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LANDOWNERS' WILLINGNESS TO SUPPLY WOODY BIOMASS FOR BIOFUEL IN WEST ALABAMA

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Abstract

The Concern for national energy security, rural development, and climate change has created a wider attention for biofuels from woody biomass in recent times. For instance, West Alabama is an area of interest for stakeholders regarding the production of woody biomass. Therefore, the main objective of this study was to examine landowners' willingness to supply woody biomass for biofuel in West Alabama. A mail survey of randomly selected landowners was conducted in eight selected counties. The results indicated that the average forestland owner is male, between ages of 40 and 57, with an average of 27 years of land ownership. The probability that landowners would dedicate their non-forested land to loblolly pine for biofuel was higher for younger landowners, and increased with price and consequently profit. The results also showed that price support and tax incentives could encourage woody biomass production. Favorable and targeted policies could enhance the supply of woody biomass.

Keywords: Woody Biomass, Ethanol, Forest Landowners, Willingness to Supply, Government Support

Introduction

Biofuel from woody biomass is one of the gasoline substitutes getting wider attention as a result of concern for national energy security, rural development, and climate change (Joshi and Mehmood 2011). The U.S. has set a national goal of 16 billion gallons of cellulosic ethanol by 2022 to mainly replace fossil transportation fuels (EPA, 2014). Most of the woody biomass comes from the Southeast, which has the highest volume of unused woody biomass that includes forest residue (Alvarez, 2007). There are 22.9 million acres of timberland in Alabama, occupying 68% of the total land area in the state (Alabama Forestry Commission 2014). West Alabama has the highest forest cover mainly slash pine and loblolly pine which is the planned feedstock for biorefineries (USDA RBCS, 2010). Six 189-dam3 biofuels refineries producing 55 million gallons per year of biofuel would be required for Alabama to meet its goal of 1.137 billion gallons (Bailey et al., 2011). Based on Gonzalez et al. (2011), seven green tons per acre per year can be obtained from short rotation loblolly pine plantation. According to the University of Alabama (2014), about 85% of the forest is owned by non-industrial private forest (NIPF) landowners. So woody biomass market is emerging and prices are not certain. Landowners' willingness to harvest sufficient forest biomass for proposed refineries in Alabama is of concern to industry experts, participants, and policy makers (Bailey et al., 2011). The question is, are Landowners in the West Alabama willing to harvest sufficient forest biomass in the region?

Therefore, the main objective of this study was to examine landowners' willingness to supply woody biomass for biofuel in West Alabama. The specific objectives were to assess landowners' opinions of different government support programs for biofuel; assess factors that affect willingness

to plant loblolly, and assess factors that affect perceptions of tax incentives and price support. The study will be relevant to better understand how forestland owners respond to emerging opportunities, and by identifying the factors that explain their response, researchers and policy makers can anticipate and plan for incentivizing them into the woody biomass supply chain. This can take the form of designing tax credits to lower cost and price support schemes that equate marginal revenue to marginal cost; while ensuring that practices meet predefined sustainability targets that ensure the preservation of biodiversity, environmental concerns, and soil preservation desires.

The rest of the paper is organized as follows: The next section, section two, depicts a short review of the literature on past studies and highlights their findings that formed the basis of the expected results. Section three discusses the theoretical and empirical frameworks used in the study and provides information on the models used to analyze the data. Section four presents the results and discussions of the findings, and section five presents the conclusion derived from the results.

Literature Review

Landowners' Willingness to Supply Woody Biomass for Biofuels

Paula et al. (2009) found that 73% of survey respondents were willing to harvest residues for production of biofuels despite the fact that many of the respondents were unaware of the use of biomass for production of biofuel. Landowners' willingness to supply biomass was positively correlated with the price, the number of acres owned, the existence of an effective market, and the opportunity to contribute to local economic development. Shivan and Mehmood (2012) identified that decent market price for woody biomass was a motivating factor for Arkansas; Virginia and Florida landowners to enter the woody biomass supply chain. Aguilar et al. (2013) showed that the majority of landowners in the state of Missouri continued to be recreation-oriented. Only about 32% of NIPF landowners would be willing to harvest 15 green tons/acre of woody biomass if they are paid at least $75/acre. A third of them indicated no willingness to harvest woody biomass regardless of price. Joshi and Mehmood (2011) revealed that the young NIPFs with large forest holdings with pine or mixed pine-hardwood plantations would be more likely to supply woody biomass for biofuel production. Their study also found that the older NIPFs did not perceive the environmental benefits of biofuel as appealing while the more educated NIPFs positively perceived the benefits of wood-based biofuel in the context of environmental and energy security related matters. Joshi et al. (2013) found out that though 51% of the respondents still did not know that biofuels can be produced from woody biomass prior to receiving survey documentation, descriptive statistics indicated that more than 89% of respondents believed that wood-based biofuel could be a promising source for reducing greenhouse gas emissions and use of fossil fuels. Elderly males and resident NIPFs who have pine stands and gave value to economic benefits were 42% more likely to harvest woody biomass for biofuel production.

Aguilar et al. (2014) found that family-forest owners were heavily influenced by saw log prices so those prices dictated whether chose to harvest biomass. In this case, prices for saw logs were too low to motivate integrated harvesting. Only 32% were willing to harvest 15 green tons/acre of woody biomass if they were paid at least $75/acre. The private supply might increase if timber prices were raised over $200 per acre. They concluded that Missouri landowners were more recreation-oriented. Leitch et al. (2013) reported that the majority (two-thirds) of the NIPFs in

that state were willing to harvest forest biomass for biofuel production. Respondents' attitudes, perceived subjective norms, and perceived control, each had a significant effect on intent to harvest. Respondents identified lack of biofuels markets and woodland access issues as major challenges to their intent to harvest biomass for biofuel. Educational material used to provide information on biomass for bioenergy did not affect NIPF intentions. Becker et al. (2013) revealed payment level offered to harvest biomass played a significant role in landowners' decisions, but that non-monetary factors were also important. Shivan and Mehmood (2012) showed that the percentage of the NIPFs willing to harvest forest biomass from their forests for biofuel production increased with an increase in the amount of bid price for energy wood. Markowski-Lindsay et al. (2012) suggested that forest owner harvesting plans, opinions about forest usage, beliefs about climate change and the biophysical characteristics of the land all played significant roles in the decision to participate biomass supply for biofuel production.

Landowner Preference for Policy Alternatives

Shivan and Mehmood (2010) found that most of the NIPFs preferred tax incentives to direct subsidy support for promoting wood-based bioenergy; however, the majority of the older NIPFs preferred the latter policy instrument. The study also found that the NIPFs with larger forest areas and managing their forests actively under timber production regime were less likely to support policy tools for promoting wood-based bioenergy. Ma et al. (2012) found that the rate of participation in a state or federally sponsored cost-share program was considerably higher (5.2%) than in a forest certification (0.8%) or conservation easement program (1.7%) in forty-eight states, excluding Alaska, Hawaii, Nevada, western Oklahoma, and western Texas. In terms of cost-share programs, the South had the highest participation rate (26%). Regarding conservation easement programs, the Pacific Coast had the highest participation rate (5.9%). It was also found that family forest owners with larger land holdings were more likely to participate in all types of programs.

Methodology

Theoretical Model

The analysis is based on the fact that the satisfaction (utility) a person derives from doing something is the main reason for doing it. Landowner respondents' decision to grow or not to grow loblolly pine on non-forest land can be considered under the general framework of utility maximization.

Utility for loblolly production = $U_L = U(1,X)$ (1)

Utility for alternative production = $U_a = U(0,X)$ (2)

X = factors that influence their decision

Decision to grow Loblolly pine on non-forested land can take place if:

$$U_L(\beta_L X_i + \varepsilon_L) > U_a(\beta_a X_i + \varepsilon_a) \qquad L \neq a \tag{3}$$

Empirical Model

The data was dichotomous in nature. Landowners' willingness to dedicate non-forested land was binary: Yes or No. Logistic regression was used since the dependent variable is binary: Y=1 or Y=0 and independent variables (X) were of varying types. Logistic regression transformed the dependent variable into Logit variable (Maddala and Lahiri, 2009). It implies that:

$$\ln\left(\frac{P}{1-P}\right) = \beta_0 + \beta x \tag{4}$$

$$p(\beta_L x_i + \varepsilon_i - \beta_a x_i - \varepsilon_i > 0 \mid x_i) \tag{5}$$

Where P is the probability function, $\varepsilon = \varepsilon_L - \varepsilon_a$ is the random disturbance term
The probability of getting a "yes" response for the explanatory variables will have a logit form:

$$\text{LogitP}(X) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \varepsilon_i \tag{6}$$

Logistic regression used maximum likelihood to estimate the odds ratio. The odds ratio (OR) capturing the willingness to grow response compared to the alternative or leaving the land to lie fallow given the explanatory variables can be estimated as:

$$\text{OR} = e^{(\alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \varepsilon_i)} \tag{7}$$

Where β_i are the coefficients of those explanatory variables.

Estimated Equations:
Willingness to Grow:
$P(WG=1) = \alpha + \beta_1 BP + \beta_2 PR + \beta_3 PK + \beta_4 ED + \beta_5 AG + \beta_6 RE + \varepsilon_i$

Government Support
Tax Incentive: $P(TI=1) = \alpha + \beta_1 LS + \beta_2 NY + \beta_3 AG + \beta_4 ED + \beta_5 PI + \beta_6 RE + \varepsilon_i$
Price Support: $P(PS=1) = \alpha + \beta_1 LS + \beta_2 NY + \beta_3 AG + \beta_4 ED + \beta_5 PI + \beta_6 RE + \varepsilon_i$

Where BP = Bid Prices; PR = Land investment to generate profit; PK = Prior Knowledge about biomass for biofuel; ED = Education; AG = Age; LS = Land Size; NY = Number of Years Owned; PI = Percentage of Income from Forestland; RE = Resident.

Expected Results
Biomass bid prices, investment to generate profit, and percentage of landowners' income from forestland were hypothesized to relate positively to landowner's likelihood of saying yes to the biomass bid price. The expectations were based on the findings of Paula et al. (2009), Rämo et al. (2009), Shivan and Mehmood (2012), Kantavichai et al. (2012), and Halder et al. (2014) who found price to be positive and significant; Joshi et al. (2013), Caldas et al. (2014) and Skevas et al. (2014) who found profit, income and economic benefits as significant and positive. Similarly, based on Becker et al. (2013), Resident, the variable representing whether landowners resided on forestland or not was expected to be positively related to their willingness to dedicate their non-forested land to loblolly production, as landowners living on their woodlands tend to have easier access to their lands. Likewise, based on the findings of Paulrud et al. (2010), Gruchy et al. (2012) and Becker at al. (2013), age of the landowners, which is also a measure of their experience, was expected to have a positive influence on their willingness to dedicate their non-forested land to loblolly pine production. Education, based on Caldas et al. (2014) was expected to have a positive and significant relationship with landowners' willingness to grow. In terms of landowners' preference for government support policies, it was hypothesized that tax incentive would be the most preferred government support program landowners would prefer.

Survey Organization

The study concentrated on West Alabama, which has the highest forest cover in Alabama. The survey was done in 8 counties: Greene, Hale, Sumter, Marengo, Choctaw, Clarke, Wilcox, and Dallas. The list of forest landowners (with 20+ acres) was purchased from List Giant.com. After, the list was cleaned for completeness 1,200 had complete addresses. The survey was divided into four parts of 300 with four bid prices, $900, $1,200, $1,470, and $1,700. Mail survey questionnaires with a brief education on biofuels were mailed out. The first (cover) page of the survey questionnaire comprised a photo of loblolly pine plantation and brief information on biomass for biofuel and the purpose for the research. Organized in seven sections, section one contained questions aimed at obtaining land and land cover characteristics. Section two asked respondents to indicate the number of years they owned their lands. Section three ranked how important factors provided affected landowners' biomass for biofuel supply decision. Section four asked if they invested in land to generate profit or not. Section five asked landowners to indicate, whether or not they had previous knowledge on biomass for biofuel production? Section six elicited level of importance landowners attach to six government policies on biomass for bioenergy. Section seven sought demographic information, such as gender, age, education, and residence, on respondents. Reminder cards and telephone calls were used when possible.

For the variables, investment for profit was rated as 1 for not important, 2 for less important, 3 for moderately important, 4 for important, and 5 for very important. Age was ranked as 1 for less than 30 years, 2 for 30-49 years, 3 for 50-65 years, and 4 for 65 years or older. Education was rated as1for elementary school or less, 2 for high school, 3 for less than high school, 4 for some college, 5 for college graduate. Percentage of income from forestland was ranked as 1 for none, 2 for less than or equal to 10%, 3 for more than 10% but less than or equal to 25%, 4 for more than 25% but less than or equal to 50%, and 5 for greater than 50%. Family income was rated as less than $22,000 as 1, $22,000-$49,999 as 2, $50,000-$89,999 as 3, and greater than $90,000 as 4.

Table 1. Definition of the Variables Used in the Binary Logit Models.

Variable	Definition
Land Size	Total acreage of land owned by landowner
Non-forested land	Total acreage of pasture, grazing and cropland the landowner owns
Number of Years	Number of years land is owned by forestland owner
Bid Prices	$900, $1,200, $1,470, and $1799
Investment for Profit	"Not Important = 1", "Less Important = 2", "Moderately Important = 3", "Important = 4", "Very Important = 5"
Age	"< 30 years = 1", "30 – 49 years = 2", "50 - 65 years = 3", and "> 65 years = 4"
Education	"Elementary or less = 1", "High School = 2", "< High School = 3", "Some College = 4", and "College Graduate or more = 5"
Percentage of Income	"None = 1", "< 10% = 2", "> 10% but ≤ 25% = 3", "> 25% but ≤ 50% = 4", and "> 50% = 5"
Family Income	"< $22,999 =1", "$23,000 - $49,999 = 2", "$50,000 - $89,999 = 3", and "> $90, 000 = 4"
Prior Knowledge	Dummy variable: "1" if landowner had prior knowledge about biofuel "0" if not
Resident	Dummy variable: "1" if landowner is resident on land "0" if not.

Prior knowledge was rated as a binary variable, 1, if the landowner had prior knowledge about biofuel and 0 if not. Resident was binary; 1 being resident on land and 0 not resident on land. All

other variables were continuous. Variables used in the analysis are presented Table 1. Excel 2010 version was used to organize the data and run the descriptive statistics. SPSS version 27 was used to do the regression analysis.

Results and Discussion

Summary Statistics

The distribution showed that the average land size on woodland was about 248, while the average land sizes under pastureland and cropland were, respectively, 65 and 47 acres. About 22,096 acres were in woodland; 13,310 acres were in Pine; 8,058 acres were in was in Pine/Hardwood mixed; 728 acres had unknown types of trees, and 4,128 acres were non-forested land. Landowners were willing to dedicate at least 17,438 acres to loblolly production; this included all non-forested lands and all land already in loblolly. In addition to the actual acreage of each forest type reported by respondents, the proportion of total land use for each forest type was also assessed (Table 2). Woodland accounted for 76.65% of the total land, while pastureland, other land use, and cropland accounted for 9.43%, 9%, and 4.92%, respectively.

Table 2. Percentage Distribution of Land Use

Variable	Percentage
Woodland	76.65
Pastureland	9.43
Other Land use	9.00
Cropland	4.92

Table 3 shows the means of selected variables. The average bid price that would encourage landowners to produce pine for biofuels was $1,414.90. The average land size was 290 acres. The average number of acres respondents were willing to dedicate was 87 acres. The average number of years respondents had owned land was 28 years. The mean age range of respondents was 40-57. Percentage of income from forestry was scaled from 1-5 where respondents with no income from forestry = 1, with less than 10% = 2, respondents with forestry income > 10% but ≤ 25% = 3, respondents with forestry income > 25% but ≤ 50% = 4, respondents with forestry income > 50% = 5. The average was 1.83 which implies that income from forestry accounts less than 10% for the average respondent. Education was scaled 1-5 where respondents with education level of elementary or less = 1, high school education= 2, < high school education = 3, some college education = 4, college graduate or more = 5. The average for the respondents was 3.15 which implies that the average respondent had some college education.

Table 3. Mean and Standard Deviation of Selected Variables

Variables	Mean	Standard Deviation
Biomass Bid Prices	$1,414.9	$271.2
Land Size	288.9	619.8
Acres to dedicate	86.7	200.7
Number of Years	27.5	15.9
Percentage of Income	1.83	1.23
Education	3.15	1.35

Landowners were asked if they knew about biomass for biofuel before the survey. Their response showed that 49% of landowners had prior knowledge of biomass for biofuel. They were also asked to indicate whether they were resident on their forest lands or not and 35% of landowners were resident on their forestland.

In a choice between 10 reasons why they owned their forestlands, 72% of the respondents indicated investment for profit, 70% each indicated privacy and bequest. Timber production is an investment for profit. Those who own it for privacy reside or use their forestlands as a get-away, and those who indicated bequest attach historical importance to its acquisition and would like to preserve it solely to pass on to their heirs. Figure 1 provides the distribution. Respondents consider scenery, hunting and fishing and timber production to be important, 50% each. There is a clear relationship between hunting and forestry. Some of the land owners are hunters and also rent out their lands for hunting; thus, making their forests an important resource.

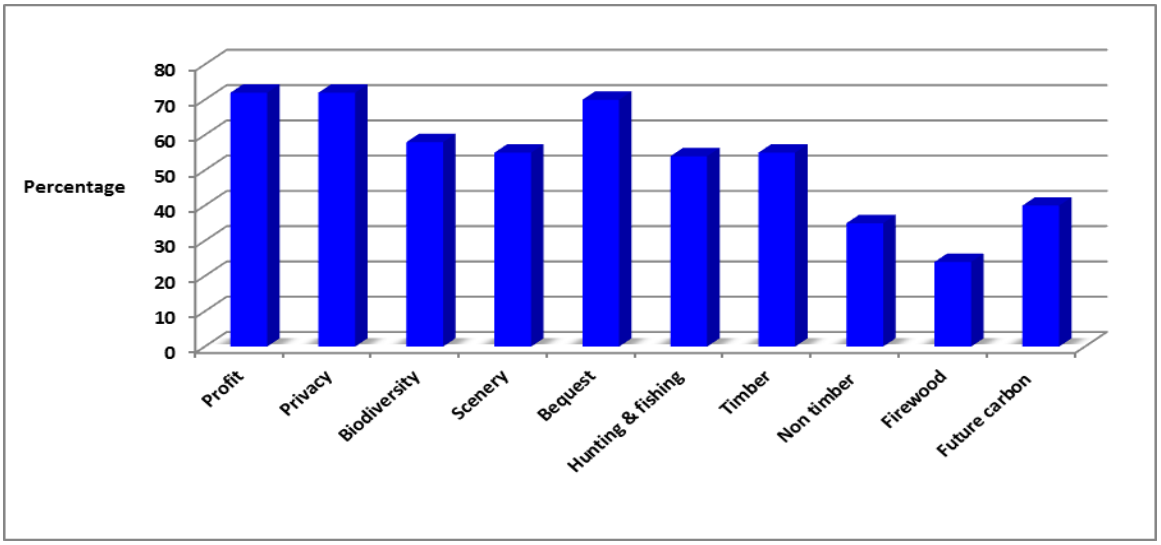

Figure 1. Importance of Landowners' Reasons for Owning their Lands

Figure 2 provides the responses to the question to respondents to indicate the level of importance of four factors, namely, price offered, risk of fire destroying their forest lands, the scenic value of their forest lands, and other factors, to their decision to grow and harvest their forestlands for biofuel production. They chose price offered as the most important factor that influenced their decision to supply biomass for biofuels.

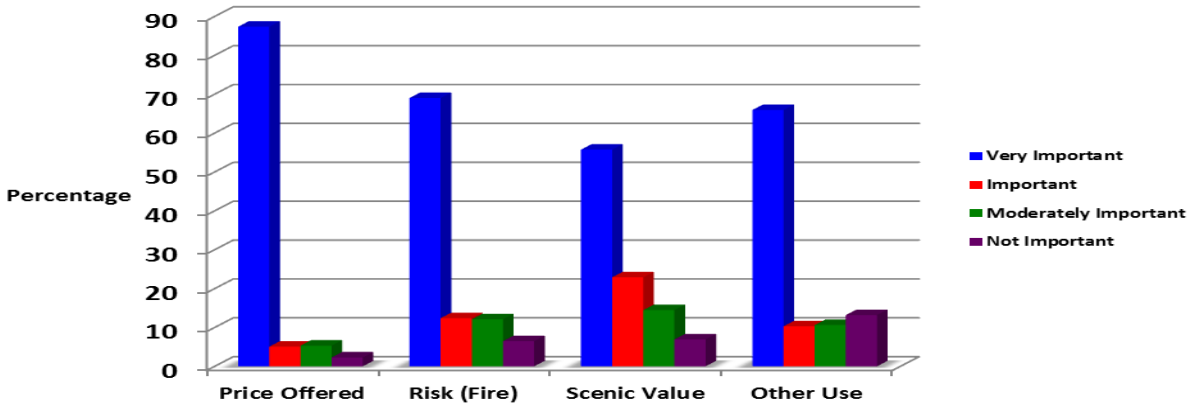

Figure 2. Importance of Factors Influencing Decision to Supply or Not Supply Biomass for Biofuels

Landowners were presented with five statements to understand their opinions on the impacts of harvesting forest biomass for biofuels (Table 4). The statements were: negatively affects wildlife, water and soil quality, timber growth and health, requires higher operation cost, and there is sufficient state guidelines and best management practices for forest biomass production. They were then asked to indicate their degree of agreement or disagreement with the statements. The response was ranked on a Likert Scale of 1–5; 1 being strongly disagree and 5 being strongly agree. A majority indicated that adopting and implementing the existing best management practices would reduce all negative impacts of biomass for biofuel. It also appears that respondents mostly agree that the forest biomass for biofuels require a higher operation cost, and not sure about the effect on wildlife, soil and water quality, and timber health.

Table 4. Landowners' Mean Level of Agreement or Disagreement with Statements Presented to Them

Statement concerning biomass for biofuel	Mean
Existing guideline and best management practices	4.03
Require higher operation cost	3.89
Negatively affects wildlife	3.69
Negatively affects soil and water quality	3.66
Negatively affect timber growth and health	3.49

Figure 3 shows the degree of landowners' agreement with statements pertaining to state and federal price support, transportation support, capital support, and tax incentives. Fifty-eight percent preferred tax incentives; and 54% preferred price support to supply biomass for biofuel industry. However, 46% preferred capital support. More landowners, therefore, prefer government assistance to promote biomass for biofuels production in the form of tax incentives to the government providing price support or providing some form of capital to them. However, only 36% of the respondents found government support in the cost of transportation to be important.

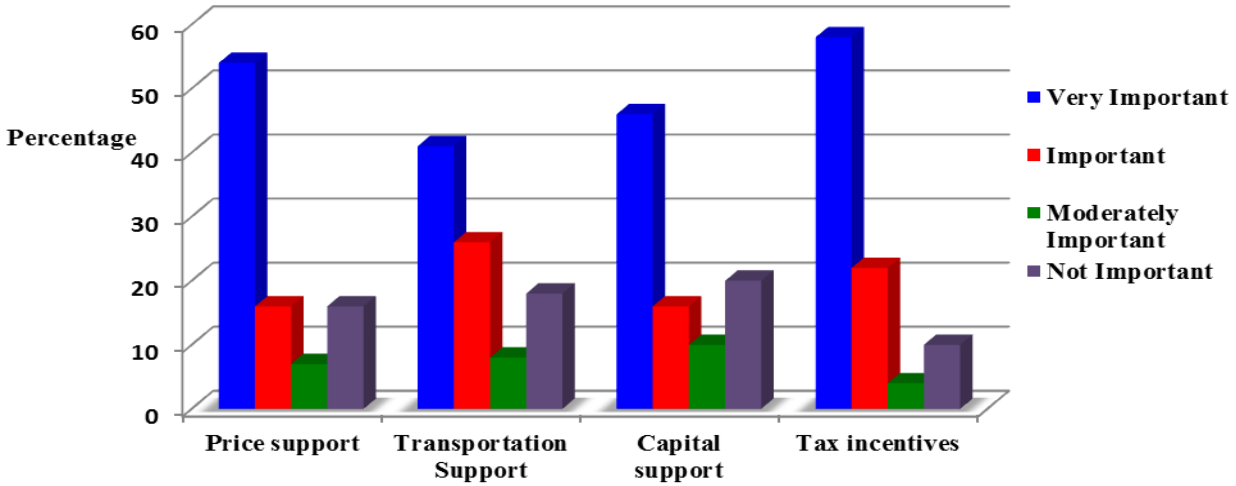

Figure 3. Landowners' Preferences for Various Types of Government Support for Biofuels

This finding confirmed earlier research by Shivan and Mehmood (2010) in Arkansas, Florida and Virginia, which indicated landowners preferred tax support for landowners who desired to go into biomass for biofuel production to other government programs. Regarding landowner previous knowledge about biomass for biofuel, 49% of them had prior knowledge while 51% had no prior knowledge of biomass for biofuel. The 49% of landowners with prior biomass for biofuel finding was higher than the 29% Paula et al. (2009) found out in Lee County, Alabama, the 33% Shaw (2009) found out in North Carolina, and the 43% Joshi and Mehmood (2011) found in Arkansas, Virginia, and Florida. It is, however, less than the 51% Joshi et al. (2013) found in Mississippi.

Regression Results

Table 5 shows the logistic regression result for landowners' willingness to plant loblolly pine. The log-likelihood ratio of 106.69 showed the model was significant at 1% level. The Variables representing landowner economic considerations were biomass bid price and investment for profit. Biomass bid price is the bid price government would offer in support biomass for biofuel production while investment profit is the main motive behind landowners' willingness to grow biomass for biofuels production. The socio-demographic variables of importance were education and place of residence to find the probability of their influence on the decision to supply biomass for biofuels. As expected, biomass bid price and investment for profit had positive signs and statistically significant at 1%. This implies that the probability of the decision to convert non-forested land to the production of loblolly pine for biofuels is influenced by higher price and consequently profit. It means a larger number of forestland owners would grow and harvest biomass for biofuels on their forest lands if the prices are high enough to make a profit. The odds ratio is slightly higher for investment for profit compared to bid price, implying that profit from biofuels has to be comparable to other alternative use of forest biomass otherwise landowners will let the land lie fallow. Prior knowledge about wood-based biofuels had a positive sign but not statistically significant. The sign indicates that the probability that a landowner will use nonforested land for the production of loblolly pine increases with prior knowledge about woody biomass based biofuels.

Table 5. Landowners' Willingness to Plant Loblolly Pine on their Non-Forested Land

Variables	Coefficient	Odd Ratio
Bid price	0.002***	1.002
Investment Profit	0.562***	1.754
Prior Knowledge	0.20	1.021
Age	-0.91	0.913
Education	-0.539***	0.589
Resident	-1.008*	0.365
Constant	0.459	0.247
Log Likelihood	106.689***	

***Significant at 1%; *Significant at 10%

That knowledge was not significant can be explained by the fact that only 49% of the respondents had prior knowledge about wood-based biofuels and biofuels in general. Age, education, and resident had negative signs indicating that these variables had negative impacts on the decision-making. Education and resident are significant at 1% and 10% level which implied that the probability that a landowner will decide to grow loblolly pine declines with the increase in education, and also if the respondent resides on the property. The more educated landowners, therefore, are less willing to grow loblolly for biofuel. It may be that educated people are more suspicious about the benefit from the new venture. For the resident, it might be that respondents that reside on their forest lands are engaged in livestock production and need pasture and cropland as sources of animal feed.

The results are consistent with Kantavichai et al. (2012) who found that $10.50 per ton or higher biomass stumpage price would induce short rotation loblolly plantation in Piedmont Alabama. Also, Shivan et al. (2012) who found that a decent market price for woody biomass was a motivating factor for Arkansas, Virginia, and Florida landowners to enter woody biomass supply chain. It also confirmed Paula et al. (2009) research finding, which indicated that price was the critical factor in Lee County, Alabama family landowners' decision to supply biomass for biofuel. Halder et al. (2014) reported that Croatian and Serbian forest land owners were highly interested in producing short rotation biofuel trees over timber production for higher prices in their respective countries. The low odd ratio of the variable bid price is also confirmed by Markowski-Lindsay et al. (2012) that forest owner participation in biomass harvesting in Massachusetts was not greatly influenced by a change in price (i.e., price per acre); the price elasticity of supply was inelastic at 0.4, meaning that a 1% increase in price leads to a 0.4% increase in landowner participation. Consistent with Caldas et al. (2014) and Skevas et al. (2014), this research found farmers or landowners who aimed to maximize profit were more willing to plant biofuel crop. A study by Halder et al. (2014) also found out that among the NIPFs with only a school level education were more willing to plant short rotation trees for energy wood production than those with a higher level of education which is consistent with the result of this study. Gruchy et al. (2012) also found that education was negative and had an odds ratio of 0.98 at 1% confidence level.

Government Support

Table 6 presents the logistic regression result on the factors that influence landowners' perceptions of tax incentives and price support. The variables in the models over 80% of the time correctly explained landowners preferred tax incentives and price support as government

programs for biomass for biofuel farmers. For the tax incentive model, the log-likelihood ratio of 85.54 showed the model was significant at 1% level. The number of years of ownership and age were significant at the 5% level. Number of years was positive implying that the longer the landowner had the land the higher the probability that he or she will be interested in tax incentive. The negative sign associated with age implies that younger forest landowners would be more interested in tax incentive in order to participate in the production of biomass for biofuel than older landowners. The findings confirm Shivan and Mehmood (2010) findings that Arkansas, Virginia, and Florida landowners have a favorable view of tax incentives as the best support for the biofuel industry. The finding also conforms to economic theory Besanko et al. (2011) that tax incentives offer the best form of government intervention compared to price ceilings, production quotas, acreage limitations, or government purchase programs. Consequently, any government that wants to correct imperfections in the economy should use the most efficient means to allocate scarce resources and offer the best welfare benefits to society as a whole.

The same variables used in the tax incentive model were used in the estimation of the price support model. Similar to the tax incentive model, the result showed that the log-likelihood ratio was statistically significant at the 1% level. However, the price support model had a higher log-likelihood ratio of 88.1 compared to 85.5 in the tax incentive model. The higher value is an indicator of the probability that the same set of parameters have a higher effect in the price support model. Age was the only variable that was significant, at the 5% level, in the price support model. It had a negative sign which shows that the probability that a landowner would be interested in price support reduces with the increase in age. The age variable in tax incentive model was also significant at the 5% level and had a negative sign. This showed that the probability that younger forest landowners will be interested in this incentive was higher than the older forest landowners. Similarly, the number of years of ownership in the tax incentive model was statistically significant at the 5% level. Number of years was positive implying that the longer the landowner had owned the land the higher the probability that he or she will be interested in tax incentive. The two models were compared to identify the most probable government support that would attract the forest landowners to participate in the production of biomass for biofuel production. The comparison suggested that the probability that price support will be more attractive for potential suppliers is higher than tax incentive.

Table 6. Factors that Influenced Landowners' Perception of Tax Incentives

Factors	Tax Incentive (Dependent)		Price Support (Dependent)	
	Coefficient	Odds Ratio	Coefficient	Odds Ratio
Land size	0.001	1.001	0.001	1.001
Number of Years Owned	0.050**	1.051	0.023	1.023
Age	-1.838**	0.159	-1.887**	0.152
Education	-0.218	0.804	-0.23	0.795
Percentage of Income	-0.316	0.729	0.961	1.063
Resident	0.004	0.996	-0.118	0.888
Constant	4.295		4.435	
Log likelihood	85.538***		88.108***	

***Significant at 1%; **Significant at 5%

Conclusion

The main objective of this study was to examine landowners' willingness to supply woody biomass for biofuel in West Alabama. The specific objectives were to assess landowners' opinions of different government support programs for biofuel; assess factors that affect willingness to plant loblolly, and assess factors that affect perceptions of tax incentives and price support. Descriptive statistics indicated that woodland accounted for 76 % of the total land, while pastureland, other land use, and cropland accounted for 9.43%, 9%, and 4.92%, respectively. The average respondents earn 10% of their income from forestry production. The average respondent was relatively younger between the ages of 40-57 years with some college education. The response also showed that about 49% of landowners had prior knowledge of biomass for biofuel and 35% of landowners were resident on their forest land. About 70-72 % of the respondents indicated that privacy and bequest, and investment on produce timber for profit were the reasons why they owned forestlands. A majority chose price offered as the most important factor that influenced their decision to supply biomass for biofuels, and also indicated that adopting and implementing the existing best management practices would reduce all negative impacts of biomass for biofuel. It also appeared that most respondents preferred tax incentives and price support to supply biomass for biofuel industry.

The regression results indicated that the bid prices for the woody biomass and investment for profit were positive and statistically significant implying that the probability that forestland owners would supply biomass for biofuels was associated with the price they would get for their woody biomass. Since the main feedstock suppliers are the forest landowners, it is fair to say that the success of the future biofuel industry could depend on providing a competitive price for woody biomass. Also, a comparison of the tax incentive and price support regression models showed that the probability that the forest landowners will supply woody biomass is higher with price support than tax incentive program. The choices of price support over tax incentive could be based on their past experience and suggest further study on the topic. The result also indicated that the younger landowners residing on the land would probably be the age group that will be involved in the supply chain for the biofuel production.

The research indicated two major factors that could affect forest landowners' willingness to supply woody biomass or be part of the supplier of the future U.S. biofuels industry. One factor which directly points at the biofuel industry is a competitive and guaranteed price to the woody biomass suppliers that gives some level of certainty. The second factor is a government price support program, which could play an important role in involving forest landowners in the supply chain of biofuel production, and at the same time, ensure a sustainable woody biomass supply for biofuel in the future. The findings of this research are limited by the assumptions made and the data used; however, they indicate the need for further detailed research on price, price support, and tax incentives.

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