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Assessment of non-industrial private forest landowner willingness to harvest woody biomass in support of bioenergy production in Mississippi

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ASSESSMENT OF NON-INDUSTRIAL PRIVATE FOREST LANDOWNER WILLINGNESS TO HARVEST WOODY BIOMASS IN SUPPORT OF BIOENERGY PRODUCTION IN MISSISSIPPI

By

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ASSESSMENT OF NON-INDUSTRIAL PRIVATE FOREST LANDOWNER

WILLINGNESS TO HARVEST WOODY BIOMASS IN SUPPORT OF

BIOENERGY PRODUCTION IN MISSISSIPPI

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Harvesting woody biomass for biofuel has become an important research topic. In Mississippi, feasibility of utilizing woody biomass for bioenergy lies in the willingness to harvest by non-industrial private forest (NIPF) landowners, who control 71% of forestlands. A mail survey of Mississippi NIPF landowners elicited preferences concerning utilizing logging residues for bioenergy. When presented with hypothetical situations that compared bioenergy utilization attributes along with those of standard harvesting practices, more landowners preferred the bioenergy scenarios, even when more money was offered for standard harvesting. Older landowners with larger landholdings were less likely to prefer bioenergy scenarios. Higher educated landowners who were financially motivated, concerned with climate change, and considered habitat management an important goal were more likely to prefer bioenergy scenarios over standard harvesting. Available markets for logging residues could increase NIPF harvest rates based solely on the different harvesting attributes, which should increase availability of feedstocks for producers.

DEDICATION

I would like to dedicate this thesis to my wonderful wife, Benita. She graciously encouraged me and patiently tolerated me throughout its entirety.

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CHAPTER I

INTRODUCTION

Now, more than ever, the United States is looking for ways to diversify energy sources. The limited availability and sustainability of fossil fuels has become readily apparent to the general public, along with the need for more environmentally friendly energy production. There is also the issue of fluctuating oil prices and our dependence on importing energy to sustain consumption. The United States began importing several energy sources in the late 1950's to keep up with domestic production. By 2008, the United States import about 57% of all petroleum consumed (EIA 2009b). The United States is the third largest oil producing country and the largest consumer. It consumed 23% of the world's petroleum in 2008, while producing only 10%. In the same year, there was approximately 5,814 million metric tons of carbon dioxide emitted from energy-related sources in the United States (EIA 2009a). The price volatility for crude oil ranged from $52 - $95 per barrel in 2009, and $60 - $98 per barrel in 2010 (EIA 2010). These issues of energy dependence, environmental damage, and economic instability have led to an urgently increasing amount of research in the development of alternative energy sources.

To reduce the dependency on non-renewable oil based energy, a viable alternative fuel must be used that is both renewable and sustainable (Coleman and Stanturf 2006). One of the most promising options to mitigate these problems in the United States is the use of bioenergy (Guo et al. 2007). Many forms of bioenergy can be produced domestically and sustainably in the United States, which makes them more promising as an alternative energy source. Some of these include wind, water, and other naturally occurring sources. An important form of bioenergy is biofuel. This typically refers to a liquid fuel, which is created from plants and woody materials. There are several biofuel production facilities in place that are currently producing grain alcohol and other transportation fuels from agricultural feedstocks. Unfortunately, using these food-based biofuels on a scale large enough to meet a significant amount of the United States energy needs could threaten food security and require significant land use changes (Hill et al. 2006). Providing inexpensive feedstock resources is an important factor in the feasibility of biofuel production (Solomon et al. 2007). Bioenergy and biofuels produced from woody biomass are particularly attractive due to a wide resource base, low production costs, and high energy yield (Grebner et al. 2009a). This form of biomass typically comes from woody plant materials that could not be used for other merchantable products, such as lumber or pulpwood. The most commonly used woody biomass feedstocks generally consist of non-valuable tree-tops and branches, small diameter trees, urban wastes, and mill residues (Perlack et al. 2005). However, larger feedstocks could be converted into bioenergy if dictated by the markets. The biomass can be transferred into energy in the forms of electricity, liquid fuels and, of course, heat. Several of these energy forms can directly replace or supplement fossil fuels to significantly reduce their overall use in electricity and liquid transportation fuels (Demirbas 2003, Gan and Smith 2006, and Solomon et al. 2007). This form of bioenergy could be managed sustainably judging from the Perlack et al. (2005) study which estimates that 368 million dry tons of non-timber woody biomass could be harvested annually on a sustainable basis in the United States. Their estimates suggest that up to one-third of the fossil-fuel based transportation fuels used in the United States each year could be replaced. Other advantages from utilizing woody biomass for bioenergy include improving forest health by reducing competition, reducing forest fire hazard, and generating additional revenue from forest wastes (Polagye et al. 2007, Solomon et al. 2007).

The United States' forest land is one of its most valuable resources, covering approximately one-third of its total land area (Smith et al. 2004). The southern United States contains 29% of the total forested area, and these are some of the most productive forest lands in the country. This makes the south an attractive location to obtain woody biomass for bioenergy feedstocks. The state of Mississippi, with approximately 20 million forested acres, holds particularly high potential for successful production of biofuels from woody biomass and wood wastes (Perez-Verdin et al. 2008). Research shows that forest residues, small diameter trees, urban wastes, and mill residues could provide enough biomass to produce 318 million gallons of biofuel on an annual basis. This could support up to five biofuel production facilities within the state, if all resources were used to their full potential (Grebner et al. 2009b). There is even research indicating the best locations, within Mississippi, to locate a bioenergy production facility based on forest inventory and geo-spatial variables (Jones et al. 2007). There is no question about the existence of a huge amount of potential bioenergy feedstocks in southern forests; the only question is whether these feedstocks will be available to bioenergy producers to harvest.

In the southern United States, about 71% of forest lands are owned by non-industrial private forest (NIPF) landowners (Smith et al. 2004). This is an important factor to consider when predicting the success of production facilities, because the vast majority of woody biomass feedstocks are under NIPF landowner control. Private landowner decisions are based on satisfying personal utility, and without a well-defined biomass market, it is very difficult to predict the amount of feedstocks that will be readily available from the significant majority of forest land holdings. This may depend on the benefits NIPF landowners receive from harvesting their biomass, and whether landowners consider it beneficial to provide these feedstocks. Some of the benefits of utilizing woody biomass may include improving forest health, reducing fire and pest risk, and helping the environment (Foster 2005). Other research has shown that economic return is often less important than other objectives when landowners are considering whether or not to harvest their timber (Amacher et al. 2003). NIPF landowners often manage their land for recreation, non-timber amenities, or bequest values. There are many things that can provide a standing forest with value besides the money received from harvesting the timber (Hartman 1976). A landowner must weigh and balance these options when making the decision to harvest. By introducing a woody biomass market, new options could be introduced to the landowner that could influence the harvesting decision. These options could include a difference in harvesting methods, silvicultural practices, and environmental effects that may be important to the landowner. Their perceptions of these attributes are very significant in determining the viability of a biomass market. Therefore, this study seeks to understand NIPF landowner attitudes towards utilizing woody biomass to produce bioenergy and whether these changes will influence the harvesting decision.

Objectives

1 – Determine how the utilization of logging residuals to produce bioenergy will influence NIPF landowners' harvesting decision in Mississippi.

2 – Determine NIPF landowner preferences concerning the utilization of logging residuals when compared to standard clearcutting in Mississippi.

Potential Benefits

This research will be useful for estimating how much woody biomass will actually be available for utilization as biofuel. There have been ample studies to prove that abundant feedstocks exist for producing a significant amount of biofuel in Mississippi. The weakness in the research lies in knowing whether those feedstocks will actually be available for use. By determining the effects these harvesting changes might have on NIPF landowners and their harvesting decision, one could more realistically estimate the amount of usable woody biomass feedstocks. The more accurate estimates could make market-entry by prospective bioenergy production facilities less risky. It could also be used by policy-makers interested in developing programs to increase bioenergy development.

CHAPTER II

LITERATURE REVIEW

Energy Consumption and Projections in the United States

The United States consumed about 100 quadrillion British Thermal Units (Btu) of energy in 2008. This is approximately a 20% increase since 1980 (EIA 2009), and it is expected to increase consumption to around 114 quadrillion Btu by 2035. Most of this energy comes from fossil fuels such as petroleum, natural gas, and coal. These fuels accounted for 84% of total consumption in 2008. This is expected to decrease to 78% in 2035, being accounted for by an increase in renewable energy consumption from 8% to 14% over the same time period (EIA, 2010). This is also projected to decrease our energy import percentage from 30% of total consumption, in 2006, to 26% in 2030 (EIA, 2009). Carbon dioxide emissions are only expected to increase by 0.3% per year from 2008 to 2035, compared to 0.8% per year from 1980 to 2008 (EIA, 2010). Most of these projections are based on research that involves an increase in the use of sustainable and renewable energies. They are subject to a high degree of variability depending on the implementation of these proposed energy plans. This trend toward increasing renewable energy use has led to further surges of research and interest in the use of bioenergy and biofuels to replace at least a small portion of non-renewable fossil fuel use.

Biomass, Bioenergy, and Biofuels

The U.S. Department of Energy (USDOE, 2010) defines biomass as any plant derived organic matter that is available on a renewable basis. This includes a variety of waste products as well as agricultural crops and trees. The term bioenergy envelopes all forms of energy that are produced from these renewable resources. They produce liquid, solid, and gaseous fuels, which can be used in a variety of energy forms such as, electricity, heat, and chemical forms of energy (USDOE, 2010). Bioenergy has become a well-substantiated hope to reduce and replace some of the unsustainable fossil fuel usage in the United States. There are several biofuel production facilities currently operating, but the growing need for sustainable energy would require a considerable increase in production to achieve certain energy goals (Hill et al. 2006). The biofuel feedstocks most commonly used today come from food and grain crops that are efficient and easily obtainable. Some consider this impractical, in the sense that providing a significant amount of energy from these feedstocks would displace important food sources (Hill et al. 2006). The United States is fortunate to have an abundance of natural resources at its disposal for use as bioenergy feedstocks. The Southern United States is one of the most productive areas due to its climate and large amount of undeveloped land available for growing potential biomass feedstocks.

Biomass Feedstocks in the Southern US and Mississippi

The southern U.S. occupies 214 million acres of forest area and the majority of timberlands in the country (Smith et al. 2004). According to Foster et al. (2005), approximately 55 million tons of woody biomass is potentially available annually for the production of bioenergy and other bio-based products from the southern forests. Primary sources of woody biomass include logging and mill residues, small diameter trees, trees that are damaged by disturbance events such as wildfires, insects, and disease outbreaks, and short rotation woody crops (Perlack et al. 2005). A study conducted by Haynes

(2003) has shown that South-wide softwood and hardwood growth exceeds removals, indicating that more wood can be sustainably harvested from these forests. Grebner et al. (2009b) estimates that these resources could provide enough biomass to produce 318 million gallons of biofuel annually just within the state of Mississippi. This could sustain five biofuel production facilities within the state. Creating cellulosic ethanol production facilities could improve local economies by creating new jobs and reducing dependency on imported foreign oil. There is estimated potential for the economy to grow by nearly $3 billion from biofuel production within 20 years. All these facts indicate the promising availability of woody biomass for bioenergy production in the southern forests.

Factors Influencing the Harvest Decision of NIPF Landowners

Harvest strategies and landowner willingness to harvest could have significant implications when determining the feasibility of a biofuel production facility that is dependent on woody biomass supplies (Prestemon and Wear 2000). In 2005, Mississippi had 1.05 billion cubic feet of total roundwood output (Bentley et al. 2005). Nonindustrial private landowners were responsible for 76% of this total. Determining NIPF landowner preferences and their effects on harvesting decisions has been a topic of intense research for many years. If changes from typical harvesting practices could take place, such as the removal of logging residuals and non-merchantable stems during a timber harvest, it could significantly influence landowner decisions. There are also several attributes that can accompany this waste-wood utilization that could have positive or negative influence. The effects of these attributes are important in determining the attainability of biomass feedstocks, and the viability of establishing bioenergy production facilities.

Amacher et al. (2003) reviewed recent studies and discussed the econometric analysis of private landowner decisions. They describe common significant variables that influence harvest decisions including technical assistance and the size of the land holding. The authors state that most landowner activities are related to prices, costs, interest rates, physical land characteristics, demographics and preferences. This would be the most important information to gather when surveying landowners in an attempt to predict harvesting decisions. Conway (2002) suggested that preferences of amenities from forestlands are also significant factors considered by landowners when entering into a timber market. She also mentions that landowner preferences and willingness to harvest are very important for predicting future land use patterns. Beach et al. (2005) reviewed econometric studies on private landowners to form a consensus of attributing factors on landowners' decisions. They determined several market drivers, policy variables, landowner characteristics, and resource conditions that were consistent with previous findings.

Dennis (1989) performed an economic analysis of harvesting behavior for private landowners. Private landowners were sent a questionnaire to gather data that might indicate a landowner's willingness to harvest. A harvest behavior model was created to illustrate the landowner's problem of "maximizing utility from the consumption of non-timber or forest-related amenity values and from the generalized purchasing power of income." Some of the descriptive variables Dennis (1989) used to estimate timber supply included timber volume, ratio of oak to white pine, current price of sawlogs, landowner education, landowner income, and landowner occupation. Adapting a generalized presentation of the Tobit model, Dennis (1989) established a model to analyze his censored samples. Tobit analysis results showed a positive correlation between landowners' level of income and timber harvesting. Stumpage prices also showed a positive relationship, but the results were not significant at the 10% level. There was a negative correlation between years of formal education and timber harvesting. These data were used to anticipate timber supply to the market. The results demonstrated that the primary factor affecting timber supply was the total number of acres that were offered for timber sales, rather than harvesting intensity on a per acre bases.

Kuuluvainen et al. (1996) derived a theoretical timber supply function based on landowner objectives in Finland. This study classified private forest landowners into four groups based on survey data: multi-objective owners, self-employed owners, recreationists, and investors. Multi-objective owners harvested a significantly higher amount of volume per year. Landowner objectives and attitudes had a significant role in timber harvest rates. The theoretical framework assumes that the landowner is maximizing his discounted utility in present and future periods. Utility is determined here as a function of consumption of goods and services and the stock of standing timber postharvest, which represents non-timber amenities. Timber sales income depends on harvest rates and timber prices. Exogenous non-forestry income is held as a separate variable. Kuuluvainen et al. (1996) then uses comparative statistics to produce a timber supply function.

Kuuluvainen et al. (1996) also performed an econometric analysis of factors affecting timber supply using a Tobit model with harvest intensity as the dependent variable. Some of the independent variables were timber price, timber volume, first difference in regional price, 5-year growth, landowner income, landowner age, and whether the landowner was a multi-objective owner, self-employed owner, investor, or recreationist. Landowners with multiple objectives harvested more timber on average, and that there was little difference among the 'single objective landowners' (self-employed, investors, and recreationists). These results can be used to evaluate long-term timber supply trends based on private landowner objectives.

Max and Lehman (1986) developed a dynamic behavioral model of timber supply with emphasis towards private forest ownership. Their results were dependent on landowner utility functions and the functions comparing standing timber harvesting to non-income forest outputs. They addressed the issue where non-industrial private forest landowners are often considered to under-produce, possibly due to mismanagement or under investing, or whether they are acting rationally based on different utilizations of forestland use. Their behavioral optimal harvest policy model was one of the first to adopt the idea that landowners have other goals besides maximizing profit. Their results showed that recreation had a strong influence on forest landowner decisions.

Hyberg and Holthausen (1989) also modeled private landowner decisions based on utility maximization with the realization that some landowners also seek non-monetary returns on their investments. Their model differs from Max and Lehman (1988), by including a production function that allows the inclusion of the reforestation decision. Max and Lehman (1988) assumed a growth function based on previous timber stock. Hyberg and Holthausen (1989) "explicitly modeled the harvest timing decision and the reforestation investment decision in a multi-period, utility maximizing framework." They also note a difference between utility maximizers and profit maximizers in that "utility maximizers harvest less often and invest more heavily in reforestation than profit maximizers (Hyberg and Holthausen 1989)." They realize the effect that public policy can have on landowner behavior. They state that public policies and incentives, which are meant to increase timber supply, are based on the idea that landowners are "profit maximizers." These policies will have much smaller impact than expected on landowners who are "utility maximizers" (Hyberg and Holthausen, 1989). Their results show that utility maximizers grow their timber longer and invest more in reforestation due to the consumption of nonmarket amenities from timberlands. Their utility maximization formula also explained some socioeconomic trends related to forest management, such as increasing capital investment with increasing wealth and ambiguous stumpage price effects, which had not previously been addressed adequately.

Pattanayak et al. (2002) used a model to account for non-timber amenities associated with joint forest production. They claim that previous models do not account for non-market forest amenities. Pattanayak et al. (2002) claims that optimal harvest age simulation and timber supply micro-econometrics are the two major categories of timber supply modeling. To create a model that accounts for all socially valuable goods produced within forests, they attempted to blend utility maximizing theory with previous timber supply models to create a conceptual timber supply model with endogenous distribution of forest capital. Their model called for an optimal rotation age determined by price of timber and capital, growth function parameters, land quality, landowner characteristics, and exogenous income from non-timber sources. They used a three-stage least squares system to account for endogenous (timber supply and forest inventory) and exogenous variables (prices and preferences). The models showed that "timber supply is a function of an endogenous distribution of forest inventory that is correlated to forest ownership and management characteristics." They believe that such an integral model that includes utility optimization for timber and non-timber amenities will significantly improve forecasting models and related forest policy implementations (Pattanayak et al. 2002).

Gong (2007) considered the implications of the reservation price strategy for making harvesting decisions. This strategy involves landowners holding out for a sufficiently high stumpage price before performing a harvest. This can have significant effects on the supply to the timber industry and consumers. It reduces supply when prices are low, which tends to increase price level. The reservation price strategy was compared to the Faustmann Rule, which assumes a constant level of harvest without regard to timber prices. The reservation price strategy tends to increase profits from timber harvesting while also decreasing the surplus of wood supply. The study found that improving harvest strategy based on price expectations is restricted because prices would reflect the changes in harvest behavior.

Historically, forest landowners were thought of simply as profit maximizers. This indicates that, when an acceptable price is obtainable, a forest landowner should choose to harvest. This is still somewhat viable in today's timber market; however, other studies have shown that the value of a standing forest can potentially provide more utility to a landowner than harvesting (Amacher et al. 2003, Kuuluvainen et al. 1996, Dennis 1989, Hartman 1976, Hyberg and Holthausen 1989). More recently, forest landowners have gained a reputation as utility maximizers. This utility comes, not only in monetary form, but also from forest recreation, wildlife viewing and hunting, bequest values, environmental benefits, and countless other benefits associated with forest land ownership. This theory is based on the premise that a landowner's decision will be based on maximizing his/her own utility from the forest, whether that comes from harvesting for profit or leaving the stand to grow (Hartman 1976). It is important to learn how landowners derive this utility in order to determining their likeliness of harvesting timber.

A common method for eliciting this information involves the use of conjoint analysis to compare attributes associated with timber harvesting and determine the influence these attributes will have on the landowners' decision (Alriksson and Oberg, 2008, Boyle et al. 2001, Stevens et al. 2000).

Conjoint Analysis

Conjoint analysis is a research technique used to determine a respondent's preference structure. This is normally directed towards researching new products or multiple attribute service designs (Zinkhan et al. 1997). Respondents are usually presented with a number of hypothetical alternatives with different combinations of attributes. They are asked to jointly consider all the characteristics of a given situation and select their preferred alternative. The buyers evaluate on the level of the full hypothetical alternatives and the utility of each attribute is then determined through decomposition. Conjoint analysis is also very useful for determining non-use values such as aesthetics, biodiversity, and conservation, which makes it very useful in the natural resources field (Alriksson and Oberg 2008, and Stevens et al. 2000). Choice modeling is one of several conjoint analysis methods used to evaluate the preferences of individuals. There are also several variations within choice modeling. These include choice experiments, contingent rating, contingent ranking, and paired comparisons. Respondents are offered several hypothetical alternatives, of which they are to choose their favorite option. A status quo alternative is included as the control. This is based on the idea that respondents will inherently prefer the option that is most likely to maximize random utility. The contingent rating and contingent ranking methods are similar, except the respondents are asked to rank the set of attributes, or rate them, in order of preference rather than just choosing one option. The paired comparison combines the choice experiment and the contingent rating methods. The choice experiment method is considered, by many, to give the most accurate estimates of welfare or utility change (Boyle et al. 2001, Hanley et al. 2001, and Mackenzie 1993).

Horne (2006) uses a choice modeling approach to assess private forest landowners' acceptance of incentive based policy instruments in forest biodiversity conservation. The purpose was to find the level of incentives necessary to increase conservation of biodiversity on private forestlands. The choice experiment was based on five attributes that would affect the landowner's decision to enter into a conservation contract: The initiator of the contract (forest owner himself; forestry organization; environmental organization; conservation trust), restrictions on forest use (small patches of forest protected, nature management plan; no silvicultural practices allowed; strict nature reserve), compensation per hectare per year (0 Euros; 70 Euros; 140 Euros; 210 Euros; 280 Euros; 350 Euros), duration of contract (5 years; 10 years; 30 years; 100 years), and cancellation policy (Forest owner can cancel; new owner can cancel; binds new owner also). The data was analyzed using multinomial logit models. The status quo option was assigned the alternative specific constant. This option was positive and statistically significant which showed a strong preference for less conservation. The compensation parameter was also positive, and showed that the higher compensations led to higher probabilities of choosing that option. The 'small patches for conservation' option was preferred for the land use restriction parameter. Short contracts were preferred over long ones, and the flexible cancellation policy, in which the landowner can cancel the contract at will, was preferred.

Bergmann et al. (2006) used choice modeling to value the attributes of renewable energy investments in Scotland. They attempt to estimate the effects of the external costs and benefits from increased investments in renewable energy. Bergmann et al. (2004) stated that choice experiment attributes should be relevant to the problem, credible and realistic, easy to understand by the respondents, and they should apply to policy analysis. The attributes chosen for their model were landscape impact, wildlife impact, air quality, number of jobs created, and price of electricity. The survey data was analyzed using a multinomial logit model. Results showed a high sensitivity to landscape and wildlife impact, where options that had detrimental impact on these subjects were not preferred. One of their renewable energy investments of growing willow as biomass would increase wildlife quality, and therefore be preferred. However, sensitivity to air quality would negate this, as the biomass would have to be burned to create energy and have an unfavorable effect on air quality. They also found that job creation was statistically significant in their rural samples, and that people were willing to pay an additional £1.08 per year for each addition of one new job.

Zinkhan et al. (1997) considered the use of conjoint analysis to evaluate forest management decisions. They mention that this technique could be useful in situations where competing management plans with multiple attributes are being evaluated by one or more owners, or when utility levels of one or more nonmarket benefits needs to be estimated for marketing applications. Timber income and aesthetic value were used as example attributes. They said that foresters would be required to at least accomplish an assessment of the forest owners’ utility function concerning a set of attributes, and evaluate each of the management alternatives in relation to that set of attributes.

Inherently, the preferred plan would maximize the forest owner's potential utility (Zinkhan et al. 1997).

Hussain et al. (in press) used a conjoint analysis to evaluate hunters' preferences towards hunting lease attributes in Mississippi (Hussain et al. in press). Hunters were surveyed and asked to select their most preferred lease option from a number of scenarios with different combinations of lease attributes. The lease attributes in question included different game species, distance of the lease from residence, accessibility, lease size, duration of lease, and the cost per acre for the lease. There were 50 hunting lease alternatives derived from the six attributes, which were rated on three levels each. These alternatives were presented to the respondent in five choice scenarios where the respondent was asked to choose the preferred option between two lease alternatives or a status quo option. The study was based on the premise of random utility theory, such that hunters would choose their preferred options that should provide them the greatest utility from the lease. This is important for letting landowners know how they can earn the greatest profit by altering their lands to provide the greatest utility to leasers and receive the maximum amount that hunters are willing to pay. The utility index was based on a combination of observed attribute choices and the individuals' unobservable preferences. The choice model was analyzed using a conditional logit model. They were then able to calculate the hunters' willingness to pay for additional units of specific attributes. All the included attributes were shown to have significant influence on preferences. Their general findings were that hunters were willing to pay more for leases that had greater species diversity, closer distance to residence, easily accessible, larger acreages, and longer lease durations. The specific amount hunters would be willing to pay for additional units of attributes was also included in the study (Hussain et al. in press). This study also uses odds ratios to show the strength of the effects from each variable. The odds ratio is based on marginal effects and provides the percent change that each variable influences the dependent variable. For example, the odds ratio of 0.98 for the distance from residence of 60 miles indicates this makes landowners 2% less likely to prefer this option. The odds ratio of 0.56 for a 90 mile distance indicates this variable makes landowners 44% less likely to prefer this option. The percent change is calculated by subtracting one from the odds ratio, which is the exponential of the estimated parameter, and multiplying by 100. The odds ratios are very useful for interpreting marginal effects when using logistic regression.

Munn et al. (2007) uses a mail survey to analyze private landowners' demands for wildlife and forest management information. They created an ordered response variable ranking landowners' need of information from 0 (no need) to 4 (very high need). The need of information was based on the importance and the availability of the information. Their responses had a skewed distribution, so the ordered complementary log-log for ordinal response variables was employed to determine the significance of other descriptive variables. They found that the location and land use patterns of their land, as well as several demographic variables like age, income, and gender, to have strong influence on landowners; demands for information. They also used odds ratios to present the strength of influence these variables had on the predicted responses.

Thesis research by Dickenson (2010) uses the ordered logit model to estimate probabilities that landowners would participate in various forest management programs involving carbon sequestration. A mail survey requested landowners to rate, on a scale of 1-10, their certainty of enrolling in various programs. After fully examining common methods of analyzing the choice models, the author concludes that the ordinal logit model is most suitable due to the inherently ordered nature of the outcomes (Borooah 2001). Dickenson (2010) also outlines the interpretation of the ordered logit model for analyzing ratings data. The first step involves looking at the effects of the odds ratio, which shows the effect that a one unit change in the independent variable has on respondents choosing one particular rating over the others. The next step is finding the probabilities of each rating outcome for the dependent variable with the independent variables set at their means. The study found that older, less-educated males, who owned less than 100 acres, were less likely to participate in improved forest management programs. Programs that required a management plan, long-term commitments, and provided low revenue streams decreased participation in all landowners.

CHAPTER III

METHODS

Background

Woody biomass is an excellent source for bioenergy feedstocks due to its large resource base, low production cost, and high energy content (Grebner 2009b). The utilization of wood wastes leftover from logging operations to produce bioenergy can also provide additional benefits by improving forest health by reducing competition, reducing forest fire hazard, leaving a cleaner harvest site, and possibly generating additional revenue (Polagye et al. 2007, Solomon et al. 2007). The southern United States has the potential to sustainably provide 55 million tons of woody biomass each year for use in bioenergy production (Foster et al. 2005). The state of Mississippi alone could provide enough wood wastes to produce 318 million gallons of biofuel on an annual basis (Grebner et al. 2009b).

One of the issues at hand is the actual attainability of these woody biomass feedstocks. Non-industrial private forest (NIPF) landowners own approximately 71% of all forested land in the South (Smith et al. 2004). Therefore, the supply of woody biomass to bioenergy production facilities would be vastly dependent on NIPF landowner decisions. It is very important to determine how NIPF landowners will react to the implementation of woody biomass harvesting for bioenergy production in order to properly gauge feedstock availability.

Determining NIPF Landowner Preferences

This study focuses on the post-harvest recovery and utilization of logging residuals. Some influential attributes landowners associate with this process include bioenergy production, cleanliness of the harvest site, reducing fire and pest risk, environmental effects on the harvest site, and the dollar value of the logging residues. The removal and utilization of logging residuals to create bioenergy can have an indirect utility to landowners through a 'warm-glow' effect from helping to reduce fossil fuel use and protecting the environment. By removing the logging residues one would produce a cleaner post-harvest site, which could be important to landowners concerned with aesthetics. It can also reduce the need for some site-preparation activities that might have been necessary otherwise and significantly reduce re-planting costs. By removing slash and downed woody-debris, the fuel load that can spread dangerous wildfires is reduced. It also removes an attractive habitat and food source from some wood-boring insects that can damage or kill other trees in the area. Some research also shows that removing these logging residues could reduce soil fertility over time, especially if all woody debris is removed (Perlack et al. 2005). There is also an issue of increased sediment runoff, which can be detrimental to water quality, and soil compaction from using more heavy equipment than normal. Another important attribute is the dollar value of these logging residuals. If, once established, bioenergy production facilities are willing to pay the landowner a considerable amount for the residues; this could significantly influence their harvesting decision. On the other hand, the transportation and processing costs for these products are also not well defined and, hypothetically, could reduce the landowner's income. However, since a market and price for these products isn't well established in Mississippi, it is difficult to foresee the degree of influence this will entail, and different alternatives will be addressed (Perez-Verdin et al. 2007). By using conjoint analysis, we can estimate the influence the individual attributes have on the landowner's harvesting decision.

Survey Design

To reach the desired study population, a random selection of private forest landowners, owning at least 100 acres of forestland, was acquired from a Mississippi timber tax database. The 100 acre limit was imposed to avoid home-sites and small landholders which are typically less likely to undergo harvesting operations (Arano & Munn 2005, and Jones et al. 2001). A mail questionnaire was established as the survey instrument. The survey was designed to use contingent valuation (CV) methods to determine NIPF landowners' preferences concerning the utilization of logging residuals. The survey was organized into six sections concerning the landowners' forest characteristics, environmental preferences, management objectives, and socio-demographic information. Two different CV methods were also included as separate sections. This study will utilize and explain the contingent rating section of the survey.

A version of the Dillman tailored design method was developed to acquire the appropriate data. An appropriate sample size was calculated at 2,560 mail surveys (Dillman 2009). Due to the complicated nature of the contingent valuation sections, the questionnaire was field tested, throughout Mississippi, at local county forestry association (CFA) meetings in Yalobusha, Clay, and Greene County to get feedback from the target audience. CFAs are local affiliates of the Mississippi Forestry Association (MFA) which consist of private forest landowners who meet regularly to keep up to date on current forestry issues in their area. Changes were made, as appropriate, in an effort to improve clarity, response rates, and data accuracy (Capparos et al. 2008). The initial survey used three versions of contingent valuation including a choice model, a contingent ranking, and a contingent rating. The contingent ranking section was found to be the least useful due to confusion with the other variations. Therefore, it was deemed non-beneficial and discarded from the questionnaire. The contingent rating was found to be the best method to reach the objectives of this study. The choice experiment model was kept in the survey to acquire comparative data for future research.

After finalizing the questionnaire, the first mailing was sent on 11/9/2009 with a reminder postcard following 1 week later. A second mailing was sent to non-respondents on 12/2/2009. The field test surveys were also used to determine which form of contingent valuation the survey audience would respond to the best. A hypothetical harvesting situation was designed to elicit landowner preferences using conjoint analysis. The supposed timber stand is an approximately 40 year old stand of unmanaged loblolly pines to be clearcut, should the landowner choose to harvest. Using the PTAEDA program to estimate growth and yield, and the most current Timber Mart-South prices in Fall of 2009, the fair market value was estimated at $3000/acre.

The contingent rating section of the survey used the hypothetical timber harvesting situations to elicit landowners' likeliness to harvest under each of 4 scenarios. The subjects were asked to rate each scenario from 1(Not likely to harvest) – 5(Likely to harvest). Scenario 1 is a standard clearcut, where the landowner receives the estimated fair market value ($3000/ac). In this situation, all logging residuals and non-merchantable timber are left in the field. No biomass will be used for the production of biofuel. This clearcut would leave a rough site which would require intensive site preparation for successful re-planting. This will serve as the base model scenario.

Scenarios 2, 3, and 4 involve a clearcut on the same hypothetical timber stand. In this situation, however, logging residuals and non-merchantable timber are removed to produce biofuel. This decreases the risk of fire and pests while helping reduce fossil fuel use and green house gas emissions. Removing the debris leaves a cleaner site which requires minimal site preparation for successful replanting. The only difference between these scenarios is the price received by the landowner. In the previous section of the survey, the subjects were also introduced to the idea that the removal of logging residuals and non-merchantable stems could have detrimental effects on soil quality, water quality, and species richness or biodiversity.

In scenario 2, they would receive fair market value identical to scenario 1 ($3000/ac). This scenario was designed under the premise that presumed harvesting and transportation costs could negate any monetary gains the landowner might receive from the harvest and utilization of logging residuals and non-merchantable trees.

For scenario 3, they would receive additional income from selling the logging residuals for profit ($3200/ac). The $200/ac increase was used because it is a rate high enough to have a significant influence on landowners' decisions, and it assumes a delivered price for the woody biomass at a rate between full pulpwood price and half pulpwood prices at the time of the survey. This is concurrent with other studies that use pulpwood prices because pulpwood production is the most comparable process to biomass production (Perez-Verdin et al. 2007). Also, harvesting woody biomass is not likely to be profitable to landowners unless delivered prices were near pulpwood prices.

Scenario 4 involves a situation where the landowner would receive less than fair market value from the harvest ($2800/ac). This was designed under a hypothetical idea that transport and harvesting costs for utilizing woody biomass could reduce the landowners' total income. Intuitively, the only reason a landowner would be more likely to harvest in this situation, rather than a standard clearcut, is if he/she preferred the associated benefits of biomass utilization over monetary benefits (See Table 1).

Table 1 A comparison of attributes within the contingent rating scenarios of a survey of NIPF landowners in Mississippi. Subjects were asked to rate (from 1 to 5) their likeliness of harvesting timber in each scenario.

	Scenario 1 (Standard Clearcut)	**Scenario 2**	**Scenario 3**	**Scenario 4**
Biofuel produced	no	yes	yes	yes
Clean harvest site	no	yes	yes	yes
Decrease fire & pest risk	no	yes	yes	yes
Site prep required	intensive	minimal	minimal	minimal
Price received at harvest	$3000/ac	$3000/ac	$3200/ac	$2800/ac

The Empirical Model

To make the contingent rating scenarios comparable, the woody biomass utilization models (scenarios 2, 3, and 4) were individually compared to the standard clearcut model (scenario 1). The dependent variable was created by forming an index from the difference between the biomass utilization scenarios and the standard clearcut scenario. The results were summarized into indices of 0, 1, or 2, indicating whether the subject is less likely, equally likely, or more likely to harvest than in a standard clearcut (Scenario 1). If a respondent rated the standard clearcut scenario higher than another scenario, then it was assigned a 0, which indicates a preference for the standard clearcut scenario. If a respondent rated the standard clearcut equal to another scenario, then it was assigned a 1. If the other scenario was rated higher than the standard clearcut, then it was assigned a 2, which indicates it is preferred over the base model. The dependent variables for each of the 3 models include the index difference between Scenario 2 and Scenario 1

(V2V1), the index difference between Scenario 3 and Scenario 1 (V3V1), and the index difference between Scenario 4 and Scenario 1 (V4V1).

The independent variables include a range of descriptive information to determine what influences these NIPF landowners' preferences. The ACRES and PREVHARV variables are based on the landowners' forest characteristics. ACRES is a continuous variable indicating how many total acres of forested land the respondent owns. PREVHARV is a dummy variable indicating whether the landowner had harvested timber on their land in the past. CLIMATE is a dummy variable indicating whether the respondent thought global climate change was a serious issue that needed to be addressed. This variable was used to address the landowners' environmental preferences. HABITAT, AESTH, FINANC, and INVEST were used to understand the landowners management objectives. These variables were transformed from a discrete choice, rating variable, into dummy variables indicating whether the objectives are thought to be important (1) or unimportant (0). AGE, EDU, and INCOME are demographic variables used to help understand NIPF landowners' decisions, and to determine whether the sampled population was an accurate representative of the total population. AGE and INCOME are continuous variables, while EDU is categorical. The age data was collected from an open-ended question. The income and education questions required the respondent to select their answer from a prepared range of choices. The income question provided fourteen choices ranging from less than $30,000 annually to more than $150,000 annually. The selection categories were broken into $10,000 ranges to increase response rate by making the answer less revealing to the respondents specific income while still providing enough detail for our research purposes. The responses were converted into a continuous variable by using the median of the range selected as a real number. The education question presented eight choices ranging from "less than high school," to "professional degree." This data was converted into a dummy variable where 1 indicates a bachelor's degree or higher, and 0 is less than a bachelor's degree.

Due to the ordinal nature of the dependent variables, the ordered logit model is used to analyze the data. The probabilities of the indices (V2V1, V3V1, and V4V1) are estimated from the model. The ten independent variables previously described are used to explain these probabilities. A positive coefficient indicates that as this variable increases the probability that the landowner prefers the bioenergy utilization models over a standard clearcut increases. A negative coefficient for one of these independent variables would indicate that an increase in that specific variable's unit would decrease the likelihood that the landowner prefers the bioenergy production model over the standard clearcut. However, the negative sign would be ambiguous to showing increasing preference for the standard clearcut over the bioenergy utilization model as the variables units increase. Three ordered logit models were used to determine the influence of utilizing logging residuals on NIPF landowner decisions:

$$V2V1 = \beta_0 + \beta_1 ACRES + \beta_2 PREVHARV + \beta_3 CLIMATE + \beta_4 HABITAT + \beta_5 AESTH + \beta_6 FINANC + \beta_7 INVEST + \beta_8 AGE + \beta_9 EDU + \beta_{10} INCOME + \varepsilon \tag{1}$$

$$V3V1 = \beta_0 + \beta_1 ACRES + \beta_2 PREVHARV + \beta_3 CLIMATE + \beta_4 HABITAT + \beta_5 AESTH + \beta_6 FINANC + \beta_7 INVEST + \beta_8 AGE + \beta_9 EDU + \beta_{10} INCOME + \varepsilon \tag{2}$$

$$V4V1 = \beta_0 + \beta_1 ACRES + \beta_2 PREVHARV + \beta_3 CLIMATE + \beta_4 HABITAT + \beta_5 AESTH + \beta_6 FINANC + \beta_7 INVEST + \beta_8 AGE + \beta_9 EDU + \beta_{10} INCOME + \varepsilon \tag{3}$$

Once these models are estimated, the effects from individual variables will be analyzed to determine their effects on the dependent variables. This will indicate the landowners' preferences for the woody biomass utilization harvesting attributes as they compare to standard clear-cutting. The ordinal logit model creates non-decreasing parameters that are called threshold points, or intercepts, to create equal boundaries between the prediction categories (0, 1, or 2 in this case). These threshold points are used to calculate predicted probabilities for landowners with given sets of characteristics being in a particular category. The odds ratios and marginal effects are calculated to show the degree to which a specific variable influences probability. Odds ratios are derived by taking the exponent of the coefficient. A positive odds ratio would indicate the percentage a variable increases likelihood of moving up a category in the dependent variable's index (increase preference over standard clearcut). A negative odds ratio would show the percentage a variable makes it less likely to move up a category in the dependent variable's index. The Brant Test of parallel regression assumption will be used to indicate whether this model is suitable. The ordered logit model runs multiple equations at the same time. For the assumption of parallel regression to be true, the different coefficients derived from the multiple equations must not vary considerably. The ordered logistic regression uses the log-likelihood ratios to interpret goodness of fit for the three models (Greene 1997).

CHAPTER IV

RESULTS

The total response rate was 703 returns from 2,438 successful mailings (28.8%). The usable response rate was 511 usable returns from 2,438 successful mailings (20.1%). The lower usable response rate is likely due to the lengthy and confusing nature of the contingent valuation methods within the survey instrument. To check for non-response bias, demographic variables from the first and second mailings were compared to check for significant differences. The bias was found to be mostly inconsequential after performing t-tests on the total acreage, age, and income variables from the first and second mailings (See Table 2).

Table 2 T-test statistics of demographic variables between the first and second survey mailings to NIPF landowners in Mississippi. They are insignificant at 5%, therefore, non-response bias is inconsequential.

	Mean	**Variance**	**t-stat**	**P(T<=t)**
ACRES 1*	554.39	1995306.48	1.31	0.09
ACRES 2**	422.17	494225.63		
AGE 1*	65.90	155.71	0.88	0.19
AGE 2**	65.01	158.27		
INCOME 1*	85.47	1898.23	1.05	0.15
INCOME 2**	81.46	1858.47		

* Uses data from respondents to the first mailing of the survey

** Uses data from respondents to the second mailing of the survey

Descriptive statistics and variable definitions for the independent variables used to explain the model are described below (See Table 3). This information provides a general idea of the study population's demographics, as well as their common responses, and the degree to which they vary. The average total acreage of our study population was 461.8 acres, with a high degree of variation. The average age was 65, and the average household income was around $86,000 per year. The average education fell between the Associates degree and Bachelors degree categories. About 87% of our study population previously had timber harvested on their land. Less than 40% of the study population thought that global climate change was an issue that should be seriously addressed. Over 80% thought that providing wildlife habitat, receiving financial gain, and maintaining forestland as an investment of assets were important objectives as a forest landowner. Almost 75% thought that improving aesthetic value was an important objective.

Table 3 Descriptive statistics for explanatory variables used to determine NIPF landowners' likeliness to harvest when utilizing logging residuals to produce bioenergy in Mississippi.

Variables	Variable Description	Mean	Std. Dev.
ACRES	Continuous variable indicating total acres of forested land owned by the respondent	461.81	1097.28
PREVHARV	Dummy variable indicating if respondent has previously harvested timber on his/her land	0.87	-
CLIMATE	Dummy variable indicating if respondents think global climate change is a serious issue	0.39	-
HABITAT	Dummy variable indicating if habitat management is an important objective for the landowner	0.80	-
AESTH	Dummy variable indicating if aesthetic value of the forest is important to the landowner	0.74	-
FINANC	Dummy variable indicating if financial benefit is an important objective for the landowner	0.83	-
INVEST	Dummy variable indicating if maintaining the forestland as an investment of assets is important to the landowner	0.83	-
AGE	Continuous variable indicating the age of the respondent in years.	64.80	12.41
EDU	Dummy variable indicating whether or not the respondent had attained a bachelors degree or higher	0.56	-
INCOME	Continuous variable indicating the annual household income of the respondent in thousands of U.S. dollars.	86.17	43.30

511 observations

20.96% usable response rate

The Brant Test was used to demonstrate that the ordinal logit was an appropriate model that did not violate the parallel regression assumption. This requires that the relationships between all the categories of the dependent variable index are the same. In the first model, V2V1, the p-value for chi^2 was 0.7. For Model V3V1, the p-value of chi^2 was 0.3. In Model V4V1, the p-value for chi^2 is 0.3. The chi-square values for nearly all variables in the three models were insignificant. This indicates that the parallel regression assumption has not been violated, and the data is suitable for the ordered logit model (See Table 4).

Table 4 Chi-square statistics from the Brant Test of parallel regression assumptions for survey data of NIPF landowners in Mississippi. Insignificant p-values indicate that the assumption is not violated.

	V2V1 MODEL		**V3V1 MODEL**		**V4V1 MODEL**	
	chi^2	**$p>chi^2$**	**chi^2**	**$p>chi^2$**	**chi^2**	**$p>chi^2$**
All	7.51	0.68	12.05	0.28	11.72	0.30
ACRES	0.22	0.64	0.06	0.81	0.15	0.70
PREVHARV	0.67	0.41	0.00	0.99	2.79	0.10
CLIMATE	1.41	0.24	6.07	0.01	1.62	0.20
HABITAT	0.00	0.99	0.26	0.61	0.59	0.44
AESTH	1.37	0.24	1.84	0.17	0.24	0.63
FINANC	0.55	0.46	0.08	0.78	0.45	0.50
INVEST	0.04	0.85	0.05	0.83	0.14	0.71
AGE	0.01	0.92	0.23	0.63	0.51	0.48
EDU	0.69	0.41	2.73	0.1	0.36	0.55
INCOME	1.26	0.26	0.69	0.40	0.56	0.45

The log-likelihood ratios of all three models used in the study were significant at 1% alpha level. This indicates a good fit for the models, and that we can reject the null hypothesis that all the predictors' regression coefficients would be equal to zero. As described previously, the harvest ratings were used to create an index to be used as the dependent variable in the ordered logit model. The following table shows the frequency of observations that were less, equally, or more likely to harvest than the base model (standard clearcut) for the other 3 bioenergy harvesting situations as they were observed from the actual data, and from the predictions from the ordered multinomial logit models. The predicted outcomes follow the same trends as the observed outcomes, which indicate that the model was successful in predicting NIPF landowners' decisions (See Table 5).

Table 5 A comparison of predicted and observed frequencies of landowner decisions from three ordered multinomial logit models based on survey data of NIPF landowners in Mississippi.

	Model 1 (V2V1)		**Model 2 (V3V1)**		**Model 3 (V4V1)**	
	% Pred	**% Obs**	**% Pred**	**% Obs**	**% Pred**	**% Obs**
0 (less likely)	0.00	2.74	0.00	2.94	5.28	25.44
1 (equally likely)	19.18	36.40	5.28	26.61	80.23	42.47
2 (more likely)	80.82	60.86	94.72	70.45	14.48	32.09

Table 6 presents the results of Model 1, where the same estimation of fair market value was received for both scenarios. Seven variables were found to have significance, at the 90% confidence level, in the first model: ACRES, CLIMATE, HABITAT, AESTH, FINANC, AGE, and EDU. A negative value means this variable is less likely to move the selection up to the next category, or less likely to increase preference over the base model. This infers that as a negative signed variable's value increases so does the landowners' preference for the standard clearcut over the bioenergy utilization scenario. For the dummy variables, a positive value means that if the subject chose "yes" (1), this would increase the landowners' preference for the bioenergy utilization scenario, relative to the standard clearcut. Significant and negative variables for the first model include ACRES, AESTH, and AGE. Significant and positive variables include CLIMATE, HABITAT, FINANC, and EDU.

Table 6 Ordered logit estimates for determining Mississippi NIPF landowners' preferences when comparing a standard clearcut to utilizing logging residuals for bioenergy when the payments are the same.

MODEL 1 (V2V1)			
	Coefficient	**P value**	**Odds Ratio**
ACRES	-0.000**	0.04	0.99
PREVHARV	0.165	0.57	1.18
CLIMATE	0.320*	0.10	1.38
HABITAT	0.834***	0.00	2.30
AESTH	-0.643**	0.02	0.53
FINANC	0.771**	0.02	2.16
INVEST	-0.548	0.11	0.58
AGE	-0.015*	0.06	0.98
EDU	0.583***	0.00	1.79
INCOME	0.003	0.18	1.00
threshold par1	3.28		
threshold par 2	0.27		

*10% confidence level

**5% confidence level

***1% confidence level

Table 7 presents the results from the second model, where the highest payment is offered for the biofuel utilization option. There were six variables significant within at least the 90% confidence level in Model 2: ACRES, HABITAT, AESTH, FINANC, AGE, and EDU. Significant variables with negative values include ACRES, AESTH, and AGE, which is the same as the previous model. Significant variables with positive values include HABITAT, FINANC, and EDU.

Table 7 Ordered logit estimates for determining Mississippi NIPF landowners' preferences when comparing a standard clearcut to utilizing logging residuals for bioenergy when the payments are higher for the latter.

	MODEL 2 (V3V1)		
	Coefficient	**P value**	**Odds Ratio**
ACRES	-0.000**	0.03	0.99
PREVHARV	0.266	0.38	1.31
CLIMATE	0.335	0.12	1.40
HABITAT	0.688**	0.02	1.99
AESTH	-0.570*	0.05	0.57
FINANC	0.977***	0.00	2.66
INVEST	-0.546	0.13	0.58
AGE	-0.017**	0.04	0.98
EDU	0.678***	0.00	1.97
INCOME	0.003	0.23	1.00
threshold par 1	2.77		
threshold par 2	0.26		

*10% confidence level

**5% confidence level

***1% confidence level

Table 8 presents the results from Model 3, where the lowest payment was offered for the bioenergy utilization option. There were four significant variables within at least 90% confidence level in the third model: ACRES, PREVHARV, HABITAT, and INVEST. Negative significant variables include ACRES, PREVHARV, and INVEST. The only positive significant variable is HABITAT.

Table 8 Ordered logit estimates for determining Mississippi NIPF landowners' preferences when comparing a standard clearcut to utilizing logging residuals for bioenergy when the payments are higher for the former.

MODEL 3 (V4V1)			
	Coefficient	**P value**	**Odds Ratio**
ACRES	-0.000*	0.09	0.99
PREVHARV	-0.586**	0.02	0.56
CLIMATE	0.233	0.18	1.26
HABITAT	0.817***	0.00	2.26
AESTH	-0.209	0.35	0.81
FINANC	0.252	0.37	1.29
INVEST	-0.721**	0.01	0.49
AGE	0.003	0.66	1.00
EDU	0.233	0.20	1.26
INCOME	-0.001	0.61	0.99
threshold par 1	1.92		
threshold par 2	0.11		

*10% confidence level

**5% confidence level

***1% confidence level

Table 9 gives a comparison of significant variables, within at least the 90% confidence level, and their signs across all three models. This allows for evaluation of trends between the models, and is a good indicator of landowner preferences. The highly significant likelihood ratio probabilities, and the insignificant Brant test probabilities indicate that all models are well fitted, and do not violate parallel regression assumptions. The table shows that all significant variable signs were consistent across the three models. This shows that landowners' preferences were consistent across the models, which is an intuitive sign that the data works well with the model.

Table 9 Comparison of the coefficient signs of variables found to be significant in at least 90% confidence from ordered logit models based on survey data of Mississippi NIPF landowners.

	Model 1 (V2V1)	**Model 2 (V3V1)**	**Model 3 (V4V1)**
ACRES	**-**	**-**	**-**
PREVHARV			**-**
CLIMATE	**+**		
HABITAT	**+**	**+**	**+**
AESTH	**-**	**-**	
FINANC	**+**	**+**	
INVEST			**-**
AGE	**-**	**-**	
EDU	**+**	**+**	
INCOME			
LR Prob > chi2	0.0000	0.0000	0.0001
Brant Prob > chi2	0.6765	0.2816	0.3043

In Model 1, 81% of landowners were predicted to prefer the bioenergy utilization scenario over the standard clearcut. This preference is based strictly on the attributes associated with the harvesting and utilization of woody biomass to produce bioenergy, because the price received for harvesting is the same between the standard clearcut and the bioenergy utilization model. The bioenergy utilization preference increased as landowners' education level, and income increased, and it decreased as landowners' total acreage and age increased. The likeliness that the bioenergy utilization scenario was preferred also increased if the landowner was concerned with global climate change, creating wildlife habitat, and receiving financial gain from their forest; it decreased if the landowner was interested in aesthetic value.

In Model 2, 95% of landowners were predicted to prefer the bioenergy utilization model. This increase in preference likelihood, relative to Model 1, is due to the increased payment to landowners who choose the bioenergy utilization scenario over the standard clearcut. An increase in education, an affinity for wildlife habitat and financial gains, and a concern for global climate change also increased the likelihood of landowners to prefer the bioenergy scenario. Increasing acreage, age, and a preference for aesthetics would decrease landowners' preferences for the attributes associated with the removal of logging residuals to produce bioenergy.

For Model 3, only 14% were more likely to prefer the bioenergy scenario. However, a smaller number, only 5% preferred the standard clearcut. 80% were predicted to be equally likely of choosing one or the other. In this model, the standard clearcut scenario actually offered more money than the biofuel utilization option. This means that a majority of landowners did not prefer the standard clearcut even when offered more money. This indicates that the attributes associated with removing and utilizing logging residuals after clearcutting are strongly preferred over a standard clearcut where logging slash is left in the woods. Preference for wildlife habitat is the only descriptive variable with positive influence on likeliness to prefer the bioenergy option. Increasing acreage reduced the likeliness. These were consistent across all three models. Contrasting from the other two models, the investment variables and previous harvest variables became significant and the previous harvest variable became negative, while several other variables became insignificant. As mentioned earlier, this is expected because the change in price offered creates a strong influence on the landowner decision which reduces the effects of the other descriptive variables. However, the results indicate that the decrease in price offered did not have as strong of an effect as we expected, because the model was still well-fitted, and there were four significant variables at the 90% confidence level.

Overall, the results were consistent with our expectations and indicate that most landowners' preferred the options where logging residuals were utilized to produce bioenergy over standard clearcutting. This trend was anticipated, and indicates a successful model for meeting our objectives. The marginal effects and odds ratios indicate that many of these specific variables had strong effects on landowner preferences. It is evident that the changes in price received by the landowner had a strong effect on landowner decisions, which reduced the significance of the other indicator variables.

CHAPTER V

DISCUSSION

Due to the nature of the questionnaire, the 20.1% usable response rate was slightly lower than desired. By oversampling, however, 511 usable observations were acquired which was more than sufficient to achieve significant results. The usable rate was much lower than the total return rate of 28.8%. This is thought to be due to the complex nature of the conjoint analysis sections of the questionnaire. These sections add considerable length and difficulty to the questionnaire, and a high percentage of respondents did not fully complete these sections, or they answered them incorrectly. Also, there was negative feedback received from pilot survey respondents concerning the difficulty of these sections of the questionnaire. Therefore, low response rates were expected and additional questionnaires were mailed to increase the number of usable responses.

Using a mail survey as the primary instrument for acquiring data, researchers are met with a variety of limitations, but also some flexibility. By including different conjoint analysis sections in the survey, a higher response rate was sacrificed to achieve greater analytical options. Analysis of the contingent rating section is only the first step in fully utilizing this survey to understand the influence of woody biomass harvesting on NIPF landowner decisions.

Brevity and simplicity are key issues in maximizing a survey’s response rate. Due to these restrictions, there were several issues that could not be fully addressed. The contingent valuation techniques required a hypothetical harvesting situation to portray the issues in question to the landowners. This survey focused simply on a 100 acre mature natural pine stand to be clear-cut. Obviously, there are numerous other harvesting situations that landowners would be likely to come into contact with. This survey's hypothetical situations were focused on being familiar to the highest number of landowners, and typical to what would be a common feedstock to bioenergy production facilities. Other scenarios involving mid-rotation thinning and non-clearcut harvests could have also been developed. Of course, there are other issues that could also have been addressed when determining the amount of available feedstocks. For example, harvesting hardwoods generally leaves a much higher volume of logging residuals that could be utilized for bioenergy. In the interest of simplifying the questionnaire, this survey only addressed clear-cutting loblolly pines. The utilization of hardwood logging residuals could present a higher payment to landowners, and therefore have a stronger influence on their willingness to harvest.

Another disadvantage to the mail survey is the presentation of the harvesting effects. There are also numerous harvesting techniques for acquiring logging residuals and other woody biomass feedstocks that could produce different effects. It is impossible to encompass all the effects and attributes that might influence a landowners' harvesting decision through an impersonal mail survey. Being limited to conjoint analysis formats, only the harvesting attributes that were considered the most important from past research, and from information acquired through pilot surveys were included in the final questionnaire. There are constant changes in harvesting techniques and advances in technology that cannot be fully addressed with these methods. This should, however, leave room for future research to address these issues.

The price offers presented in the contingent rating sections is another aspect that suffered from the limitations of the survey instrument. A hypothetical high, medium, and low harvesting income were the only ones presented to the landowner. In a real-life transaction, there would be a number of variables affecting this price that could not be addressed in the survey. There is also the possibility of government incentives or tax-credits that could significantly influence landowners' harvesting decisions. The bioenergy field holds very high potential to receive government funding in the interest of meeting energy goals. By reducing tax rates for NIPF landowners and increasing payments for bioenergy feedstocks, these hypothetical policies can have very strong influences on a landowners' harvest decision.

All the predicted outcomes from the model were within two percent of the observed outcomes from the survey data. This indicates that the variables are good predictors of the landowners' preferences between the paired harvesting scenarios. All three models had log likelihood ratios that were significant at the 1% alpha level, and the signs for nearly all variables were as expected.

The ACRES variable was negative, as expected, and statistically significant in all three models. Therefore, as a landowners' acreage increased, the more likely he was to prefer the basic clearcut model over the bioenergy utilization model. This is likely due to landowners with larger amounts of acreage being more interested in strictly producing timber. They are prone to be familiar with timber harvesting operations and prefer standard clearcutting as a practical and efficient means of earning utility from their forest land. Large forest landowners are typically already largely invested in a certain area of profitability from their forest, and changing harvest operations could lead to complications that they might rather not take part in. The odds ratio for the ACRES variable was 0.99 for each of the three models. This indicates that with each unit increase in acreage, landowners were 1% less likely to prefer the bioenergy utilization model. Interestingly, this remained constant across all three models, regardless of varying payments to the landowner which could indicate that landowners with higher total acreages are not as easily influenced by small changes in price, or that they simply do not prefer the bioenergy harvesting scenario.

The PREVHARV variable was only statistically significant in the third model. It was found to be negative with an odds ratio of 0.56, which indicates that landowners who had harvested previously would be 44% less likely to move up in rating from the base model to the bioenergy utilization models. This was the only unexpected sign from any of the models. Pilot surveys and discussions with private forest owners indicated that one thing landowners dislike most about harvesting timber is the mess it can leave afterwards on their land. A common expression from several landowners in the survey comments was that they had clearcut once before, and would never do it again due to devastation of their land. One of the beneficial attributes of harvesting logging residuals from a logging site is the cleanliness of the site afterwards. Therefore, landowners who had harvested previously were expected to be more likely to harvest with a bioenergy utilization model due to the cleanliness of the site afterward. However, the negative sign indicates that the landowners that had previously harvested were less likely to move up a level on the dependent variable index (likeliness to harvest). Since both options involved clearcutting, some landowners may still be hesitant to trust this new process of harvesting logging residuals to provide a clean enough site, or prevent devastation of their land. This does not necessarily mean they preferred standard clearcuts to the bioenergy utilization scenarios. This is, in fact, a new process that landowners would be unfamiliar with. To them, a clearcut is still a clearcut, regardless if residuals are used to produce bioenergy.

CLIMATE was statistically significant in both models one and two. The signs were both positive, as expected. This variable was developed to determine the NIPF landowners' environmental preferences or environmental awareness. The question asked whether they believed global climate change is an important issue. It was predicted that those landowners who thought this was important had stronger environmental concerns, and would therefore be more likely to prefer the biofuel utilization scenarios over standard clearcuts. This would be due to the environmental benefits associated with producing bioenergy from woody biomass and reducing fossil fuel use. This proved to be true and significant in the first two models, where landowners who thought climate change was important were more likely to prefer the bioenergy utilization scenario over a standard clearcut, in which no biofuels are produced. The odds ratios indicate that landowners who were concerned about climate change were 38%, 40%, and 26% more likely to prefer the bioenergy scenarios across models one, two, and three, respectively.

The HABITAT variable was an indicator of whether landowners thought providing wildlife habitat was in important management goal for their forest land. This variable was positive and statistically significant in all three models. This indicates that landowners, who deemed wildlife habitat management as important, were more likely to prefer the biofuel utilization scenarios to standard clearcuts. The odds ratios indicate that they were 130% more likely in Model 1, 99% more likely in Model 2, and 126% more likely in Model 3. This variable had strong influence on landowner decisions in all three models. The signs were expected because most individuals who are concerned with wildlife habitat are more concerned with protecting the environment. This could make them more attracted to bioenergy production. It was also expected because most individuals who enjoy wildlife are not as enthusiastic about the micro fauna and flora that might benefit from leaving wood wastes in the field. These landowners were likely to be interested in being provided with a clean site from harvesting logging residuals so that they could easily develop food plots or other habitat management projects to benefit the more appreciable large game. Cleaner harvest sites can also expedite replanting, and possibly initiate faster reforestation, which could produce quicker benefits to hunters and others who enjoy wildlife.

The AESTH variable was negative and statistically significant in models one and two. The negative sign was expected because landowners that hold aesthetic value in high esteem typically do not prefer clearcutting for any means. One of the limitations of this survey was the presentation of the hypothetical harvesting situation to present clearcutting or no harvesting as the only options. This is one of the reasons we expected a negative sign. This is likely due to aesthetic-loving landowners choosing not to harvest on each of the paired scenarios in the models, which produces a negative sign for the variable. The odds ratios indicate that landowners who enjoy aesthetics were 47% less likely to move up a category on the likeliness to harvest index in Model 1, and 43% less likely in Model 2. As mentioned earlier, this does not mean the landowners preferred a standard clearcut to the bioenergy utilization scenario. With this dependent variable and model, we can see respondents' preference to the bioenergy utilization model, however, the absence of this preference is ambiguous for indicating actual preference to the opposing standard clearcut model. It simply means they were less prone to move up on the likeliness to harvest index.

FINANC was statistically significant in the first two models. As expected, it had a positive coefficient in all 3 models. This indicates that landowners who thought receiving the highest financial returns possible to be of significant importance were more likely to move up a category and likely prefer the biofuel utilization scenarios to the standard clearcut. This is easily explained from the financial benefits the bioenergy utilization scenarios present to the landowner in the first two models. In the Model 1, the landowner receives identical payments, but the biofuel utilization harvests produce a cleaner site, which can reduce replanting efficiency and site preparation costs. In the Model 2, the bioenergy option provides the same benefits, along with increased payment. It is easy to see how a financially oriented person would prefer these options. This variable was statistically insignificant in Model 3, where the landowner would receive lower payment by choosing the bioenergy option, but the positive sign indicates that taking a loss in payments with the bioenergy utilization model was still preferred to the standard clearcut. This is likely due to the financial benefits associated with lower site preparation and re-planting costs. The odds ratios indicate that landowners who were financially motivated were 116% more likely to move up a category and prefer the bioenergy utilization scenario in Model 1, and 166% more likely in Model 2. This variable holds very strong influence on landowner decisions, especially in models one and two.

The INVEST variable was only statistically significant in the Model 3. It had a negative sign, as was expected. This indicates that forest landowners who thought maintaining their forestland as an investment of assets was an important objective were less likely to move up a category in the third model. This means that the bioenergy utilization option was not preferred over the standard clearcut by those concerned with forestland investments. This is to be expected because the third model involves lower payments in the bioenergy utilization scenario than in the standard clearcut. Also, landowners who are invested in the forestland may not be simply trying to receive the highest financial benefit possible, in the short term, as in the FINANC variable. They might be more interested in long term investments and portfolio diversity, and are less likely to harvest frequently, and more likely to hold on to their assets until needed. The odds ratio shows that landowners were 51% less likely to prefer the bioenergy utilization scenario, in Model 3, if they thought maintaining forestland for investment purposes was important.

AGE was negative and statistically significant in models one and two. This indicates that as landowners' ages increase, they are less likely to prefer the bioenergy utilization option over the standard clearcut scenario. This was expected because typically age is inversely related with likeliness to harvest, and older landowners are less likely to take on a timber harvesting operation. Older landowners who are more keen to traditional harvesting techniques could prefer standard clearcuts rather than be introduced to deviations from familiar harvest operations that might result from the bioenergy utilization option. The odds ratio was 0.98 for both significant AGE variables. This means a 2% decrease in likeliness to move up a category for each year increase in age.

The EDU variable was positive and statistically significant in both models one and two. This shows that as education level increased among landowners, the more likely they were to prefer the bioenergy utilization scenario over the standard clearcut option. This was expected, because higher educated landowners tend to hold more value on environmental protection and current issues. Higher educated landowners are more likely to be aware of the environmental benefits associated with bioenergy production. It is also possible that they are more likely to derive personal utility from helping reduce fossil fuel use by providing bioenergy feedstocks. The odds ratios indicate that landowners with a bachelors degree or higher were 79% or 97% more likely to prefer a bioenergy producing scenario for models one and two, respectively. This variable can have very strong influence on the landowners' decision.

INCOME was not statistically significant in all 3 models. It was positive in models 1 and 2, which indicates that landowners with larger incomes were more likely to move up a category in the comparison index between the bioenergy utilization option and the standard clearcut option. This would indicate that they preferred utilizing logging residuals to create bioenergy rather than leaving wood waste in the forest, as is typical with a standard clearcut. The positive sign was expected because typically people with higher disposable incomes place more value on the environment, and are more inclined to help reduce fossil fuel use and increase the use of sustainable energy sources.

By assigning the index as the dependent variable for each model, the scenarios are all directly comparable to the standard clearcut. All models indicate a strong preference towards the attributes associated with the removal and utilization of logging residuals to be used in the production of bioenergy. This is specified by the predicted frequencies of 'twos' in the dependent variables, which indicates a higher ranking for the bioenergy utilization scenario than the clearcut scenario. Even in Model 3, where the landowner loses money by selecting the alternative to the standard clearcut, the predicted and observed frequencies of 'twos' outweighed the frequency of 'ones.' This is an excellent indicator that landowners prefer utilizing logging residuals over standard clearcuts, and that offering this option could increase landowners' overall likeliness to harvest their trees.

CHAPTER VI

SUMMARY AND CONCLUSIONS

While several studies have shown that the Southern United States contains ample bioenergy feedstocks with great potential for supporting biofuel production facilities, there has been little research to determine the availability of these feedstocks for harvest. This factor is dependent on preferences and decisions of NIPF landowners, who control 71% of timberland in the South (Smith et al. 2004). This study uses a mail survey with conjoint analysis to determine how the removal and utilization of logging residuals to produce bioenergy can influence NIPF landowners' harvesting decision, and to establish their preferences when comparing this to a standard clearcut. When presented with hypothetical situations that compared the bioenergy utilization harvesting attributes along with those of standard clearcutting, landowners preferred those associated with the bioenergy utilization scenarios, even when more money was offered for the standard clearcutting option.

The preferable attributes associated with the removal of logging residuals involved providing a cleaner harvest site, reducing the amount of site-preparation required for successful replanting, decreasing the risk of fire and pests, and the production of usable bioenergy from wood wastes. The price received for harvesting also had a strong effect on landowner decisions, however, the other attributes tended to outweigh this factor. This is consistent with the changing priorities of NIPF landowners as they have shifted in the past decades from profit maximizers to utility maximizers.

Other demographics, environmental preferences, management objectives, and forest characteristics also had significant effects on landowners' decisions.

The results indicate that the strong majority of NIPF landowners did not prefer traditional clearcutting when compared to harvest methods that involved the removal and utilization of logging residuals to produce bioenergy, even when price changes forced landowners to receive less money for this option. This is indicative that most landowners would be more likely to take on harvesting operations if these options were available to them. This is very important in today's economy, where venture capitalists would want to reduce the overall risk of establishing biofuel production facilities in Mississippi and the Southern United States. This information can make them more certain that feedstocks would be available to them in a market controlled by non-industrial private forest landowners. By knowing that the effects from removing bioenergy feedstocks are preferred by landowners over standard clearcuts, they can improve their marketing abilities and potentially increase their overall production. It could also be useful for government programs and policy-makers that are trying to increase bioenergy development, for the same reasons.

Future research could include the determination of willingness to pay for individual attributes, or the willingness to accept price offers based on harvesting attributes. This could provide further detail on NIPF landowner preferences. Further analysis of the choice experiment data collected from the current mail survey can help provide this information. Also, other information should be collected concerning different forest types and harvesting methods. The limitations of the mail questionnaire only allowed a very basic presentation of the comparison between standard clearcutting and clearcutting with the removal of logging residuals for bioenergy purposes. Now that some of the issues NIPF landowners are concerned with have been identified, research pertaining to the marketing of the preferred attributes and associated benefits could help convince some landowners to deviate from their traditional harvesting, or no-harvesting, frame of mind.

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APPENDIX A

SURVEY INSTRUMENT

A Survey of Non-Industrial Private Forest Landowners' Willingness to Harvest Woody Biomass

I. Forest Characteristics:

We would like to ask a few questions about the forestland you own. Please answer the following questions to the best of your knowledge.

1. How many total acres of forested land do you own (summary of all tracts/stands, in all locations)? ____________ acres

2. Please, fill in the following table about your forested land acreage, as a summary of all tracts in all locations.

Cover Type *(any age)*	Acres *write in the total number of acres you own for each cover type*	Percent harvestable *estimate the % of trees that are at least pulpwood sized (6 inches diameter)*
Planted Pine	__________	___________
Natural Pine	__________	___________
Upland Hardwoods	__________	___________
Bottomland Hardwoods	__________	___________
Mixed - Pine and Hardwoods	__________	___________
Cutover *(recently harvested and unplanted, but will remain in timber production)*	__________	

3. How long have you owned the oldest portion of your forestland? _____years

4. How far is your permanent residence from your nearest tract of forested land?

________miles

5. Do you currently have a written management plan for any of your forestland?

❑ Yes ❑ No ❑ Don't Know

6. Have you ever harvested timber on your land before?

❑ Yes ❑ No ❑ Don't Know

7. Do you plan to harvest trees in the future?

❑ Yes ❑ No ❑ Don't Know

II. Landowner Environmental Preferences:

We would like to gather some information on your environmental concerns, and your thoughts about using trees to produce bioenergy.

1. Do you think that global climate change is an issue that should be seriously addressed, through either government policy or other methods?

❑ Yes ❑ No ❑ Don't Know

2. Do you recycle?

❑ Yes ❑ No ❑ Don't Know

3. Were you previously aware that leftover woody biomass from logging operations (typically unused materials such as treetops, branches, and non-merchantable trees) can be used to create bioenergy?

❑ Yes ❑ No ❑ Don't Know

4. Do you think that bioenergy produced from woody biomass (trees) could be a promising source for reducing fossil fuel use and greenhouse gas emissions in the United States?

❑ Yes ❑ No ❑ Don't Know

5. Do you think that using woody biomass to create bioenergy will be a financial benefit to non-industrial private forest landowners, such as yourself, in the future?

❑ Yes ❑ No ❑ Don't Know

6. Would you be more willing to harvest your trees if the wasted materials from logging operations could reduce fossil fuel use and greenhouse gas emissions in the U.S.?

❑ Yes ❑ No ❑ Don't Know

III. Landowner Objectives:

We would now like to ask you a few questions concerning the management objectives for your forestland. Rate the following objectives individually, by their level of importance to you. Circle the number that best describes how important you think each objective is. (1 – Very Unimportant; 2 – Unimportant; 3 – Neutral; 4 – Important; 5 – Very Important)

1. Provide wildlife habitat for hunting, wildlife viewing, or other use.

Very Unimportant 1 2 3 4 5 Very Important

2. Improve or maintain aesthetic value, or beauty, of the forest.

Very Unimportant 1 2 3 4 5 Very Important

3. Receive the highest financial return possible from your forestland.

Very Unimportant 1 2 3 4 5 Very Important

4. Maintain forestland to pass down to future generations.

Very Unimportant 1 2 3 4 5 Very Important

5. Maintain forestland as an investment of assets.

Very Unimportant 1 2 3 4 5 Very Important

IV. Selection of Preferred Harvesting Methods:

Imagine you are the controlling landowner of 100 acres of 40± year-old natural loblolly pines. The current fair market value for the timber is around $3000 per acre. (This is a hypothetical timber stand)

You will be given harvesting plans that vary according to some important attributes (described below). Some options involve using woody biomass to produce bioenergy. By choosing to harvest, the 100 acres would be clear-cut producing the given effects. *There is no right or wrong answer. We are simply interested in learning your preferences as a private forest landowner.*

**********<u>This table is not a question</u>. It provides information for the questions below. **********

Attributes	Description		Levels	
Woody biomass utilization	The amount of logging residue and non-merchantable trees that will be removed from the site for creating bioenergy	95%	70%	0%
Environmental quality effect	The effect of timber harvesting on soil quality, water quality, and species richness or biodiversity	Substantial decrease	Slight decrease	No change
Site preparation required	The intensity of site preparation required to attain similar re-planting results.	No site prep required	Minimal site prep required	Intensive site prep required
Price received	The $/acre amount you will be paid for selling your trees	High $3200/ac	Average $3000/ac	Low $2800/ac

<u>**Please compare the harvest plans and select your favorite option (A, B, or C) for each of the next five questions.**</u>

Question 1. Based on the given attributes, please select your preferred option for harvesting the hypothetical timber stand described above.

Harvest Attributes	Harvest Plan A	Harvest Plan B	Harvest Plan C
Woody biomass utilization	95%	0%	-
Environmental quality effect	Substantial decrease	Substantial decrease	-
Site preparation / cleanliness of site	No site prep required	Intensive site prep required	-
Price received per acre	$3000/ac	$3000/ac	-
Select one	❑ A	❑ B	❑ No harvest

Question 2. Based on the given attributes, please select your preferred option for harvesting the hypothetical timber stand described above.

Harvest Attributes	Harvest Plan A	Harvest Plan B	Harvest Plan C
Woody biomass utilization	0%	0%	-
Environmental quality effect	No change	Substantial decrease	-
Site preparation / Cleanliness of site	Intensive site prep required	No site prep required	-
Price received per acre	$3000/ac	$3000/ac	-
Select one	❑ A	❑ B	❑ No harvest

Question 3. Based on the given attributes, please select your preferred option for harvesting the hypothetical timber stand described above.

Harvest Attributes	Harvest Plan A	Harvest Plan B	Harvest Plan C
Woody biomass utilization	95%	95%	-
Environmental quality effect	Slight decrease	No change	-
Site preparation / Cleanliness of site	Intensive site prep required	Minimal prep required	-
Price received per acre	$3000/ac	$3000/ac	-
Select one	❑ A	❑ B	❑ No harvest

Question 4. Based on the given attributes, please select your preferred option for harvesting the hypothetical timber stand described above.

Harvest Attributes	Harvest Plan A	Harvest Plan B	Harvest Plan C
Woody biomass utilization	95%	0%	-
Environmental quality effect	No change	Slight decrease	-
Site preparation / Cleanliness of site	Intensive site prep required	intensive site prep required	-
Price received per acre	$2800/ac	$3500/ac	-
Select one	❑ A	❑ B	❑ No harvest

Question 5. Based on the given attributes, please select your preferred option for harvesting the hypothetical timber stand described above.

Harvest Attributes	Harvest Plan A	Harvest Plan B	Harvest Plan C
Woody biomass utilization	0%	0%	-
Environmental quality effect	Slight decrease	Slight decrease	-
Site preparation / Cleanliness of site	No site prep required	Minimal site prep required	-

Price received per acre	$3200/ac	$2800/ac	-
Select one	❑ A	❑ B	❑ No harvest

V. Willingness to Harvest Rating:

These questions are based on the same hypothetical timber stand described in Section IV.

In this section, you have four timber-harvesting scenarios, with some important differences. We would like you to indicate your likeliness of harvesting this timber within the next year. **Circle the number that indicates your likeliness of harvesting. Please specify whether you would: (1 – Definitely Not Harvest, 2 – Probably Not Harvest, 3 – Don't Know, 4 – Probably Harvest, or 5 – Definitely Harvest)**

1. This is a standard timber harvest. You receive current fair market prices for all timber products ($3000/ac). All logging residue and non-merchantable timber left as falls. No biomass used for the production of biofuels. A rough site requires intensive site preparation for successful re-planting. How likely are you to harvest in the next year?

Not Likely to Harvest Likely to Harvest

1 2 3 4 5

2. Standard harvest operations are used, but logging residues and other typically wasted products are removed to produce biofuels. This can decrease risk of fire and pests and help reduce fossil fuel use and green house gas emissions. A clean site requires minimal site preparation for re-planting. You receive current fair market prices for all timber products ($3000/acre). How likely are you to harvest in the next year?

Not Likely to Harvest Likely to Harvest

1 2 3 4 5

3. In this situation, you have the same harvest effects and site preparation requirements as # 2, but you receive additional income from selling the logging residues to produce biofuel ($3200/acre). How likely are you to harvest in the next year?

Not Likely to Harvest Likely to Harvest

1 2 3 4 5

4. In this situation, you have the same harvest effects and site preparation requirements as # 2 and # 3, but your income is reduced due to increased shipping and processing costs of the logging residues to be used for bioenergy ($2800/acre). How likely are you to harvest in the next year?

Not Likely to Harvest Likely to Harvest

1 2 3 4 5

VI. Socio-Demographic Information:

This section helps us assess how well our survey represents all non-industrial private forest landowners. Please answer the following questions to help us make our survey as useful as possible. All personal information will be kept completely confidential.

1. What is your age? ________ years

2. What is your gender? ❑ Male ❑ Female

3. What is your county? County____________________ State______________

4. What best describes your permanent residence? ❑ Rural ❑ Urban

5. What is your occupation status?

❑ Full time ❑ Retired

❑ Part time ❑ Other (please specify) ___________________

6. Please, select your highest level of educational attainment listed here.

❑ Less than high school ❑ Bachelor's degree

❑ High school graduate or GED ❑ Master's degree

❑ Some college ❑ Doctoral degree

❑ Associate's degree ❑ Professional degree

7. Please, select your annual household income level.

❑ Less than $30,000	❑ $90,001 - $100,000
❑ $30,001 - $40,000	❑ $100,001 - $110,000
❑ $40,001 - $50,000	❑ $110,001 - $120,000
❑ $50,001 - $60,000	❑ $120,001 - $130,000
❑ $60,001 - $70,000	❑ $130,001 - $140,000
❑ $70,001 - $80,000	❑ $140,001 - $150,000
❑ $80,001 - $90,000	❑ More than $150,000

Thank you for completing this questionnaire. Your contribution to our study is greatly appreciated. Please return your completed questionnaire in the postage paid business reply envelope as soon as possible. Thanks again.

APPENDIX B

SURVEY CORRESPONDENCE

First Mailing Cover Letter

November 1, 2009

Dear Forest Landowner,

Mississippi State University is very interested in learning about your willingness to harvest trees on your property or properties. They would also like to know about your willingness to collect logging residuals such as tree tops and branches for supplying woody biomass to an emerging bioenergy industry in Mississippi.

We are requesting your help to determine if there are enough landowners in Mississippi willing to harvest trees and collect logging residuals to supply sufficient quantities of woody biomass to an emerging bioenergy industry in Mississippi. Please take 20 minutes to complete the enclosed questionnaire titled "Survey of Non-Industrial Private Forest Landowners' Willingness to Harvest Woody Biomass." The primary purpose of this survey is to gather your thoughts and opinions about harvesting and collection woody biomass.

It is important that each questionnaire be completed and returned so our results will accurately represent the collective opinions of all forest landowners. Study results will be invaluable for Mississippi State University as they look to promote bioenergy development in the state. If you choose to fill out the questionnaire, please know that your participation is voluntary, you may stop at any time, and you do not have to answer any objectionable questions.

Please note the return envelope has an identification code for processing purposes only. It will be used to remove your name from the mailing list when you return the questionnaire. Your name will never be placed on the questionnaire or associated with any of your responses.

We appreciate your willingness to take part in this study. If you should have any questions or need help filling out the survey, please contact Donald L. Grebner at (662) 325-0928 or by e-mail at dgrebner@cfr.msstate.edu or Steven R. Gruchy at (662) 325-8357 or by e-mail at srg81@msstate.edu or Marc Measells at (662) 325-3550 or by e-mail at mmeasells@cfr.msstate.edu. Thank you in advance for your assistance with this study.

We ask that you please return your questionnaire in the enclosed self-addressed, postage-paid envelope before <u>November 30, 2009</u>.

Sincerely,

Donald L. Grebner, Associate Professor
Department of Forestry
Mississippi State University

Reminder Postcard

Dear Forest Landowner:

About a week ago, I mailed you a questionnaire titled "Survey of Non-Industrial Private Forest Landowners' Willingness to Harvest Woody Biomass."

If you have already completed and returned your questionnaire, please accept my sincere thanks. If you would like to participate in this project and have not yet returned the questionnaire, please return the survey by **November 30th**. It is extremely important that you return the questionnaire if the results are to accurately represent the collective opinions of all forest landowners.

If you did not receive a questionnaire, or it was misplaced, please call me today at (662) 325-0928 or e-mail me at dgrebner@cfr.msstate.edu and I will mail one to you immediately.

Sincerely,

Donald L. Grebner, Associate Professor
Department of Forestry, MSU

Second Mailing Cover Letter

December 1, 2009

Dear Forest Landowner,

About 4 weeks ago, we wrote you seeking information on your interest and your willingness to harvest trees and collect logging residuals such as tree tops and branches for supplying woody biomass to an emerging bioenergy industry in Mississippi. As of today, we have not received your completed mail questionnaire.

The number of questionnaires completed so far is very encouraging, but your response may provide additional, valuable information that we have not received. Study results will be invaluable for Mississippi State University as they look to promote bioenergy development in the state.

In case our first letter did not reach you, we have enclosed a replacement questionnaire. We ask that you take a few minutes to complete the questionnaire and return it in the postage-paid reply envelope by **December 17, 2009**.

It is important that each questionnaire be completed and returned so our results will accurately represent the collective opinions of all forest landowners. If you choose to fill out the questionnaire, please know that your participation is voluntary, you may stop at any time, and you do not have to answer any objectionable questions.

You may be assured of complete confidentiality. The return envelope has an identification code for processing purposes only. It will be used to remove your name from the mailing list when you return the questionnaire. Your name will never be placed on the questionnaire or associated with any of your responses.

We appreciate your willingness to take part in this study. If you should have any questions or need help filling out the survey, please contact Donald L. Grebner at (662) 325-0928 or by e-mail at dgrebner@cfr.msstate.edu or Steven R. Gruchy at (662) 325-8357 or by e-mail at srg81@msstate.edu or Marc Measells at (662) 325-3550 or by e-mail at mmeasells@cfr.msstate.edu. Thank you in advance for your assistance with this study.

We ask that you please return your questionnaire in the enclosed self-addressed, postage-paid envelope before December 17, 2009.

Sincerely,

Donald L. Grebner, Associate Professor
Department of Forestry
Mississippi State University

APPENDIX C

LIMDEP ORDERED LOGIT MODEL RESULTS

MODEL 1:

ORDERED;Lhs=V2V1IND;Rhs=ONE,ACRES,PREVHARV,CLIMATE,HABITAT,AESTH,FINANCIA,INVESTME,AGE,EDU1,INCOME;Logit;Brant test; Marginal Effects$

```
Normal exit from iterations. Exit status=0.
+---------------------------------------------+
| Ordered Probability Model                   |
| Maximum Likelihood Estimates                |
| Model estimated: Dec 14, 2010 at 02:58:53PM.|
| Dependent variable              V2V1IND     |
| Weighting variable                 None     |
| Number of observations              511     |
| Iterations completed                 20     |
| Log likelihood function       -370.1647     |
| Number of parameters                 12     |
| Info. Criterion: AIC =          1.49575     |
|   Finite Sample: AIC =          1.49698     |
| Info. Criterion: BIC =          1.59524     |
| Info. Criterion:HQIC =          1.53475     |
| Restricted log likelihood     -392.7736     |
| McFadden Pseudo R-squared      .0575621     |
| Chi squared                    45.21773     |
| Degrees of freedom                   10     |
| Prob[ChiSqd > value] =         .1985952E-05 |
| Underlying probabilities based on Logistic  |
+---------------------------------------------+

+---------------------------------------------+
| Ordered Probability Model                   |
| Cell frequencies for outcomes               |
|  Y Count Freq  Y Count Freq  Y Count Freq   |
|  0    14 .027  1   186 .363  2   311 .608   |
+---------------------------------------------+
+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
---------+Index function for probability
 Constant|    3.57515093       .74171651     4.820   .0000
 ACRES   |    -.00017265     .831467D-04    -2.076   .0379   461.812133
 PREVHARV|     .16477714       .28691766      .574   .5658    .86692759
 CLIMATE |     .32002631       .19763480     1.619   .1054    .39334638
 HABITAT |     .83434570       .28121647     2.967   .0030    .79843444
 AESTH   |    -.64325095       .26951549    -2.387   .0170    .74363992
 FINANCIA|     .77125876       .32905133     2.344   .0191    .82583170
 INVESTME|    -.54801447       .34758930    -1.577   .1149    .83365949
 AGE     |    -.01524320       .00806478    -1.890   .0587   64.8043053
 EDU1    |     .58300031       .20535215     2.839   .0045    .55577299
 INCOME  |     .00345047       .00253504     1.361   .1735   86.1741683
---------+Threshold parameters for index
 Mu(1)   |    3.28301078       .27447388    11.961   .0000

+------------------------------------------------+
| Brant specification test for equal coefficient |
| vectors in the ordered logit model. The model  |
| implies that logit[Prob(y>j|x)]=mj - beta(j)*x |
```

```
| for all j = 0,..., 1. The chi squared test is  |
| H0:beta(0) = beta(1) = ... beta( 1)            |
| Chi squared test statistic =      7.51101      |
| Degrees of freedom         =     10            |
| P value                    =       .67648      |
+------------------------------------------------+
=======================================================================
====
Specification Tests for Individual Coefficients in Ordered Logit Model
(Note, Coefficients for values beyond y = 5 are not reported.)
Degrees of freedom for each of these tests is  1
=======================================================================
====
        |   Brant Test    | Coefficients in implied model Prob(y > j).
|
Variable| Chi-sq  P value |   0    |   1    |   2    |   3    |   4    |   5
|
ACRES   |    .22   .63919 |  .0001| -.0003|
PREVHARV|    .67   .41328 | -.6826|  .2323|
CLIMATE |   1.41   .23561 | -.3126|  .3485|
HABITAT |    .00   .99183 |  .8270|  .8348|
AESTH   |   1.37   .24217 |-1.9799| -.5885|
FINANCIA|    .55   .45908 | 1.2800|  .7191|
INVESTME|    .04   .84832 | -.6870| -.4996|
AGE     |    .01   .91940 | -.0126| -.0150|
EDU1    |    .69   .40778 |  .0970|  .6020|
INCOME  |   1.26   .26231 |  .0141|  .0033|

+----------------------------------------------------------------------
---+
| Summary of Marginal Effects for Ordered Probability Model (logit)
|
+----------------------------------------------------------------------
---+
Variable|    Y=00    Y=01    Y=02    Y=03    Y=04    Y=05    Y=06
Y=07 |
-----------------------------------------------------------------------
---+
ACRES       .0000   .0000   .0000
*PREVHAR   -.0039  -.0355   .0394
*CLIMATE   -.0069  -.0679   .0748
*HABITAT   -.0239  -.1790   .2029
*AESTH      .0124   .1321  -.1446
*FINANCI   -.0221  -.1659   .1880
*INVESTM    .0103   .1121  -.1224
AGE         .0003   .0033  -.0036
*EDU1      -.0135  -.1243   .1378
INCOME     -.0001  -.0007   .0008
+----------------------------------------------------------------------
-----+
|   Cross tabulation of predictions. Row is actual, column is
predicted.    |
|   Model = Logistic  .  Prediction is number of the most probable
cell.    |
```

```
+-------+-------+-----+-----+-----+-----+-----+-----+-----+-----+-----
+-----+
| Actual|Row Sum|  0  |  1  |  2  |  3  |  4  |  5  |  6  |  7  |  8  |
9  |
+-------+-------+-----+-----+-----+-----+-----+-----+-----+-----+-----
+-----+
|      0|     14|    0|    7|    7|
|      1|    186|    0|   51|  135|
|      2|    311|    0|   40|  271|
+-------+-------+-----+-----+-----+-----+-----+-----+-----+-----+-----
+-----+
|Col Sum|    511|    0|   98|  413|    0|    0|    0|    0|    0|    0|
0|
+-------+-------+-----+-----+-----+-----+-----+-----+-----+-----+-----
+-----+
```

Model 2:

ORDERED;Lhs=V3V1IND;Rhs=ONE,ACRES,PREVHARV,CLIMATE,HABITAT,AESTH,FINANCIA,INVESTME,AGE,EDU1,INCOME;Logit;Brant test; Marginal Effects$

```
Normal exit from iterations. Exit status=0.
+----------------------------------------------+
| Ordered Probability Model                    |
| Maximum Likelihood Estimates                 |
| Model estimated: Dec 14, 2010 at 02:50:26PM.|
| Dependent variable              V3V1IND      |
| Weighting variable                 None      |
| Number of observations              511      |
| Iterations completed                 18      |
| Log likelihood function       -335.8327      |
| Number of parameters                 12      |
| Info. Criterion: AIC =          1.36138      |
|   Finite Sample: AIC =          1.36261      |
| Info. Criterion: BIC =          1.46086      |
| Info. Criterion:HQIC =          1.40038      |
| Restricted log likelihood     -359.0456      |
| McFadden Pseudo R-squared      .0646518      |
| Chi squared                    46.42588      |
| Degrees of freedom                   10      |
| Prob[ChiSqd > value] =         .1199971E-05 |
| Underlying probabilities based on Logistic  |
+----------------------------------------------+

+----------------------------------------------+
| Ordered Probability Model                    |
| Cell frequencies for outcomes                |
|  Y Count Freq  Y Count Freq  Y Count Freq    |
|  0    15 .029  1   136 .266  2   360 .704    |
+----------------------------------------------+
+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
---------+Index function for probability
 Constant|    3.43553118       .78977848     4.350   .0000
 ACRES   |    -.00017828     .814424D-04    -2.189   .0286   461.812133
 PREVHARV|     .26648111       .30287025      .880   .3789    .86692759
```

```
 CLIMATE |     .33597989       .21644043     1.552   .1206    .39334638
 HABITAT |     .68824872       .30044410     2.291   .0220    .79843444
 AESTH   |    -.56974795       .29373083    -1.940   .0524    .74363992
 FINANCIA|     .97705993       .33665520     2.902   .0037    .82583170
 INVESTME|    -.54568073       .36705591    -1.487   .1371    .83365949
 AGE     |    -.01737267       .00874748    -1.986   .0470   64.8043053
 EDU1    |     .67773363       .22108974     3.065   .0022    .55577299
 INCOME  |     .00327206       .00274362     1.193   .2330   86.1741683
---------+Threshold parameters for index
 Mu(1)   |    2.76811980       .26102988    10.605   .0000

+-------------------------------------------------+
| Brant specification test for equal coefficient |
| vectors in the ordered logit model. The model  |
| implies that logit[Prob(y>j|x)]=mj - beta(j)*x |
| for all j = 0,..., 1. The chi squared test is  |
| H0:beta(0) = beta(1) = ... beta( 1)            |
| Chi squared test statistic =     12.05221      |
| Degrees of freedom         =     10            |
| P value                    =       .28158      |
+-------------------------------------------------+
=======================================================================
====
Specification Tests for Individual Coefficients in Ordered Logit Model
(Note, Coefficients for values beyond y = 5 are not reported.)
Degrees of freedom for each of these tests is  1
=======================================================================
====
        |   Brant Test    | Coefficients in implied model Prob(y > j).
|
Variable| Chi-sq  P value |   0   |   1   |   2   |   3   |   4   |   5
|
ACRES   |    .06   .80533 | -.0002| -.0002|
PREVHARV|    .00   .98686 |  .3181|  .3040|
CLIMATE |   6.07   .01379 | -.9738|  .3974|
HABITAT |    .26   .60737 | 1.0742|  .6785|
AESTH   |   1.84   .17469 |-2.1514| -.5108|
FINANCIA|    .08   .77873 |  .7785| 1.0235|
INVESTME|    .05   .82867 | -.3400| -.5626|
AGE     |    .23   .63357 | -.0282| -.0170|
EDU1    |   2.73   .09848 | 1.7941|  .6397|
INCOME  |    .69   .40586 | -.0024|  .0037|

+----------------------------------------------------------------------
---+
| Summary of Marginal Effects for Ordered Probability Model (logit)
|
+----------------------------------------------------------------------
---+
Variable|    Y=00    Y=01    Y=02    Y=03    Y=04    Y=05    Y=06
Y=07 |
-----------------------------------------------------------------------
---+
ACRES       .0000   .0000   .0000
*PREVHAR   -.0067  -.0489   .0556
```

```
*CLIMATE   -.0075  -.0587   .0662
*HABITAT   -.0195  -.1294   .1489
*AESTH       .0116   .0951  -.1067
*FINANCI   -.0313  -.1865   .2177
*INVESTM    .0106   .0894  -.1000
AGE          .0004   .0031  -.0035
*EDU1      -.0164  -.1211   .1374
INCOME     -.0001  -.0006   .0007
+-----------------------------------------------------------------------
-----+
|   Cross tabulation of predictions. Row is actual, column is
predicted.    |
|   Model = Logistic  .  Prediction is number of the most probable
cell.    |
+-------+-------+-----+-----+-----+-----+-----+-----+-----+-----+-----
+-----+
| Actual|Row Sum|  0  |  1  |  2  |  3  |  4  |  5  |  6  |  7  |  8  |
9  |
+-------+-------+-----+-----+-----+-----+-----+-----+-----+-----+-----
+-----+
|      0|     15|    0|    2|   13|
|      1|    136|    0|   15|  121|
|      2|    360|    0|   10|  350|
+-------+-------+-----+-----+-----+-----+-----+-----+-----+-----+-----
+-----+
|Col Sum|    511|    0|   27|  484|    0|    0|    0|    0|    0|    0|
0|
+-------+-------+-----+-----+-----+-----+-----+-----+-----+-----+-----
+-----+
```

Model 3:

ORDERED;Lhs=V4V1IND;Rhs=ONE,ACRES,PREVHARV,CLIMATE,HABITAT,AESTH,FINANCIA,INVESTME,AGE,EDU1,INCOME;Logit;Brant test; Marginal Effects$

```
Normal exit from iterations. Exit status=0.
+---------------------------------------------+
| Ordered Probability Model                   |
| Maximum Likelihood Estimates                |
| Model estimated: Dec 14, 2010 at 02:38:18PM.|
| Dependent variable              V4V1IND     |
| Weighting variable                 None     |
| Number of observations              511     |
| Iterations completed                 17     |
| Log likelihood function       -532.4913     |
| Number of parameters                 12     |
| Info. Criterion: AIC =          2.13108     |
|   Finite Sample: AIC =          2.13231     |
| Info. Criterion: BIC =          2.23057     |
| Info. Criterion:HQIC =          2.17008     |
| Restricted log likelihood     -550.1896     |
| McFadden Pseudo R-squared      .0321675     |
| Chi squared                    35.39645     |
| Degrees of freedom                   10     |
| Prob[ChiSqd > value] =         .1068290E-03 |
| Underlying probabilities based on Logistic  |
+---------------------------------------------+
```

```
+---------------------------------------------+
| Ordered Probability Model                   |
| Cell frequencies for outcomes               |
|  Y Count Freq  Y Count Freq  Y Count Freq   |
|  0   130 .254  1   217 .424  2   164 .320   |
+---------------------------------------------+
+---------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+---------+--------------+----------------+--------+--------+----------+
---------+Index function for probability
 Constant|    1.31381629       .62257710     2.110   .0348
 ACRES   |    -.00021920       .00013094    -1.674   .0941   461.812133
 PREVHARV|    -.58595246       .25794666    -2.272   .0231    .86692759
 CLIMATE |     .23338728       .17442320     1.338   .1809    .39334638
 HABITAT |     .81703370       .24857350     3.287   .0010    .79843444
 AESTH   |    -.20885372       .22476218     -.929   .3528    .74363992
 FINANCIA|     .25212079       .28333499      .890   .3736    .82583170
 INVESTME|    -.72144363       .29438455    -2.451   .0143    .83365949
 AGE     |     .00303357       .00706164      .430   .6675   64.8043053
 EDU1    |     .23301757       .18367716     1.269   .2046    .55577299
 INCOME  |    -.00116456       .00229319     -.508   .6116   86.1741683
---------+Threshold parameters for index
 Mu(1)   |    1.92332788       .11453100    16.793   .0000

+------------------------------------------------+
| Brant specification test for equal coefficient |
| vectors in the ordered logit model. The model  |
| implies that logit[Prob(y>j|x)]=mj - beta(j)*x |
| for all j = 0,..., 1. The chi squared test is  |
| H0:beta(0) = beta(1) = ... beta( 1)            |
| Chi squared test statistic =     11.71898      |
| Degrees of freedom         =     10            |
| P value                    =       .30430      |
+------------------------------------------------+
========================================================================
====
Specification Tests for Individual Coefficients in Ordered Logit Model
(Note, Coefficients for values beyond y = 5 are not reported.)
Degrees of freedom for each of these tests is  1
========================================================================
====
        |   Brant Test    | Coefficients in implied model Prob(y > j).
|
Variable| Chi-sq  P value |   0    |   1    |   2    |   3    |   4    |   5
|
ACRES   |    .15   .69800 | -.0002| -.0002|
PREVHARV|   2.79   .09466 |-1.1952| -.4129|
CLIMATE |   1.62   .20250 |  .0746|  .3676|
HABITAT |    .59   .44388 |  .7215|  .9919|
AESTH   |    .24   .62701 | -.2834| -.1339|
FINANCIA|    .45   .50028 |  .0960|  .3859|
INVESTME|    .14   .71234 | -.9003| -.7297|
AGE     |    .51   .47567 |  .0070|  .0002|
EDU1    |    .36   .54997 |  .1484|  .3001|
```

```
INCOME  |    .56   .45249 | -.0024|  .0000|

+----------------------------------------------------------------------
---+
| Summary of Marginal Effects for Ordered Probability Model (logit)
|
+----------------------------------------------------------------------
---+
Variable|    Y=00    Y=01    Y=02    Y=03    Y=04    Y=05    Y=06
Y=07 |
----------------------------------------------------------------------
---+
ACRES       .0000   .0000   .0000
*PREVHAR    .0963   .0377  -.1340
*CLIMATE   -.0426  -.0078   .0504
*HABITAT   -.1680   .0112   .1569
*AESTH      .0376   .0079  -.0455
*FINANCI   -.0485  -.0037   .0522
*INVESTM    .1169   .0488  -.1657
AGE        -.0006  -.0001   .0006
*EDU1      -.0434  -.0063   .0496
INCOME      .0002   .0000  -.0002
+----------------------------------------------------------------------
-----+
|   Cross tabulation of predictions. Row is actual, column is
predicted.    |
|   Model = Logistic  .  Prediction is number of the most probable
cell.    |
+-------+-------+-----+-----+-----+-----+-----+-----+-----+-----+-----
+------+
| Actual|Row Sum|  0  |  1  |  2  |  3  |  4  |  5  |  6  |  7  |  8  |
9  |
+-------+-------+-----+-----+-----+-----+-----+-----+-----+-----+-----
+------+
|      0|    130|   10|  115|    5|
|      1|    217|   12|  170|   35|
|      2|    164|    5|  125|   34|
+-------+-------+-----+-----+-----+-----+-----+-----+-----+-----+-----
+------+
|Col Sum|    511|   27|  410|   74|    0|    0|    0|    0|    0|    0|
0|
+-------+-------+-----+-----+-----+-----+-----+-----+-----+-----+-----
+------+
```