statement for both landowner groups was that biofuel production had the potential to increase the demand for wood and wood residues (in case of forest landowners, mean=4.0) or agricultural crops and residues (in case of farm landowners, mean=3.8). The third and fourth statements that the forest landowners agreed most with were that they needed different management system in their forest for supplying biomass (mean = 3.9) and that local facilities will help improve the employment (3.9). The least agreed upon statements for the forest landowners was that it was

profitable to grow and sell thinned material/wood to bioenergy market vs. the current markets such as pulp markets (mean = 2.7) and that bioenergy production from wood would have a negative environmental impact (mean=2.8).

Table8. Forest Landowner Agreement with Bioenergy Statements

Statements (Forest Landowners)	Mean*	Std. Deviation
<i>Domestically produced fuel is critical to the national security</i>	4.2	1
Biofuel production has the potential to increase the demand for wood and wood residues	4	0.7
I will have to manage my land differently (e.g, change species, rotation length, planting density, etc.) if I produce/ supply biomass for the biofuels or biopower industry	3.9	0.8
<i>Local bioenergy plants/ facilities will improve the employment in my region</i>	3.9	0.8
Using pre-commercial thinning in forestlands for energy is a potential income opportunity	3.8	0.7
<i>Bio-based fuels and biopower are likely to be more expensive than petroleum or electricity, respectively</i>	3.8	0.8
The government should provide tax breaks for forest landowners willing to produce biomass for bioenergy	3.7	1.2
<i>Bio-based fuels will reduce US dependence on foreign oil</i>	3.7	1
Growing and supplying wood for energy is a promising local option to improve rural economy	3.7	1
Woody residues (left on forest site) when used for bioenergy purposes provides more value to the landowner than other uses	3.7	0.8
<i>Bio-based fuels/ bioenergy are very important in meeting our national energy needs</i>	3.6	1
I would like to learn more about growing and harvesting wood for bioenergy (biofuels & biopower)	3.6	1
<i>Current government regulations/ policies are not helpful to me for growing & supplying wood for the bioenergy industry</i>	3.6	1

Table 8. Continued

<i>I believe in the long-term viability (future) of the bioenergy industry</i>	3.6	1
<i>I would like more information about the economics of growing and supplying biomass for bioenergy</i>	3.5	1
<i>Compared to fossil fuels, bio-based fuels are more environmentally friendly</i>	3.5	1.1
<i>I am interested in field days (on site information) to learn more about growing trees for biopower/biofuels</i>	3.4	1.1
It is profitable to grow short rotation woody crops for energy	3.4	1
The government should provide cost share programs for forest landowners willing to produce biomass for bioenergy	3.3	1.2
The cost of growing woody crops for energy purposes is more than the returns from the market	3.3	1.1
Growing biomass for bioenergy is not currently profitable for landowners	3.2	1.2
I believe genetically modified trees are an important biomass source for producing biofuels or biopower	3.2	1.2
I believe harvesting timber for energy will be detrimental to the site's productivity	3.1	1.1
I am interested in supplying forest residues/trees to produce bioenergy	3.1	1.2
<i>Bioenergy/ biofuels are more likely to be successful when produced at a small/local scale not a large/commercial scale</i>	3	1.2
Use of bio-based fuels/ power will reduce energy costs for my forest operations	3	1.1
<i>Bioenergy produced from wood is likely to have a negative environmental impact</i>	2.8	1.3
It is more profitable to grow and sell thinned material/thinned wood to the bio-energy industry (electricity/fuels) vs. other forestry markets (e.g., pulp)	2.7	1

*Note: Mean agreement on a five-point Likert scale (1=strongly disagree to 5=strongly agree)

The third and fourth most agreed statements by farm landowners were their interest in information about the economics of growing and supplying crops for bioenergy (mean=3.7)

and that compared to fossil fuels they agree that bio-based fuels were more environmentally friendly (mean=3.6). Similar to the forest landowners (though lower mean agreement overall), farm landowners least agreed that bioenergy produced from agricultural crops will have a negative environmental impact (mean=2.4) and that it was more profitable to grow and sell crops for the bioenergy industry vs. current markets (mean=2.5).

Table9. Farm Landowner Agreement with Bioenergy Statements

Statements (Farm Landowners)	Mean	Std. Deviation
<i>Domestically produced fuel is critical to the national security</i>	4.0	1.0
Biofuel production is likely to increase the demand for agriculture crops and residues	3.8	1.0
<i>I would like more information about the economics of growing and supplying crops for bioenergy</i>	3.7	1.0
<i>Compared to fossil fuels (petroleum), bio-based fuels are more environmentally friendly</i>	3.6	1.1
Growing and supplying agriculture crops for biofuels or biopower is likely to improve the local economy in my region	3.6	1.1
<i>Local bioenergy plants/ facilities will improve the employment in my region</i>	3.6	1.0
<i>Bio-based fuels will reduce US dependence on foreign oil</i>	3.5	1.1
<i>Current government regulations/policies are not helpful to me for growing and supplying agricultural crops/residues for the bioenergy industry</i>	3.5	1.0
The government should provide tax breaks for farmland owners willing to produce biomass for bioenergy	3.5	1.2
<i>I am interested in field days (on site information) to learn more about growing crops for biopower and biofuels</i>	3.5	1.1
Agriculture residues when used for bioenergy purposes provide better value than current uses	3.5	1.1
<i>Bio-based fuels/ bioenergy are very important in meeting our national energy needs</i>	3.4	1.1
<i>I believe in the long-term viability (future) of the bioenergy industry</i>	3.4	1.0
The cost of growing biomass for energy purposes is more than the returns from the market (not profitable)	3.4	1.0

Table 9. Continued

Increase in production/ distribution of bio-based energy will increase the cost of growing and supplying agriculture crops to the market	3.4	1.0
Bio-based fuels/biopower are likely to be more expensive than petroleum/electricity	3.4	1.0
I would be more interested in producing/supplying agricultural crops if more government cost-share programs are available	3.3	1.1
It is profitable to grow grasses in addition to crops on my farmland for energy purposes	3.1	1.1
Harvesting agricultural biomass for bioenergy will reduce the necessary nutrients in the soil	3.1	1.2
<i>Bioenergy/biofuels are more likely to be successful when produced & distributed at a small/ local scale and not at a large/ commercial scale</i>	2.9	1.1
It is more profitable to grow and sell crops for the biofuels industry vs. other agriculture markets	2.5	1.2
<i>Bioenergy produced from agriculture crops will have a negative environmental impact</i>	2.4	1.1

19. Discussion and Conclusions

Findings from this study show that TN farmers and forest landowners show that over half of the forest landowners as well as half of the farm landowners are not aware of biomass other than corn for the bioenergy industry. Most landowners reported that they were aware of switchgrass followed by wood and wood residues and mill residues. This is not surprising given the emphasis on switchgrass for bioenergy education and information in TN (Clark 2007, Larson et al. 2007) and the focus of this biomass in the majority of previous perception studies on farm landowners in TN. all the previous studies on switchgrass. Least awareness was found among the forest landowners for GM and short rotation trees as biomass for bioenergy.

Only 10% of the farm landowners in TN in our study reported currently producing or supplying biomass to the bioenergy industry and the major crops used were reported as corn, switchgrass and soybean. None of the forest landowners were supplying wood/wood residues as biomass, currently and only about 2 percent indicated considering supplying biomass in the near future. This is in contrast to a previous study on private forest landowner intent to supply woody feedstocks for bioenergy production in Kentucky where approximately two-thirds of their survey respondents claimed they were planning on harvesting energy wood in the future (Leitch et al. 2013). Note that over half of our study respondents reported that they were interested to know more about producing or supplying biomass. Approximately one-third of farm landowners also reported that they were interested in information about producing and supplying biomass for the bioenergy industry. Our findings are similar to that of the past studies in that landowners are mostly hesitant and are looking for information about how they can participate in this industry. Qualls et al (2012) show that lack of information on logistics and economics was a major factor that influenced farm landowners' interest in supplying switchgrass. This is also substantiated by our finding that 43% of forest landowners and 37% of farm landowners reported having no knowledge about types of biomass to supply for bioenergy. Moreover, lack of adequate knowledge about the market was found in our study to be the most commonly reported barrier to supplying biomass for bioenergy by forest landowners and second commonly reported barrier by farm landowners.

We also found that those landowners who were interested in information about supplying or producing biomass or were considering supplying biomass for bioenergy were most interested in forest residues or thinned material from forests (24% of forest landowners)

and corn (37% of farm landowners) and switchgrass (30% of farm landowners). In contrast to findings from earlier study (Jensen et al. 2007), we found that farm landowners in TN who owned larger tracts of lands were currently supplying crops to the bioenergy market and also those with larger tracts of land were more interested in supplying or looking for information to supply biomass in the future. Jensen et al. (2007) found that farmers with large farm size were less willing to convert their land to switchgrass from current crop. The difference between the findings could be because of their study's focus on switchgrass while this study did not focus on a specific biomass.

In addition to lack of knowledge, landowners indicate lack of established market and competitive profit margins as a major barrier. This finding supports finding from a study of forest landowners in Southeast US (Conrad et al 2011) where 90% of forest landowners were looking for competitive price and a presence of a vibrant energy market. Additionally, Jensen et al (2003a) also found interest from farmers in biodiesel if the price was competitive with traditional diesel market. Competitive price margins vs. current crops/timber was found to be the most commonly reported factors that would motivate landowners to supply biomass.

Farm landowners most commonly indicated prohibitive start-up costs and lack of necessary equipment for growing and supplying biomass as the primary barrier. Thus, it is not surprising that almost 30% of the farm landowners and 18% of forest landowners report that they would be interested in supplying biomass if tax credits and cost-share programs were available. Since 1978, the federal government has provided tax credits ranging from 40 to 60 cents per gallon of ethanol. In 2009, the credit was reduced to 45 cents per gallon for traditional ethanol while cellulosic biofuel receives \$1.01 per gallon (Alter and Kirchner

2009). These credits are used specifically to influence large-scale producers to be involved in the forest bioenergy industry. The 2002 Farm Bill provides incentives for feedstock producers, promotes the development of bio-refineries, and initiates educational programs for several stakeholders involved. The 2007 Farm Bill modified the 2002 bill by decreasing the credit on corn-based ethanol and increased the credit on cellulose-based ethanol. Not only do these policies set standards for the renewable energy industry but they also provide landowners supplying these markets with some incentives to provide this material. This information should be disseminated to the interested landowners, through educational programs.

Site issues, lack of local processing facility and environmental concerns were other as important barriers to biomass supply identified by farm landowners. Furthermore, guaranteed supply or supply contracts were important to almost 14% of farm landowners in our study as an incentive or motivation for growing and supplying biomass. A past study on switchgrass and miscanthus farmers in central France showed that farmers were interested in growing biomass only if they were offered appropriate contractual agreements (Bocqueho and Jacquet 2010). This indicates that in the absence of competitive profits from bioenergy industry, long term supply contracts could be beneficial to help increase the acceptance of bioenergy as a market for agricultural crops.

The results of our study also confirms findings from previous studies in other states where those landowners who manage their land for conservation and recreation or livestock (farmers) are less likely to be interested in supplying biomass (Jensen et al. 2007, Joshi and Mehmood 2011, Fewell 2013, Leich et al. 2013). About eight percent each, of our forest

landowners, reported that environmental concerns including problems to protection of woodlands and disturbance to wildlife habitat was a major barrier to supplying biomass. In addition, 7% of forest landowners indicated that they would be motivated to supply biomass only if their forests or woodlands are protected. In addition, more than half of the farm landowners who currently used their lands for livestock indicated they were not interested in supplying biomass.

Forest and farm landowners responded to various bioenergy attributes that they agreed with or concerned about and the most agreed statement was that domestically produced fuel could lead to national security. A prior study across 12 southeastern United States reported that farm landowners' willingness to participate in the bioenergy landscape in addition to a better profit margin depended on their likelihood for contributing to improvements in the nation's energy security and environment (Qualls et al, 2012). Other similar attributes such as bioenergy's contribution to nation's energy portfolio and reduction in dependence on foreign oil were also rated highly (high mean agreements on these statements) by the landowners. Respondent landowners also agreed highly to environmental benefits of bio-based fuels compared to fossil fuels (mean agreement 3.5 to 3.6 in a 5 point agreement scale). National security, environmental benefits, and rural employment should therefore be key components for promotion when targeting landowners.

The results of this study show that extension and outreach personnel will be key to inducing participation of forest and farm landowners in the bioenergy industry. The importance of assistance and training to the landowners on key issues related to production, economics and supply of biomass will provide information that landowners are looking for to

help them understand this market better. It is clear that landowners will be interested only if local energy markets are vibrant and competitive with other current markets. These local markets will also be important as the agricultural incomes decline (forecast, USDA-ERS 2006), and need for economic development and value added operation grows in rural areas. In addition, government involvement in reviewing current tax breaks and cost-share programs as well as take further policy initiatives to involve the landowners in the bioenergy industry will be important as we look toward a viable and sustainable bioenergy future.

19.1 Avenues for Future Research

Although we made every effort to increase the response rate of our study for the forest and farm landowners, we could not get a better response rate from especially the farm landowners in our study. Future studies could attempt to ascertain a methodology that could help get a better response rate from the landowner community. While the results highlight importance of various attributes in production or supply of bioenergy, regional differences within the state could not be provided due to a low sample size for each region. This study showed importance of preserving the natural environment for the forest landowners, interest in supply contracts especially for farm landowners, and tax breaks and cost-share programs for both forest and farm landowners. Future studies could target each of these areas of interest for the landowners to identify the issues within each of these attributes in detail. For example, what type of supply contracts are the landowners looking for or what type of tax breaks and cost share programs will be most effective for the acceptance of bioenergy industry? To gain a better overall picture of how forest and farm landowners feel on each of the attributes of supply and production across the South Eastern United States, a similar

study with appropriate sample size should be conducted in other states. Moreover, another factor that could be important for future research could be the level of government involvement and assistance that would be helpful in training and providing information to landowners.

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APPENDICES

Appendix A

**20.1 NORTH CAROLINA:
Additional Forest landowner Tables:**

Table A.1 Ownership Type

What type of ownership is your forestland under? (n = 144)	
Sole Ownership	64.60%
Family-owned	28.50%
Partnership	2.10%
Corporation	2.80%
Other	2.10%

Within this study respondents were asked to provide information on the type of ownership their land falls under. The majority of respondents who answered this question have sole ownership of their property, while 28.5% of respondents reported their land is family owned. Approximately 7.2% of respondents reported their land being owned within a partnership, corporation, or other.

Table A. 2. Percentage of Respondents owning Forest Land in North Carolina

Do you own forest land in North Carolina (n = 162)	
Yes	88.90%
No	11.10%

Out of respondents who completed the this question within the survey 88.9% responded that they do in fact own forested lands in North Carolina

Table A. 3. Procurement of Forest Land

How did you come to own your forestland? (n =144)	
Inherited	52.80%
Purchased	45.10%
Other	2.10%

The majority of respondents inherited their property (52.8%) while the rest of the respondents reported that they mainly purchased their forested land (45.1%)

Table A. 4. Amount of forest land respondents reported owning

Please indicate how much forestland you currently own in acres (n = 143)	
acres	Percent
1-9	7.00%
10-30	20.30%
31-49	21.00%
50-100	21.00%
101-149	9.10%
150-200	9.10%
201-299	4.90%
300-400	2.10%
Over 400	5.60%

In the survey we asked landowners to report the amount of land they owned in acres. The majority of respondents who answered this question own 100 acres or less (69.0%) While approximately 20% own between 100 and 200 acres. Private landowners characteristically own small land holdings, so having the majority of our respondent's report they own less than 100 acres is not surprising.

Table A. 5. Percentage of respondents also owning farm land

Do you own any farmland? (n=144)	
yes	66.00%
no	34.00%

Within this study we also assessed the possibility of forest landowners also owning farm land. 66% of respondents who answered this question reported that they do own farm land in addition to their forest land.

Table A. 6. Percent of household income from forest management practices.

What percentage of your household income comes from your forestland? (n = 143)	
0	65.70%

1-10	26.60%
11-20	5.60%
31-40	1.40%
41-50	0.70%

The majority of respondents reported that they received no additional income from forestry practices conducted on their property. Approximately 27% reported only gaining a small amount of income from their land.

Table A. 7.

Please indicate the primary type of forestland you own (manage and or harvest) (n = 144)	
Natural Hardwood	12.50%
Planted Hardwood	1.40%
Mixed Hardwoods and Pine	43.80%
Natural Pine	5.60%
Planted Pine	32.60%
Other	4.20%

The majority of landowners in this study reported owning mixed pine hardwood stands (43.8%) or planted pine stands (32.60%) followed by natural hardwood stands with 12.5%

Table A. 8.

What reasons are most important to you in owning your forestland? (n = 100)					
	Extremely Important	Somewhat Important	Neutral	Somewhat Unimportant	Least Important
Economic	46.6%	13.8%	16.4%	8.6%	14.7%
Hunting Lease	9.4%	4.2%	19.8%	14.6%	51.0%
Other	67.6%	0.0%	8.8%	0.0%	23.5%
Recreation	29.4%	14.7%	22.9%	13.8%	19.3%
Tax Breaks	24.0%	14.0%	24.0%	13.0%	25.0%
Wildlife	19.8%	22.8%	25.7%	13.9%	17.8%

Respondents reported that the most important reason for owning their forest land is was other reasons that what was provided to them within the answer category, when asked to elaborate on what they meant by other some of the most common responses we received were to keep it in their family, conservation, and to keep it out of development. The least important reason was for hunting leases.

Table A. 9.

Do you participate in any forest certification programs? (n = 140)	
Yes	14.30%
No	85.70%

The majority of landowners reported that they do not participate in certification programs, this could be because they do not actively manage their property, and the fact that they characteristically do not reach out to professionals for help and advice on their practices if they conduct any.

Table A.10.

Do you participate in any applied cost-share funds or programs(gain assistance from government) (n= 142)	
Yes	18.30%
No	81.70%

Landowners in this study also do not participate in cost share programs again this could be contributed to their lack of active forest management and outreach to professionals who could guide them into programs such as these.

Table A. 11.

Do you plant genetically modified trees on your forestland? (n=142)	
Yes	13.40%
No	65.50%
Not Sure	21.10%

The majority of landowners in this study do not plant genetically modified trees on their property. Small landholdings do not bring in enough income to afford planting high quality seedlings unless the property is under an intensive management regime where landowners cooperate with professionals and cost share programs. This type of participation could eliminate some of the cost landowners would experience with planting genetically modified

21.2 Additional Farm Landowner Tables

Table A. 12

Do you own farmland in North Carolina? (n=105)	
	Percentage of Respondents
Yes	100%

Surveys were mailed to 1500 farm landowners within North Carolina, of the respondents who completed this survey 100% reported owning farm land.

Table A. 13

Please indicate how much farmland you currently own in acres (n=105)	
Acres	percent
1-9	6.73%
10-30	24.04%
31-49	9.62%
50-100	29.81%
101-149	9.62%
150-200	4.81%
201-299	7.69%
300-400	4.81%
Over 400	2.88%

Respondents were asked to report on the amount of farm land they currently own in acres. The majority of landowners in this study own less than 150 acres of farm land.

Table A. 14

What type of ownership is your farmland under? (n=105)	
Type of Ownership	Percentage
Sole Ownership	64.42%
Family-owned	26.92%
Partnership	0.96%
Corporation	0.96%
Other "please specify in space provided below"	6.73%
(Note: Other includes LLC, and Family trust)	

This study also wanted to assess the type of ownership farm land is under within North Carolina, respondents in this study reported the majority of their property is under sole ownership or family owned.

Table A. 15

What percentage of your household income comes from your farmland? (n = 105)	
Percent of household income	Percent of Respondents
0	25.49%
1-10	49.02%
11-20	10.78%
21-30	0.98%
31-40	1.96%
41-50	1.96%
51-60	1.96%
61-70	0.98%
71-80	0.98%
81-90	0.98%
91-100	4.90%

The majority of landowners in this study reported receiving less than 50% of their household income from their farmland.

Table A.16

Do you own any forestland? (n=105)		
	Percent of Respondents	Acres owned
Yes	74.50%	5,605
No	25.49%	

74.50% of landowners who responded to this survey reported that they owned forest land in addition to their farmland. Out of the 105 responses received landowners reported owning a total of 5,605 acres of timber.

Table A. 17

Please indicate the primary agriculture crop under which the majority of your agriculture land is dedicated to (n=105)	
Soybeans	23.47%
Wheat	1.02%
Hay	24.49%
Cotton	2.04%
Sweet Potato	4.08%
Corn	21.43%
Tobacco	1.02%
Other	22.45%

Landowners were also asked to report the primary crops that they produce from their farm land. The three main crops produced by farm landowners are hay, soybeans, and corn.

Table A. 18

What reasons are most important to you in owning your farmland? (n =105)					
	Extremely Important	Somewhat important	Neutral	Somewhat unimportant	least important
Economic (crop harvest for income)	28.57%	14.29%	12.38%	44.76%	0.00%
Livestock	25.71%	6.67%	21.90%	42.86%	2.86%
Tax Breaks	17.10%	9.52%	24.76%	48.57%	0.00%

Poultry	3.81%	0.95%	24.76%	65.71%	4.76%
Other	35.24%	2.86%	2.86%	58.10%	0.95%
(Note: Other includes: Family Heritage, rent, hunting and fishing, privacy, and working the land)					

For these landowners owning their farm land for economic crop harvests, livestock and poultry production, as well as tax breaks were somewhat unimportant to them when compared to their perceived importance on other factors such as family heritage, renting the property, recreation, and privacy

Table A. 19.

Do you participate in any applied cost-share funds or programs(gain assistance from government) (n=105)		
	Percentage of Respondents	Types of programs
Yes	13.86%	CRP, DCP, ASCS, and Tobacco Subsidies
No	86.14%	

The majority of landowners responded that they do not participate in any cost share programs to assist in the operation of their farm. Those who do utilize these programs reported their property is under programs such as CRP, DCP, ASCS, and tobacco subsidies.

Table A. 20.

Do you plant genetically modified crops on your farmland? (n = 105)	
	Valid Percent
Yes	23.08%
No	67.31%
Not Sure	9.62%

The majority of respondents reported that they do not plant genetically modified organisms on their property, approximately 9.62%, where not sure, this could be due to the fact that they may rent their property to someone who farms.

Table A. 21.

Which of the following sources of bioenergy are you aware of? (n=105)		
Bioenergy Sources	Aware	Not aware
Forest residues/ Trees	40.00%	60.00%
Mill residues	26.67%	73.33%
Food crops other than corn	23.08%	76.92%
Landfill waste	43.81%	56.19%
Corn	64.42%	35.58%
Genetically Modified Trees	10.48%	89.52%
Used cooking oil	60.00%	40.00%
Algae	20.95%	79.05%
Ag crop Residues	16.19%	83.81%
Genetically Modified Ag Crops	19.05%	80.95%
Grasses	29.52%	70.48%

Landowners were also asked to state their awareness on any of the bioenergy feedstocks⁷ provided in table 21. Majority of landowners reported knowing about corn, landfill waste, used cooking oil, and forest residues and trees.

21.3 Forest Landowner Survey:

North Carolina State University is a land-
Grant university and a constituent institution
Of The University of North Carolina

NC STATE UNIVERSITY

College of Natural Resources
Campus Box 8005 Biltmore Hall
Raleigh, NC 27695-8005

Dear Forest Landowner,

On behalf of the College of Natural Resources at North Carolina State University and the support of the US Department of Agriculture, we are conducting a survey of forest and farm landowners in North Carolina to understand your perceptions about the bioenergy industry in the South-east US. This study is important to help inform the industry, researchers, and policy makers in your state to improve their understanding of your interest and concerns about bio-based energy. In order for the results to truly represent the industry, it is important that each questionnaire be completed and returned (if you feel that you may not be able to complete the questionnaire, please forward it to an appropriate person who can complete it).

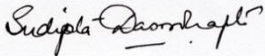
This **voluntary and confidential** (please do not include your name on any of the documents in the return envelope) survey is designed for easy completion and will take only a few minutes of your time. If you do not own a forest or farm land, it will be extremely useful if you could only check the first question in the questionnaire and return it to us so we can take you off our mailing list. Your answers will be treated in absolute confidence and used only in a statistical combination with all other responses.

As a token of appreciation for completing the survey, we will enter your name in a drawing* for a \$25 home depot gift card (a total of 4 gift cards).

Please return your completed, postage paid survey by placing it in the return envelope and dropping it in the mail. If you have any questions regarding this study please call me at (919) 515-5708.

Thank you in advance for your time and assistance. We are very grateful for your help.

Sincerely,



Sudipta Dasmohapatra
Associate Professor



Priscilla Morris
Graduate Research Assistant

Please Select

I would like to be entered in the drawing for the gift cards.

1. Do you own forestland in North Carolina?

No Please stop here and return the survey in the postage paid envelope

Yes Please continue to question 2

2. What (are) the ZIP/postal code(s) at which your forestland(s) is (are) located? _____

3. What type of ownership is your forestland under?

Sole Ownership

Family-owned

Partnership

No

Please read the following before you answer the next section:

Bioenergy in this survey is defined as energy for transportation or electricity obtained from natural sources.

13. Which of the following sources of bioenergy are you aware of? (Select all that apply)

- | | |
|---|---|
| <input type="checkbox"/> Landfill wastes | <input type="checkbox"/> Grasses |
| <input type="checkbox"/> Agriculture crop residues | <input type="checkbox"/> Forest Residues/Trees |
| <input type="checkbox"/> Food crops other than corn (e.g., sorghum) | <input type="checkbox"/> Genetically modified trees |
| <input type="checkbox"/> Mill residues (sawmill) | <input type="checkbox"/> Corn |
| <input type="checkbox"/> Genetically modified agricultural crops | <input type="checkbox"/> Used cooking oil |
| <input type="checkbox"/> Algae | |

14. Are you currently producing and/or supplying biomass from your forestland for bioenergy purposes?

- Currently producing/ supplying (see question 15)
- Considering producing/supplying (see question 15)
- Not interested (skip question 15)
- Need more information (skip question15) before producing/supplying
- Other (please specify) _____

15. As a forest landowner which crops would you be more likely to manage for bioenergy purposes? (Please select all that apply)

- | | |
|---|---|
| <input type="checkbox"/> Softwoods | <input type="checkbox"/> Short rotation woody crops |
| <input type="checkbox"/> Hardwoods | <input type="checkbox"/> Mixed |
| <input type="checkbox"/> Genetically modified trees | <input type="checkbox"/> Other (please specify) _____ |

Please read the following before answering question 16.

Bio-Based Feedstocks: An organic raw material used to create fuel for an industrial process; **Woody biomass:** Wood and wood-based residues; **Biofuel:** Fuel made from renewable biomass (trees, crops, grasses, etc.); **Short Rotation Woody Crops:** Fast growing wood species planted at high density, and grown at a short 10-15 year rotation length to increase yield.

16. Please rate your relative agreement of the following statements (strongly disagree to strongly agree, you may also select don't care or don't know) (Please select one in each row)

Question	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Care/ Neutral	Don't Know
I am worried that bioenergy produced from wood will have a negative environmental impact	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, domestically produced fuel is critical to the national security	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, use of bio-based fuels/ power will reduce energy costs for my forest operations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bio-based fuels will reduce US dependence on foreign oil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I am interested in supplying forest residues/trees to produce bioenergy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Question	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Care/ Neutral	Don't Know
Current government regulations/ policies are not helpful to me for growing & supplying wood for the bioenergy industry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, using pre-commercial thinning in forestlands for energy is a potential income opportunity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bio-based fuels/ bioenergy are very important in meeting our national energy needs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe it will be profitable to grow grasses in addition to timber in my forest land for energy purpose	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, bio-based fuel is a better alternative to petroleum-based fuels	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe genetically modified trees are an important biomass source for producing biofuels or biopower	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
A local bioenergy plant/ facility will improve the employment in my local region.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe harvesting timber for energy will be detrimental to the site's productivity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, the government should provide tax breaks for forest landowners willing to produce biomass for bioenergy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe it will be profitable to grow grasses in addition to timber in my forest land for energy purpose	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe that it is more profitable to grow and sell wood for the biofuels industry vs. to other forestry markets (e.g., pulp)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, woody residues (left on forest site) when used for bioenergy purposes provides more value to the landowner than other uses	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe that it is more profitable to grow and sell wood to the bio-power	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Question	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Care/ Neutral	Don't Know
industry (electricity) vs. other forestry markets (pulp)						
In my opinion, the government should provide cost share programs for forest landowners willing to produce biomass for bioenergy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, growing biomass for bioenergy is not profitable for landowners	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have heard of forest certification programs or BMP's for biomass production (to ensure renewable production)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I will have to manage my land differently (e.g. change species, rotation length, planting density, etc.) if I produce/ supply to the biofuels or biopower industry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe in the long-term viability (future) of the bioenergy industry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bioenergy/ biofuels are more likely to be successful when produced at a small/local scale not a large/commercial scale	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bio-based fuels & biopower are likely to be more expensive than petroleum or electricity, respectively	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I am interested in field days (on site information) to learn more about growing trees for biopower/biofuels	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would like to learn more about growing and harvesting wood for bioenergy (biofuels & biopower)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I think it is profitable to grow short rotation woody crops for energy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have sought professional advice about growing woody biomass for energy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The cost of growing woody crops for energy purposes is more than the returns from the market	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Question	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Care/ Neutral	Don't Know
Growing wood for energy is a promising local option to improve rural economy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Compared to fossil fuels, bio-based fuels are more environmentally friendly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would like to know more about growing genetically modified trees for biofuels or biopower	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would like more information about the ECONOMICS of growing and supplying biomass for bioenergy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, biofuel production could increase the demand for wood	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

17. Please rank (1=most profitable, 3=least profitable) the following wood-to-energy markets based on your perceptions of their profitability to a forest landowner:

- _____ Supplying wood for pellet industry
- _____ Supplying wood for biofuels (transportation)
- _____ Supplying wood for power (electricity)
- _____ Other energy markets (please specify) _____
- _____ None of the above

18. What type of barriers will you/ do you face in order to grow trees for bioenergy purposes? (please explain)

19. Please indicate what incentives will motivate you to supply or produce biomass (trees, logging residues, etc.) for bioenergy? (please explain)

20. What is your gender?

- Male
- Female

21. What is your year of birth? _____

22. Please indicate your educational background?

Years of High School completed _____

Years of College completed _____

23. What was your total household income in 2012 (include all income earners in your household)?

- | | |
|---|---|
| <input type="checkbox"/> Under \$25,000 | <input type="checkbox"/> \$50,000 to less than \$100,000 |
| <input type="checkbox"/> \$25,000 to less than \$50,000 | <input type="checkbox"/> \$100,000 to less than \$150,000 |
| <input type="checkbox"/> Prefer not to answer | <input type="checkbox"/> \$150,000 and over |

24. Which of the following best describes your ethnicity (please select all that apply)?

- | | |
|--|--|
| <input type="checkbox"/> White/Caucasian | <input type="checkbox"/> Native Hawaiian or Other Pacific Islander |
| <input type="checkbox"/> Hispanic/Latino | <input type="checkbox"/> Black/African-American |
| <input type="checkbox"/> American Indian/Native American | <input type="checkbox"/> Asian/Oriental |
| <input type="checkbox"/> Prefer not to answer | <input type="checkbox"/> Some other race (please specify) _____ |

Thank you for completing this survey!

21.4 Farm Landowner Survey:

North Carolina State University is a land-Grant university and a constituent institution Of The University of North Carolina

NC STATE UNIVERSITY

College of Natural Resources
Campus Box 8005 Biltmore Hall
Raleigh, NC 27695-8005

Dear Farm Landowner,

On behalf of the College of Natural Resources at North Carolina State University and the support of the US Department of Agriculture, we are conducting a survey of forest and farm landowners in North Carolina to understand your perceptions about the bioenergy industry in the South-east US. This study is important to help inform the industry, researchers, and policy makers in your state to improve their understanding of your interest and concerns about bio-based energy. In order for the results to truly represent the industry, it is important that each questionnaire be completed and returned (if you feel that you may not be able to complete the questionnaire, please forward it to an appropriate person who can complete it).

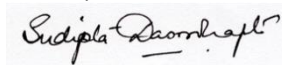
This **voluntary and confidential** (please do not include your name on any of the documents in the return envelope) survey is designed for easy completion and will take only a few minutes of your time. If you do not own a forest or farm land, it will be extremely useful if you could only check the first question in the questionnaire and return it to us so we can take you off our mailing list. Your answers will be treated in absolute confidence and used only in a statistical combination with all other responses.

As a token of appreciation for completing the survey, we will enter your name in a drawing* for a \$25 home depot gift card (a total of 4 gift cards).

Please return your completed, postage paid survey by placing it in the return envelope and dropping it in the mail. If you have any questions regarding this study please call me at (919) 515-5708.

Thank you in advance for your time and assistance. We are very grateful for your help.

Sincerely,



Please Select

I would like to be entered in the drawing for the gift cards.

1. Do you own farmland in North Carolina?

- No Please stop here and return the survey in the postage paid envelope
 Yes Please continue to question 2

2. What (are) the ZIP/postal code(s) at which your farmland(s) is (are) located? _____

3. What type of ownership is your farmland under?

- Sole Owner
 Family-owned
 Partnership
 Corporation
 Other (please specify) _____

4. Please indicate how much farmland you currently own in acres. (Select one)

- 1-9 10-30 31-49 50-100
 101-149 150-200 201-299 300-400
 Over 400

5. What percentage of your household income comes from your farmland? (select one) (best guess)

- 0 1-10 11-20 21-30
 31-40 41-50 51-60 61-70
 71-80 81-90 91-100

6. Do you own any forest land?

- Yes, Acres _____
 No

7. Please indicate the primary agriculture crop under which the majority of your agriculture land is dedicated to. (select one)

- Sugarcane Hay Sweet Potato Tobacco
 Soybeans Cotton Corn Peanut
 Wheat Other (please specify) _____

8. What reasons are most important to you in owning your farmland? (Please rank the following on a 1-3 scale; 1=Extremely Important to 3= Least Important)

- ____ Economic (crop harvest for income)
____ Livestock
____ Tax breaks
____ Poultry
____ Other1 (please specify and rank) _____
____ Other2 (please specify and rank) _____

9. Do you participate in any applied cost-share funds or programs (gain assistance from government)?

- Yes, please specify which funds/programs: _____
 No

10. Do you plant genetically modified crops on your farmland?

[**Genetically Modified Crop:** A crop whose genetic characteristics have been altered for a better and/or faster yield.]

- Yes
 No

Please read the following before you answer the next section:

Bioenergy in this survey is defined as energy for transportation or electricity obtained from natural sources.

11. Which of the following sources of bioenergy are you aware of? Select all that apply

- Forest residue/trees
 Mill residues (at sawmills)
 Food crops other than corn (e.g., sorghum)
 Landfill wastes
 Corn
 Genetically modified trees
 Used cooking oil
 Algae
 Agricultural crop residues
 Genetically modified agricultural crops
 Grasses

12. Are you currently producing and/or supplying biomass (crops, crop residues, etc.) from your farmland for bioenergy purposes?

- Currently producing/ supplying (see question 13)
 Considering producing/supplying (see question 13)
 Not interested (skip question 13)
 Need more information (skip question 13) before producing/supplying
 Other (please specify) _____

13. Which crops would you be more likely to plant/supply in your farmland for bioenergy purposes? (select all that apply)

- | | |
|---|--|
| <input type="checkbox"/> Soybeans | <input type="checkbox"/> Crop Residues |
| <input type="checkbox"/> Genetically Modified Crops | <input type="checkbox"/> Genetically Modified Trees |
| <input type="checkbox"/> Corn | <input type="checkbox"/> Other1 (please specify) _____ |
| <input type="checkbox"/> Trees | <input type="checkbox"/> Other2 (please specify) _____ |
| <input type="checkbox"/> Miscanthus (grass) | <input type="checkbox"/> Need information about this |
| <input type="checkbox"/> Switchgrass | |
| <input type="checkbox"/> Sorghum | |

Please read the following before answering question 14.

Bio-Based Feedstocks: An organic raw material used to create fuel for an industrial process; **Woody biomass:** Wood and wood-based residues; **Biofuel:** Fuel made from renewable biomass (trees, crops, grasses, etc.); **Short Rotation Woody Crops:** Fast growing wood species planted at high density, and grown at a short 10-15 year

rotation length to increase yield.

14. Please rate your relative agreement of the following statements (strongly disagree to strongly agree, you may also select don't care or don't know) (Please select one in each row)

Statements	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Care/ Neutral	Don't Know
I am worried that bioenergy produced from agriculture crops will have a negative environmental impact	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe it will be profitable to grow grasses in addition to crops on my farmland for energy purposes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe converting crop residues to bioenergy can be done economically (profitably)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I am interested in field days (on site information) to learn more about growing crops for biopower & biofuels	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe that it is more profitable to grow and sell crops for the biofuels industry vs. other agriculture markets	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe in the long-term viability (future) of the bioenergy industry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, bio-based fuel is a better alternative to petroleum-based fuels	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The cost of growing biomass for energy purposes is more than the returns from the market (not profitable)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, biofuel production could increase the demand for agriculture crops and residues	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, the government should provide tax breaks for farmland owners willing to produce biomass for bioenergy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Statements	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Care/ Neutral	Don't Know
A local bioenergy plant/ facility will improve the employment in my local region	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Growing agriculture crops for biofuels or biopower could improve the local economy in my region	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe harvesting agricultural biomass for bioenergy will reduce the necessary nutrients in the soil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Compared to fossil fuels (petroleum), bio-based fuels are more environmentally friendly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Current government regulations/policies are not helpful to me for growing & supplying agricultural crops/residues for the bioenergy industry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bioenergy/biofuels are more likely to be successful when produced & distributed at a small/ local scale & not at a large/ commercial scale	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, domestically produced fuel is critical to the national security	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bio-based fuels & biopower are likely to be more expensive than petroleum/electricity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bio-based fuels will reduce US dependence on foreign oil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Increase in production/ distribution of bio-based energy will increase the cost of growing & supplying agriculture crops to the market	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bio-based fuels/ bioenergy are very important in meeting our national energy needs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would be more interested	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Statements	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Care/ Neutral	Don't Know
in producing/supplying agricultural crops if more government cost-share programs are available						
I would like more information about the ECONOMIC of growing and supplying crops for bioenergy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe genetically modified crops are an important biomass source for producing biofuels or biopower	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Agricultural energy crops can be grown in areas that are not suitable for food crop production	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have sought professional advice about growing agriculture crops for energy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, agriculture residues when used for bioenergy purposes provide better value than current uses	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

15. Please rank (1=most profitable, 3=least profitable) the following crop-to-energy markets based on your perceptions of their profitability to a farmland owner:

- _____ Supplying crops/residues for pellet industry
- _____ Supplying crops/residues for biofuels (transportation)
- _____ Supplying crops/residues for power (electricity)
- _____ Other energy markets (please specify) _____
- _____ None of the above

16. What type of barriers do you face or would face in order to grow agriculture crops for bioenergy (biofuel/biopower)? (please explain)

17. Please indicate what incentives would motivate you to supply or produce agricultural biomass for bioenergy? (please explain)

18. What is your gender?

- Male
 Female

19. What is your year of birth? _____

20. Please indicate your educational background?

Years of High School completed _____

Years of College completed _____

21. What was your total household income in 2012 (include all income earners in your household)?

- Under \$25,000
 \$25,000 to less than \$50,000
 \$50,000 to less than \$100,000
 \$100,000 to less than \$150,000
 \$150,000 and over
 Prefer not to answer

22. Which of the following best describes your ethnicity (please select all that apply)?

- White/Caucasian
 Black/African-American
 American Indian/Native American
 Asian/Oriental
 Native Hawaiian or Other Pacific Islander
 Hispanic/Latino
 Some other race (please specify) _____
 Prefer not to answer

Thank you for completing this survey!

Please return the survey (folded lengthwise) in the postage paid return envelope and place in the mail upon completion.

Appendix C

21.5. Tennessee: Additional Forest Landowner Tables

Table C.1.

What type of ownership is your forestland under? (n=192)	
	Percentage of Respondents
Sole Ownership	68.80%
Family-owned	22.90%
Partnership	4.70%
Corporation	2.10%
Other	1.60%
Note: Other includes, LLC and Trust	

Table C.2.

How did you come to own your forestland? (n=192)	
	Frequency
Inherited	22.90%
Purchased	75.50%
Other	1.60%
Note: Other includes, transfer and family trust	

Table C.3.

Please indicate how much forestland you currently own in acres (n=191)	
Acres Owned	Percentage of Respondents
1-9	0.50%
10-30	24.60%
31-49	16.80%
50-100	24.60%
101-149	9.90%
150-200	6.30%
201-299	6.80%
300-400	2.60%
Over 400	7.70%

Table C.4.

Do you own forest land in Tennessee (n=193)	
	Percentage of Respondents
Yes,	99.00%
No	1.00%

Table C.5.

Do you own any Farmland? (n=189)	
	Percentage of Respondents
Yes	47.10%
No	51.90%

Table C.6.

Please indicate the primary type of forestland you own (n= 192)	
	Percentage of Respondents
Natural Hardwood	36.50%
Planted Hardwood	1.60%
Mixed Hardwoods and Pine	51.60%
Natural Pine	4.20%
Planted Pine	6.30%

Table C.7.

What percentage of your household income comes from your forestland? (n=195)	
0	87.10%
1-10	17.30%
11-20	10.00%

Table C.8.

Do you participate in any forest certification programs? (n= 190)	
	Percentage Of respondents
Yes	10.50%
No	89.50%

Table C.9.

Do you participate in any applied cost-share funds or programs(gain assistance from government) (n=191)	
	Percentage of Respondents

Yes	5.80%
No	94.20%

Table C.10.

Do you plant genetically modified trees on your forestland? (n = 191)	
	Percentage of Respondents
Yes	8.40%
No	84.30%
Not Sure	7.30%

Table C.11.

Which of the following sources of bioenergy are you aware of? (n=195)		
Bioenergy Feedstock's	Aware	Not Aware
Ag Crop Residues	34.87%	65.13%
Algae	32.31%	67.69%
Corn	75.90%	24.10%
food crops other than corn	38.46%	61.54%
Forest Residues/Trees	41.54%	58.46%
Genetically modified ag crops	20.00%	80.00%
Genetically modified trees	13.33%	86.67%
Grasses	46.67%	53.33%
Landfill waste	57.44%	42.56%
Mill Residues	41.54%	58.46%
Used Cooking Oil	69.23%	30.77%

Table C. 12.

What reasons are most important to you in owning your forestland? (n= 136)					
	Extremely Important	Somewhat important	Neutral	Somewhat unimportant	Least Important
economic	27.9	8.8	14.7	11.0	37.5

Hunting lease	13.6	11.0	11.9	10.2	53.4
Other	61.5	7.7	10.3	10.3	10.3
Recreation	45.6	20.8	18.8	4.0	10.7
tax breaks	18.0	12.5	20.3	15.6	33.6
Wildlife Management	44.9	23.1	13.6	10.2	8.2
Note: Other includes: Hunting, Family Heritage, Privacy, and Erosion Control.					

Table C. 13. Tennessee Forest Landowner Factor Analysis of Bioenergy Agreement Statements: Variance Explained 72.58%, Method: PCA, Varimax, Rotation, KMO .757 (n=183)

Information Needs and Interest	Loading	Mean	St. Deviation
I am interested in field days (on site information) to learn more about growing trees for biopower/biofuels	0.81	3.39	0.99
I am interested in supplying forest residues/trees to produce bioenergy	0.78	3.04	1.05
I would like to know more about growing genetically modified trees for biofuels or biopower	0.82	3.55	0.98
I would like to learn more about growing and harvesting wood for bioenergy (biofuels & biopower)	0.87	3.15	0.94
Profitability to Landowners	Loading	Mean	St. Deviation
Growing wood for energy is a promising local option to improve rural economy	0.73	3.43	0.80
I think it is profitable to grow short rotation woody crops for energy	0.75	3.22	1.13
In my opinion, using pre-commercial thinning in forestlands for energy is a potential income opportunity	0.67	2.89	1.02
Support to the Biofuels Market vs. Other Forestry Markets	Loading	Mean	St. Deviation
I believe that it is more profitable to grow and sell wood for the biofuels industry vs.to other forestry markets (e.g., pulp)	0.80	2.96	0.54
I believe that it is more profitable to grow and sell wood to the bio-power industry (electricity) vs. other forestry markets (pulp)	0.89	2.67	0.79
Better Environmental Alternative to Fossil Fuels	Loading	Mean	St. Deviation

Compared to fossil fuels, bio-based fuels are more environmentally friendly	0.89	3.28	0.82
In my opinion, bio-based fuel is a better alternative to petroleum-based fuels	0.77	3.58	0.74
Current Professional Outreach	Loading	Mean	St. Deviation
I have heard of forest certification programs or BMP's for biomass production (to ensure renewable production)	0.80	2.16	0.84
I have sought professional advice about growing woody biomass for energy	0.83	3.16	0.60
Environmental/ Site Concerns	Loading	Mean	St. Deviation
I am worried that bioenergy produced from wood will have a negative environmental impact	0.77	3.03	0.80
I believe harvesting timber for energy will be detrimental to the site's productivity	0.82	2.91	0.71

Table 14. Binary Logistic Regression: Backward Selection

		Variables in the Equation					
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 11 ^a	Information Needs	2.347	.373	39.654	1	.000	10.459
	Environmental/ Site Concerns	-.522	.245	4.542	1	.033	.594
	Constant	-.671	.231	8.412	1	.004	.511

21.6 Additional Farm Landowner Tables

Table C.15.

What type of Ownership is your farmland under? (n=109)	
Sole Ownership	62.39%
Family-owned	32.11%
Partnership	4.59%
Corporation	0.92%

Table C.16.

Please indicate how much farmland you currently own in acres (n=111)	
1-9	1.80%
10-30	10.81%
31-49	11.71%
50-100	25.23%
101-149	6.31%
150-200	11.71%
201-299	9.01%
300-400	6.31%
Over 400	17.12%

Table C.17.

Do you own any forestland? (n=107)	
Yes	77.57%
No	22.43%

Table C.18.

Do you own Farm land in Tennessee? (n=110)	
yes	68.18%
no	31.82%

Table C.19.

Please indicate the primary agriculture crop under which the majority of your agriculture land is dedicated to. (n=105)	
Sugarcane	1.0%

Soybeans	9.5%
Wheat	1.9%
Hay	58.1%
Cotton	3.8%
Sweet Potato	1.0%
Corn	9.5%
Other	15.2%
Note Other Includes: Cattle and Pasture for grazing	

Table C.20.

Do you participate in any applied cost-share funds or programs(gain assistance from government) (n=110)	
Yes	29.1%
No	70.9%

Table C.21.

Do you plant genetically modified crops on your farmland? (n=111)	
yes	25.20%
no	74.80%

Table C.22.

Which of the following sources of bioenergy are you aware of?(n= 111)		
Bioenergy Feedstocks	Aware	Not Aware
Ag Crop Residues	29.7%	70.3
Algae	25.2%	74.8%
Corn	59.5%	40.5%
Food crops other than corn	26.1%	73.9%
forest residue/ tree	43.2%	56.8%
Genetically modified ag crops	35.1%	64.9%

Genetically Modified trees	28.8%	71.2%
Grasses	47.7%	52.3%
Landfill wastes	27.0%	73.0%
Mill residue	39.6%	60.4%
Used cooking oil	50.5%	49.5%

Table C.23.

What reasons are most important to you in owning your farmland? (n = 111)				
	Extremely Important	Somewhat important	Neutral	Somewhat unimportant
Economic	23.4%	9.9%	22.5%	44.1%
Livestock	48.6%	8.1%	15.3%	27.9%
Tax Breaks	23.4%	8.1%	6.3%	62.2%
Poultry	1.8%	.9%	31.5%	65.8%
Other	18.9%	12.6%	14.4%	54.1%
Note Other Includes: Hunting, Share Cropping, Family Security, Investment				

Table C.24. TN Farm Correlation on Bioenergy Agreement Statements

Bioenergy Agreement Statements with the least Correlation			
	N	Mean	Std. Deviation
A local bioenergy plant/ facility will improve the employment in my local region	111	3.4595	.97032
Bio-based fuels/ bioenergy are very important in meeting our national energy needs	109	2.9266	.83562
Compared to fossil fuels (petroleum), bio-based fuels are more environmentally friendly	108	3.2593	.71526
I would be more interested in producing/supplying agricultural crops if more government cost-share programs are available	109	3.5872	.98330
I would like more information about the ECONOMIC of growing and supplying crops for bioenergy	110	3.2727	.82294
In my opinion, the government should provide tax breaks for farmland owners willing to produce biomass for bioenergy	108	3.2870	.80942
The cost of growing biomass for energy purposes is more than the returns from the market (not profitable)	110	3.3636	.82091

Table C.25. Farm Binary Logistic Regression: Backward Selection

		Variables in the Equation					
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 10 ^a	Age	-.061	.027	5.215	1	.022	.941
	Government Involvement/ Assistance	.800	.278	8.293	1	.004	2.224
	Gender	1.912	1.111	2.959	1	.085	6.764
	Acres Owned	.635	.278	5.211	1	.022	1.887
	Constant	1.976	2.032	.946	1	.331	7.217

Appendix D

21.7 Tennessee Forest Landowner Survey:



THE UNIVERSITY of TENNESSEE
KNOXVILLE, CHATTANOOGA, MARTIN, TULLAHOMA, MEMPHIS &

College of Natural Resources
Campus Box 8005 Biltmore Hall
Raleigh, NC 27695-8005

Dear Forest Landowner,

On behalf of University of Tennessee and North Carolina State University, with the support of the US Department of Agriculture, we are conducting a survey of forest and farm landowners in Tennessee to understand your perceptions about the bioenergy industry in the South-east US. This study is important to help inform the industry, researchers, and policy makers in your state to improve their understanding of your interest and concerns about bio-based energy. In order for the results to truly represent the industry, it is important that each questionnaire be completed and returned (if you feel that you may not be able to complete the questionnaire, please forward it to an appropriate person who can complete it).

This **voluntary and confidential** (please do not include your name on any of the documents in the return envelope) survey is designed for easy completion and will take only a few minutes of your time. If you do not own a forest or farm land, it will be extremely useful if you could only check the first question in the questionnaire and return it to us so we can take you off our mailing list. Your answers will be treated in absolute confidence and used only in a statistical combination with all other responses.

As a token of appreciation for completing the survey, we will enter your name in a drawing* for a \$25 home depot gift card (a total of 4 gift cards).

Please return your completed, postage paid survey by placing it in the return envelope and dropping it in the mail. If you have any questions regarding this study please call me at (919) 515-5708.

Thank you in advance for your time and assistance. We are very grateful for your help.

Sincerely,

Timothy G. Rials, Director
Center for Renewable Carbon
University of Tennessee

Sudipta Dasmohapatra
Associate Professor
North Carolina State University

Priscilla Morris
Graduate Research Assistant
North Carolina State University

Please select:

I would like to be entered in the drawing for the gift cards.

1. Do you own forestland in Tennessee?

- No Please stop here and return the survey in the postage paid envelope
 Yes Please continue to question 2

2. What (are) the ZIP/postal code(s) at which your forestland(s) is (are) located? _____

3. What type of ownership is your forestland under?

- Sole Ownership
 Family-owned
 Partnership
 Corporation
 Other (please specify) _____

4. How did you come to own your forestland?

- Inherited
 Purchased
 Other, please specify _____

5. Please indicate how much forestland you currently own in acres (select one)

- 1-9 10-30 31-49 50-100
 101-149 150-200 201-299 300-400
 Over 400

6. Do you own any farmland?

- Yes, Acres _____
 No

7. What percentage of your household income comes from your forestland? (select one)

- 0 1-10 11-20 21-30
 31-40 41-50 51-60 61-70
 71-80 81-90 91-100

8. Please indicate the primary type of species you grow on your forestland (select one)

- Natural Hardwood Natural Pine
 Planted Hardwood Planted Pine
 Mixed Hardwoods and Pine
 Other (please specify) _____

9. What reasons are most important to you in owning your forestland? (Please rank the following on a 1-5 scale, 1=Extremely Important to 5= Least Important)

- _____ Economic (e.g., timber harvest for income)
_____ Tax breaks
_____ Recreation (e.g., hiking, bird watching)
_____ Wildlife Management
_____ Hunting Lease
_____ Other (please specify) _____

10. Do you participate in any forest certification programs (American Tree Farm system, Sustainable Forestry Initiative, etc.)

- Yes Please list types of programs: _____
 No

11. Do you participate in any applied cost-share funds or programs (gain assistance from government activities) with respect to your forest land?

- Yes, Please specify which funds/programs: _____
 No

12. Do you plant genetically modified trees on your forestland?

[Genetically Modified Tree Definition: A tree whose genetic characteristics have been altered for a better and/or faster yield.]

- Yes Not Sure
 No

Please read the following before you answer the next section:

Bioenergy in this survey is defined as energy for transportation or electricity obtained from natural sources.

13. Which of the following sources of bioenergy are you aware of? (Select all that apply)

- Landfill wastes Grasses
 Agriculture crop residues Forest Residues/Trees
 Food crops other than corn (e.g., sorghum) Genetically modified trees
 Mill residues (sawmill) Corn
 Genetically modified agricultural crops Used cooking oil
 Algae

14. Are you currently producing and/or supplying biomass from your forestland for bioenergy purposes?

- Currently producing/ supplying (see question 15)
 Considering producing/supplying (see question 15)
 Not interested (skip question 15)
 Need more information (skip question 15) before producing/supplying
 Other (please specify) _____

15. As a forest landowner which crops would you be more likely to manage for bioenergy purposes? (Please select all

that apply)

- | | |
|---|---|
| <input type="checkbox"/> Softwoods | <input type="checkbox"/> Short rotation woody crops |
| <input type="checkbox"/> Hardwoods | <input type="checkbox"/> Mixed |
| <input type="checkbox"/> Genetically modified trees | <input type="checkbox"/> Other (please specify) _____ |

Please read the following before answering question 16.

Bio-Based Feedstocks: An organic raw material used to create fuel for an industrial process; **Woody biomass:** Wood and wood-based residues; **Biofuel:** Fuel made from renewable biomass (trees, crops, grasses, etc.); **Short Rotation Woody Crops:** Fast growing wood species planted at high density, and grown at a short 10-15 year rotation length to increase yield.

16. Please rate your relative agreement of the following statements (strongly disagree to strongly agree, you may also select don't care or don't know) (Please select one in each row)

Question	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Care/ Neutral	Don't Know
I am worried that bioenergy produced from wood will have a negative environmental impact	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, domestically produced fuel is critical to the national security	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, use of bio-based fuels/ power will reduce energy costs for my forest operations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bio-based fuels will reduce US dependence on foreign oil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I am interested in supplying forest residues/trees to produce bioenergy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Current government regulations/ policies are not helpful to me for growing & supplying wood for the bioenergy industry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, using pre-commercial thinning in forestlands for energy is a potential income opportunity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bio-based fuels/ bioenergy are very important in meeting our national energy needs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe it will be profitable to grow grasses in addition to timber in my forest land for energy purpose	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, bio-based fuel is a better alternative to petroleum-based fuels	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe genetically modified trees are an important biomass source for producing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Question	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Care/ Neutral	Don't Know
biofuels or biopower						
A local bioenergy plant/ facility will improve the employment in my local region.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe harvesting timber for energy will be detrimental to the site's productivity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, the government should provide tax breaks for forest landowners willing to produce biomass for bioenergy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe it will be profitable to grow grasses in addition to timber in my forest land for energy purpose	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe that it is more profitable to grow and sell wood for the biofuels industry vs. to other forestry markets (e.g., pulp)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, woody residues (left on forest site) when used for bioenergy purposes provides more value to the landowner than other uses	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe that it is more profitable to grow and sell wood to the bio-power industry (electricity) vs. other forestry markets (pulp)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, the government should provide cost share programs for forest landowners willing to produce biomass for bioenergy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, growing biomass for bioenergy is not profitable for landowners	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have heard of forest certification programs or BMP's for biomass production (to ensure renewable production)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Question	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Care/ Neutral	Don't Know
I will have to manage my land differently (e.g. change species, rotation length, planting density, etc.) if I produce/ supply to the biofuels or biopower industry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe in the long-term viability (future) of the bioenergy industry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bioenergy/ biofuels are more likely to be successful when produced at a small/local scale not a large/commercial scale	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bio-based fuels & biopower are likely to be more expensive than petroleum or electricity, respectively	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I am interested in field days (on site information) to learn more about growing trees for biopower/biofuels	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would like to learn more about growing and harvesting wood for bioenergy (biofuels & biopower)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I think it is profitable to grow short rotation woody crops for energy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have sought professional advice about growing woody biomass for energy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The cost of growing woody crops for energy purposes is more than the returns from the market	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Growing wood for energy is a promising local option to improve rural economy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Compared to fossil fuels, bio-based fuels are more environmentally friendly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would like to know more about growing genetically modified trees for biofuels or biopower	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would like more information about the ECONOMICS of growing and supplying biomass for bioenergy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Question	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Care/ Neutral	Don't Know
In my opinion, biofuel production could increase the demand for wood	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

17. Please rank (1=most profitable, 3=least profitable) the following wood-to-energy markets based on your perceptions of their profitability to a forest landowner:

- Supplying wood for pellet industry
 Supplying wood for biofuels (transportation)
 Supplying wood for power (electricity)
 Other energy markets (please specify) _____
 None of the above

18. What type of barriers will you/ do you face in order to grow trees for bioenergy purposes? (Please explain)

19. Please indicate what incentives will motivate you to supply or produce biomass (trees, logging residues, etc.) for bioenergy? (Please explain)

20. What is your gender?

- Male
 Female

21. What is your year of birth? _____

22. Please indicate your educational background?

- Years of High School completed _____
 Years of College completed _____

23. What was your total household income in 2012 (include all income earners in your household)?

- Under \$25,000 \$50,000 to less than \$100,000
 \$25,000 to less than \$50,000 \$100,000 to less than \$150,000
 Prefer not to answer \$150,000 and over

24. Which of the following best describes your ethnicity (please select all that apply)?

- White/Caucasian Native Hawaiian or Other Pacific Islander
 Black/African-American Hispanic/Latino
 American Indian/Native American Asian/Oriental
 Prefer not to answer Some other race (please specify) _____

Thank you for completing this survey!

Please return the survey (folded lengthwise) in the postage paid return envelope and place in the mail upon completion

21.8 Tennessee Agriculture Landowner Survey:



THE UNIVERSITY of TENNESSEE
KNOXVILLE, CHATTANOOGA, MARTIN, TULLAHOMA, MEMPHIS &

College of Natural Resources
Campus Box 8005 Biltmore Hall
Raleigh, NC 27695-8005

Dear Farm Landowner,

On behalf of University of Tennessee and North Carolina State University, with the support of the US Department of Agriculture, we are conducting a survey of forest and farm landowners in Tennessee to understand your perceptions about the bioenergy industry in the South-east US. This study is important to help inform the industry, researchers, and policy makers in your state to improve their understanding of your interest and concerns about bio-based energy. In order for the results to truly represent the industry, it is important that each questionnaire be completed and returned (if you feel that you may not be able to complete the questionnaire, please forward it to an appropriate person who can complete it).

This **voluntary and confidential** (please do not include your name on any of the documents in the return envelope) survey is designed for easy completion and will take only a few minutes of your time. If you do not own a forest or farm land, it will be extremely useful if you could only check the first question in the questionnaire and return it to us so we can take you off our mailing list. Your answers will be treated in absolute confidence and used only in a statistical combination with all other responses.

As a token of appreciation for completing the survey, we will enter your name in a drawing* for a \$25 home depot gift card (a total of 4 gift cards).

Please return your completed, postage paid survey by placing it in the return envelope and dropping it in the mail. If you have any questions regarding this study please call me at (919) 515-5708.

Thank you in advance for your time and assistance. We are very grateful for your help.

Sincerely,

Timothy G. Rials, Director
Center for Renewable Carbon
University of Tennessee

Sudipta Dasmohapatra
Associate Professor
North Carolina State University

Priscilla Morris
Graduate Research Assistant
North Carolina State University

Please select:

I would like to be entered in the drawing for the gift cards.

1. Do you own farmland in Tennessee?

- No Please stop here and return the survey in the postage paid envelope
 Yes Please continue to question 2 (If you sublease your property to a farmer please forward this survey to the farmer)

2. What (are) the ZIP/postal code(s) at which your farmland(s) is (are) located? _____

3. What type of ownership is your farmland under?

- Sole Owner
 Family-owned
 Partnership
 Corporation
 Other (please specify) _____

4. Please indicate how much farmland you currently own in acres. (Select one)

- 1-9 10-30 31-49 50-100
 101-149 150-200 201-299 300-400
 Over 400

5. What percentage of your household income comes from your farmland? (select one) (best guess)

- 0 1-10 11-20 21-30
 31-40 41-50 51-60 61-70
 71-80 81-90 91-100

6. Do you own any forest land?

- Yes, Acres _____
 No

7. Please indicate the primary agriculture crop under which the majority of your agriculture land is dedicated to. (select one)

- Sugarcane Hay Sweet Potato Tobacco
 Soybeans Cotton Corn Peanut
 Wheat Other (please specify) _____

8. What reasons are most important to you in owning your farmland? (Please rank the following on a 1-3 scale; 1=Extremely Important to 3= Least Important)

- ____ Economic (crop harvest for income)
____ Livestock
____ Tax breaks
____ Poultry
____ Other1 (please specify and rank) _____
____ Other2 (please specify and rank) _____

9. Do you participate in any applied cost-share funds or programs (gain assistance from government)?

Yes, please specify which funds/programs: _____

No

10. Do you plant genetically modified crops on your farmland?

[**Genetically Modified Crop:** A crop whose genetic characteristics have been altered for a better and/or faster yield.]

Yes

No

Please read the following before you answer the next section:

Bioenergy in this survey is defined as energy for transportation or electricity obtained from natural sources.

11. Which of the following sources of bioenergy are you aware of? Select all that apply

- Forest residue/trees
- Mill residues (at sawmills)
- Food crops other than corn (e.g., sorghum)
- Landfill wastes
- Corn
- Genetically modified trees
- Used cooking oil
- Algae
- Agricultural crop residues
- Genetically modified agricultural crops
- Grasses

12. Are you currently producing and/or supplying biomass (crops, crop residues, etc.) from your farmland for bioenergy purposes?

- Currently producing/ supplying (see question 13)
- Considering producing/supplying (see question 13)
- Not interested (skip question 13)
- Need more information (skip question 13) before producing/supplying
- Other (please specify) _____

13. Which crops would you be more likely to plant/supply in your farmland for bioenergy purposes? (select all that apply)

- Soybeans
- Genetically Modified Crops
- Corn
- Trees
- Miscanthus (grass)
- Switchgrass
- Sorghum
- Crop Residues
- Genetically Modified Trees
- Other1 (please specify) _____
- Other2 (please specify) _____
- Need information about this

Please read the following before answering question 14.

Bio-Based Feedstocks: An organic raw material used to create fuel for an industrial process; **Woody biomass:** Wood and wood-based residues; **Biofuel:** Fuel made from renewable biomass (trees, crops, grasses, etc.); **Short Rotation Woody Crops:** Fast growing wood species planted at high density, and grown at a short 10-15 year rotation length to increase yield.

14. Please rate your relative agreement of the following statements (strongly disagree to strongly agree, you may also select don't care or don't know) (Please select one in each row)

Statements	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Care/ Neutral	Don't Know
I am worried that bioenergy produced from agriculture crops will have a negative environmental impact	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe it will be profitable to grow grasses in addition to crops on my farmland for energy purposes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe converting crop residues to bioenergy can be done economically (profitably)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I am interested in field days (on site information) to learn more about growing crops for biopower & biofuels	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe that it is more profitable to grow and sell crops for the biofuels industry vs. other agriculture markets	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe in the long-term viability (future) of the bioenergy industry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, bio-based fuel is a better alternative to petroleum-based fuels	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The cost of growing biomass for energy purposes is more than the returns from the market (not profitable)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, biofuel production could increase the demand for agriculture crops and residues	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, the government should provide tax breaks for farmland owners willing to produce biomass for bioenergy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
A local bioenergy plant/ facility will improve the employment in my local	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Statements	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Care/ Neutral	Don't Know
region						
Growing agriculture crops for biofuels or biopower could improve the local economy in my region	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe harvesting agricultural biomass for bioenergy will reduce the necessary nutrients in the soil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Compared to fossil fuels (petroleum), bio-based fuels are more environmentally friendly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Current government regulations/policies are not helpful to me for growing & supplying agricultural crops/residues for the bioenergy industry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bioenergy/biofuels are more likely to be successful when produced & distributed at a small/ local scale & not at a large/ commercial scale	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, domestically produced fuel is critical to the national security	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bio-based fuels & biopower are likely to be more expensive than petroleum/electricity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bio-based fuels will reduce US dependence on foreign oil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Increase in production/ distribution of bio-based energy will increase the cost of growing & supplying agriculture crops to the market	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bio-based fuels/ bioenergy are very important in meeting our national energy needs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would be more interested in producing/supplying	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Statements	Strongly Disagree	Disagree	Agree	Strongly Agree	Don't Care/ Neutral	Don't Know
agricultural crops if more government cost-share programs are available						
I would like more information about the ECONOMIC of growing and supplying crops for bioenergy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I believe genetically modified crops are an important biomass source for producing biofuels or biopower	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Agricultural energy crops can be grown in areas that are not suitable for food crop production	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have sought professional advice about growing agriculture crops for energy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In my opinion, agriculture residues when used for bioenergy purposes provide better value than current uses	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

15. Please rank (1=most profitable, 3=least profitable) the following crop-to-energy markets based on your perceptions of their profitability to a farmland owner:

- _____ Supplying crops/residues for pellet industry
- _____ Supplying crops/residues for biofuels (transportation)
- _____ Supplying crops/residues for power (electricity)
- _____ Other energy markets (please specify) _____
- _____ None of the above

16. What type of barriers do you face or would face in order to grow agriculture crops for bioenergy (biofuel/biopower)? (Please explain)

17. Please indicate what incentives would motivate you to supply or produce agricultural biomass for bioenergy? (Please explain)

18. What is your gender?

- Male
 Female

19. What is your year of birth? _____

20. Please indicate your educational background?

Years of High School completed _____
Years of College completed _____

21. What was your total household income in 2012 (include all income earners in your household)?

- Under \$25,000
 \$25,000 to less than \$50,000
 \$50,000 to less than \$100,000
 \$100,000 to less than \$150,000
 \$150,000 and over
 Prefer not to answer

22. Which of the following best describes your ethnicity (please select all that apply)?

- White/Caucasian
 Black/African-American
 American Indian/Native American
 Asian/Oriental
 Native Hawaiian or Other Pacific Islander
 Hispanic/Latino
 Some other race (please specify) _____
 Prefer not to answer

Thank you for completing this survey!

Please return the survey (folded lengthwise) in the postage paid return envelope and place in the mail upon completion.