Three Essays on Pine Straw in Alabama:
Needlefall Yields, Market Demands, and Landowner Interest in Harvesting

by

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Abstract

Forestry in the South is undergoing a paradigm shift in which timber production is not necessarily the major ownership objective for landowners. As pulp and other forest products markets wane and smallholders are increasingly cut out of traditional markets, landowners are turning to alternative forms of income. Agroforestry and production of non-timber forest products (NTFPs) offer ways for landowners to generate income while allowing timber to remain standing. In Alabama, pine straw is one NTFP with strong potential, but an undeveloped market as compared to other states. This dissertation explores the market potential of pine straw in Alabama from three perspectives.

First, quantitative analyses were performed on data of needlefall in longleaf stands throughout the Southeast. Relationships were observed between pine straw yields and several independent variables (basal area, age, site index, and tree density). Second, a mail survey was conducted of buyers of pine straw (e.g. retailers and landscapers) to gain an understanding of consumer demand and characteristic preferences. Findings provide insight to management demands of landowners interested in selling pine straw. Third, a mail survey was conducted to assess willingness of landowners to engage in alternative forestry enterprises, including pine straw harvesting operations.

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CHAPTER 1

Introduction

Markets for U.S. timber are disappearing as demand for forest products declines and manufacturing facilities are moved to countries with less expensive labor and raw material. In recent decades there has been an increase in forest industry consolidation (Bliss et al. 2010), transfer and subdivision of large amounts of forest acreage (Wear and Greis 2002), and the decline of long-term ownership (Clutter et al. 2007). Owners of small tracts are increasingly cut out of traditional markets. Landowners seek new ways to generate income from their forestland, while maintaining ecologically diverse, sustainable forest systems.

Timber products marketed and sold in the southeastern U.S. include sawtimber (frequently used to make dimensional lumber) and pulpwood (often used to make paper and packaging). A dismal housing market and struggling retail sales have led to a decline in the traditional timber forest industry. Pine straw, collected from the floors of pine forests throughout the southeastern United States, is considered a non-timber forest product (NTFP) and provides forestland owners with regular, short-term income while allowing tree diameter growth to continue. However, production of NTFPs often requires more intensive management of forests, which studies show non-industrial private forest (NIPF) owners are less inclined toward (Arano and Munn 2006). Workman et al. (2003) discovered that while a large number of forest owners in the U.S. South were familiar with and interested in NTFP production, only a small percentage actually engage in the

activity. There is little information available on why few landowners participate in alternative forestry enterprises. If a NTFP market is to be developed, there needs to be a more thorough understanding of what drives landowner decisions and how their varying management objectives dictate the decision to invest (or not) in such activities.

Harvesting pine straw is considered a form of "forest farming," one category of agroforestry (Hill and Buck 2000). Pine straw is a byproduct of a natural biological process. Needles are shed on an annual basis with higher shed rates occurring in the fall. Pine straw can be used for pet bedding and in livestock barns (Zwolinski and Quicke 1998), though it is most frequently found in flower beds and as other landscaping ground cover. Aside from being decorative, pine straw provides many mulching benefits, which is why it has become a valuable commodity among landscapers across the country. Pine needles interlock and stay in place while protecting against surface erosion, moderating soil temperature and moisture, and inhibiting growth of weeds (Pote et al. 2004). Pine straw reduces runoff and, because it reduces the impact of rain on the soil surface, it protects against compaction (Taylor and Foster 2004). Needle removal from pine forests can have negative impacts (e.g. increased erosion and decreased water infiltration), but landowners can carefully manage to minimize such effects.

Pine straw production yields can vary widely depending on a range of biological variables (species, site index, tree age, basal area, and number of trees per acre) and management practices (fertilization, herbicide usage, harvest intervals, and thinning regimes). Through proper planning and development of a management regime, landowners can harvest straw without jeopardizing the growth potential of their pine trees. Extra income earned from pine straw sales can be used by landowners to cover

living expenses, property taxes (thus, continued ownership), or to further invest in land management. Pine straw is also compatible with many land uses, including timber production. Pine straw can be harvested on marginal or poor quality forest acreage or sites unsuitable for production of traditional timber products, such as pulpwood (Taylor and Foster 2004). Pine straw can also be produced as a primary product, with timber as a secondary product.

In the Southeast, pine straw is usually harvested from the forest floor of three primary Southern pine species often grown by private landowners in plantation systems: longleaf, slash, or loblolly stands. Longleaf pine (*Pinus palustris* Mill.) once dominated the landscape of the U.S. South, but now accounts for approximately 3 million acres (less than 3% of its original range). Longleaf forests are home to a high diversity of plants and animals, many of which are endangered or threatened. The sparse canopy of the trees allows sunlight to reach the ground, making the structure of longleaf forests ideal for multiple-use management (Franklin 2008). Because of its ecological importance, there is a push among conservation organizations to restore the longleaf forest ecosystem. Though native to a wide variety of sites, longleaf pine grows better in sandy, well-drained soils than other tree species. The natural range of longleaf pine extends from southeastern Virginia, down along the Atlantic coast into northern Florida, and west into the coastal plains, piedmont, and ridge and valley regions of Georgia and Alabama, and into eastern Texas (Burns and Honkala 1990). Longleaf pine needles are approximately 20 to 46 centimeters (8 to 18 inches) in length and they usually occur in fascicles of three (Samuelson and Hogan 2006). They appear shiny and dark green in color before falling, usually after two years.

Slash pine (*Pinus elliottii* Engelm.) has a relatively limited native range, growing from the southern tip of South Carolina through south Georgia, down into central Florida and west through south Alabama into southern Mississippi and a portion of eastern Louisiana (Burns and Honkala 1990). Its needles are usually 15 to 28 centimeters (6 to 11 inches) long and occur in fascicles of two or three (Samuelson and Hogan 2006). Before falling (usually after two years) they are shiny and appear green to dark green in color.

Loblolly pine (*Pinus taeda* L.) is considered the South's most commercially important species and accounts for more than one-half of the region's pine volume. Its native range includes 14 states, extending from southern New Jersey to central Florida and west into eastern Texas (Burns and Honkala 1990). Almost the entire states of Alabama and Georgia fit in this species' range. Needles of the loblolly pine are usually 12 to 23 centimeters (5 to 9 inches) long and occur in fascicles of three, sometimes four (Samuelson and Hogan 2006). They appear green to dark green in color before falling, usually after three to four years.

Despite the presence and abundance of all three species in Alabama, the pine straw market is less developed in the state than in other southern states. North Carolina, Florida, and Georgia are considered to be the leaders in the pine straw industry (Mills and Robertson 1991). One source states that in North Carolina in the mid- to late-1980s the pine straw industry reached $10 million in retail sales (Mills and Robertson 1991); another source estimates that in 1996 pine straw was a $50 million business in the state (Rowland 2003). A report estimates that in 2003 pine straw accounted for $79 million in

value sold by Florida landowners, exceeding sales of chip-and-saw logs and sawtimber (Hodges et al. 2005).

The state with the most detailed records regarding pine straw production is Georgia. Figure 1.1 shows the farm gate value for pine straw in Georgia starting in 2000 (the first year the University of Georgia Center for Agribusiness and Economic Development compiled data for pine straw as a separate commodity). In 2000, pine straw was valued at $15,563,253 and accounted for 2.1% of the forest products market (Doherty et al. 2001). Of 56 commodities listed for the state, pine straw ranked 37th. Boatright and McKissick (2010) estimate that in 2009, pine straw contributed more than $81 million to Georgia's economy (an increase of 420.5% from the 2000 commodity figures), and accounted for more than 16% of the forest products market. Of 61 commodities listed for the state that year, pine straw ranked 25th. According to the Alabama Forestry Commission's Forest Resource Report for 2008 (Alabama Forestry Commission n.d.), the state's forest products total was $791 million. If pine straw were to account for 16% of the forest products market (like it does in Georgia), it could potentially yield cash receipts of $129 million.

Alabama ranks number two in the country in terms of the percent of forestland owned by non-industrial private landowners – second only to Georgia (Alabama Forestry Commission 2011). Alabama, Georgia, Florida and Mississippi contain more than half of the area of pine plantations in the South. In 1995, Alabama ranked third in the area of pine plantations on private land, but is expected to surpass Florida and become second by 2040 (Wear and Greis 2002). It is difficult to estimate pine straw harvests for Alabama; yields are not reported in the state's Agricultural Statistics.

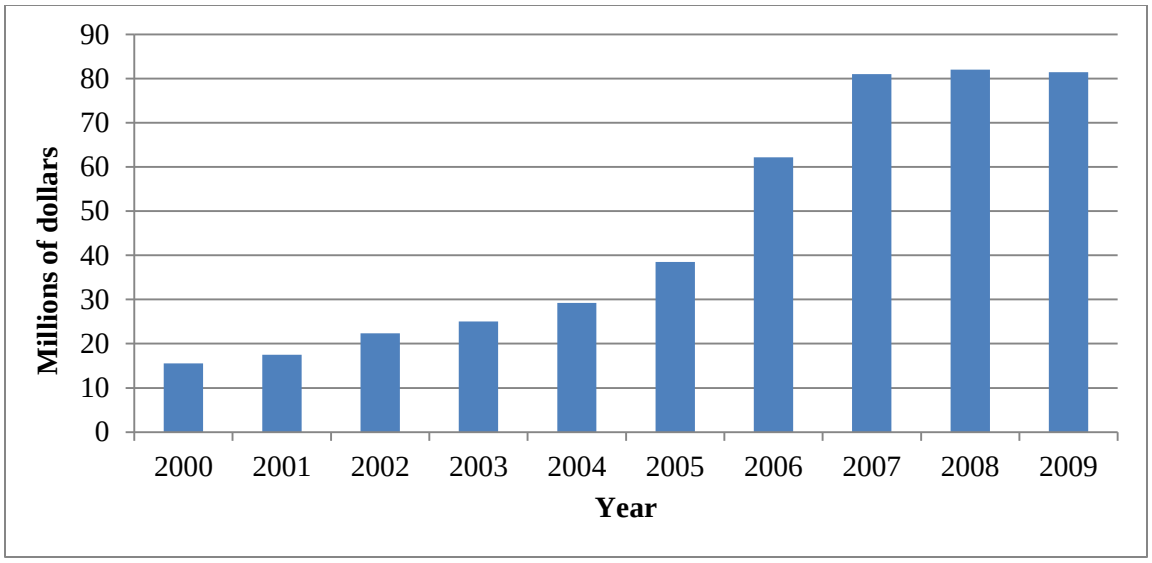

Figure 1.1. Farm gate value for pine straw in Georgia, 2000-2009, University of Georgia Center for Agribusiness and Economic Development

Despite the high potential for pine straw production in Alabama's many pine forests, the market is not well developed. One possible explanation for this is the lack of outreach programming and publications geared toward the state's landowners. Other states' Extension systems and landowner organizations have been promoting pine straw as a marketable product for years (e.g. the North Carolina Pine Needle Producers Association, which collaborates with the Forest Service and North Carolina State University, was formed in 1988). Another reason why Alabama lags behind Georgia (a state with similar percentages of nonindustrial private forest owners) in the production and sale of pine straw may be the difference in pine species composition in the two states. Longleaf and slash are considered highly desirable by the industry, largely because of their longer needle lengths, while loblolly is less desirable (Mills and Robertson 1991; Nix 2011; Mance et al. n.d.). A comparison of pine species group by area for the two

states is made in Figure 1.2. Data from the Forest Inventory and Analysis (FIA) National Program provide acreages at the county level for pine groups (USDA Forest Service 2011). In In FIA data provided for pine species in the South, acreages are classified into three groups: longleaf/slash, loblolly/shortleaf, and white/red/jack (though, only a handful of counties in Alabama and Georgia reported acreage for this group). There was a 108.7% difference in the area of sampled longleaf/slash pine group forestland between the two states for 2010; Georgia had more than three times the acres in longleaf/slash than Alabama. There was a 12.7% difference in area of loblolly/shortleaf, with Georgia having approximately one million fewer acres in loblolly/shortleaf than Alabama.

Between 2000 and 2010 there were counties in both states that saw decreases in longleaf/slash acreage as well as counties that saw increases. FIA data show that during this time 23.9% of counties in Alabama saw a decrease in area of sampled longleaf/slash pine group forestland; counties had an average percentage change of -37.0. In Georgia 20.8% of counties saw a decrease in area of longleaf/slash, with the change averaging -25.0%. Therefore, a smaller percentage of Georgia counties saw a decrease in longleaf/slash acreage and those decreases were smaller, on average, than those in Alabama. When looking at increases in longleaf/slash acreage, Georgia again fares better. Between 2000 and 2010, 25.4% of Alabama counties saw an increase in longleaf/slash acreage, with percent changes averaging 50.4%. In Georgia, 30.2% of counties witnessed an increase in longleaf/slash acreage, with percent changes averaging 53.6%. Therefore, a higher percentage of Georgia counties saw an increase in longleaf/slash acreage and those increases were larger, on average, than those in

Alabama. In both states, roughly half of the counties reported no change in the area of sampled longleaf/slash between 2000 and 2010.

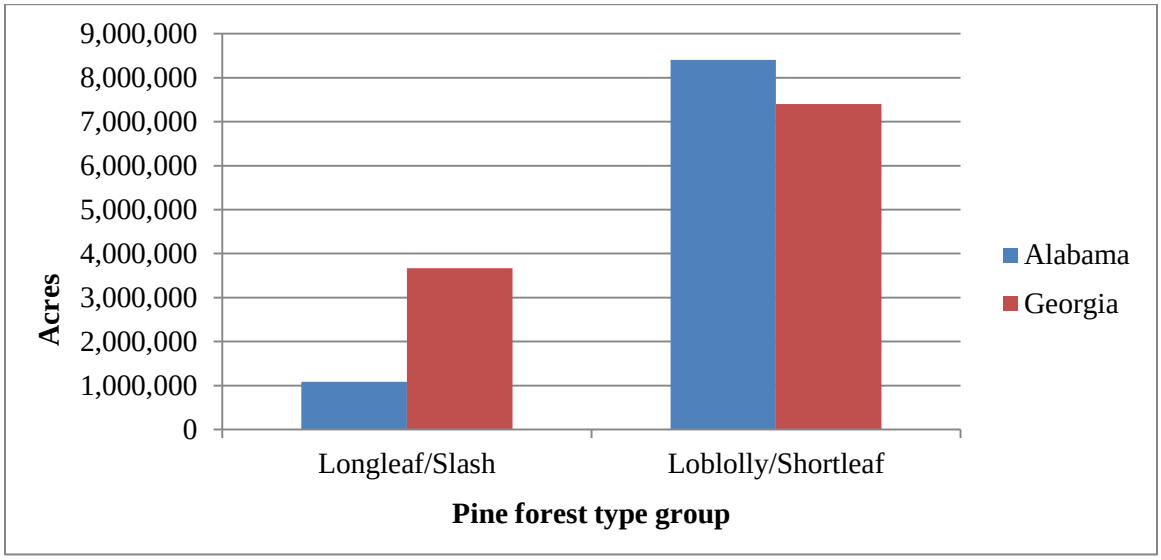

Figure 1.2. Area of sampled forestland in Georgia and Alabama by forest type group, 2010 Forest Inventory and Analysis (FIA)

In 2009 the top pine straw producing county in Georgia (Laurens County) harvested straw from about 55,000 acres at an average per-acre value of $125, totaling $6,875,000 (Boatright and McKissick 2010). In the 2000 Georgia Farmgate Value Report, pine straw was valued at approximately $35 per acre (Doherty et al. 2001). That year Laurens County reported harvesting straw from 50,500 acres for a total farm gate value of $1,767,500. Therefore, during this ten-year span, the top pine straw producing county in the state saw a 289% increase in cash receipts from pine straw. This prompted an exploration of how forestland acreage between the two pine species groups might have changed during that time in Laurens County. Figure 1.3 shows the acreage of private forestland by forest type groups sampled in FIA data year spans starting in 1997 and

ending in 2010. Not only does this figure demonstrate a steady increase in area of longleaf/slash, it also shows that in Laurens County, the longleaf/slash pine group surpassed loblolly/shortleaf in the latter half of the decade.

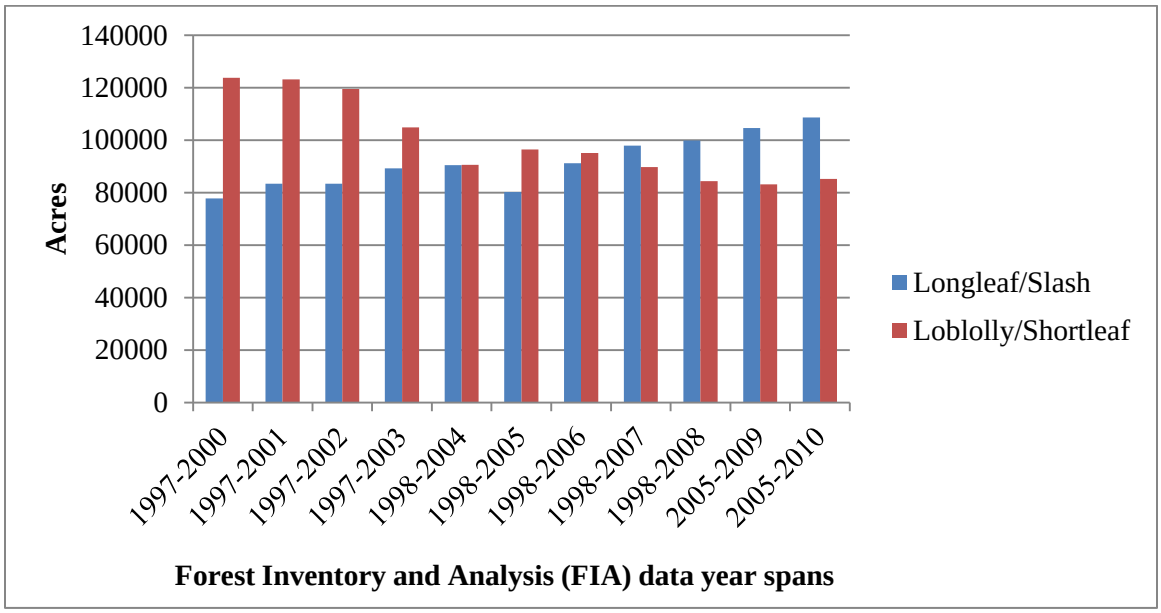

Figure 1.3. Area of sampled private forestland by forest type group in Laurens County, Georgia, Forest Inventory and Analysis (FIA)

Laurens County, Georgia, saw a significant increase in longleaf/slash acreage and in farm gate value from pine straw during a 10-year time span. While it is unclear what factors prompted these drastic changes, there is no doubt that landowners and forest laborers in the region, as well as the state's agricultural economy as a whole, likely benefitted from the production and marketing of pine straw. Such benefits might include income for landowners, employment for harvesters, business contracts for pine straw dealers, and retail sales profits for manufactures of equipment used in pine straw collection. There is a need to explore how Alabama counties can reap similar benefits.

For instance, researchers can consider what changes in forestland composition and structure or marketing outlets would lead to a more robust pine straw industry in the state.

This dissertation examines three distinct, but related aspects of the pine straw industry in Alabama: the biological production potential of longleaf forests, market demands and characteristic preferences of pine straw buyers, and landowner willingness to engage in production of non-timber forest products, including pine straw. A greater understanding of each of these will contribute to a clearer picture of a little-understood market dependent on informal social networks (e.g. landowners and pine straw dealers linked through word of mouth). To achieve the research objectives, this dissertation presents the results of three separate studies:

1. The first study (Chapter 2) was based on secondary biological data of forest stands located throughout the Southeast. The chapter explores how biological characteristics of forest stands influence the amount of needlefall. The chapter begins with a review of scientific publications and "gray" literature that have presented needlefall estimates based on varying factors related to forest structure or productivity. Correlation and regression analyses are used to determine what variables influence production rates of pine straw. This chapter sets up the biological framework within which the other components of the overall study can be evaluated.
2. The second study (Chapter 3) examines the market demands and characteristic preferences for pine straw among pine straw buyers in Alabama. It begins with a discussion of pine straw as a market commodity and general characteristics of the product. Results from a mail survey of buyers of pine straw in six Alabama cities

provide descriptive statistics as well as data for statistical analyses. Statistical tests are used to evaluate differences in responses by region and respondent buyer type.

3. The third study (Chapter 4) explores the role of forestland owners in the pine straw market commodity chain. The primary research question addressed in this chapter is: What factors influence a forestland owner's interest in or willingness to harvest pine straw? The chapter begins with a discussion of landowners and agroforestry systems in general. It also discusses land management issues associated with pine straw harvesting operations.

CHAPTER 2

Pine Straw Yields in the Southeastern United States and Alabama

2.1. Introduction

Pine straw yields (the amount of pine needles that fall to the forest floor) vary depending on a variety of factors. Such factors include tree species, site quality, stand density and stocking, stand age, available nutrients, weather conditions, and silvicultural practices (such as fertilization) (Duryea 2000, Rowland 2003, Dickens et al. 2005). Other factors affect how much pine straw can efficiently be harvested from a site, such as baling method (hand or mechanical), road access, season of harvest, how frequently a stand is raked, and general stand conditions (including cleanliness of the understory and topography) (Mance et al. n.d., Taylor and Foster 2004). A plantation that is flat and has an understory free of vegetation and debris will facilitate raking much more so than a sloping natural stand where vegetation has not been controlled (Morris et al. 1992, Taylor and Foster 2004). Also important are factors indirectly related to a stand, but nonetheless important in terms of whether pine straw operations are feasible, such as proximity to markets.

The goal of this chapter is to present a biological framework within which the remaining components of the study can be evaluated. It is based on analyses of pine straw yield data collected as part of the Regional Longleaf Growth Study (Kush et al. 1987). The information collected and generated through tasks associated with this study provides a quantitative assessment of the biologic potential of longleaf pine forests, based

on various stand characteristics. This information is crucial to knowing production potential and, therefore, market potential of longleaf pine straw in the Southeast. Research questions to be addressed in the study include: What variables show strong correlations to higher needle fall? How do interactions of different site characteristics impact pine straw production? What stand characteristics appear to have the most impact on pine straw production?

In a number of technical reports and outreach publications, general ranges of pine straw yields are given for different species, often based on one or two factors (such as basal area or stand age) (see, e.g., Duryea 2000, Gresham 1982, Blevins et al. 2005). A collection of these estimates and their parameters is shown in Table 2.1. Estimations provided in such gray literature are usually not specific to any particular location and are only given to help landowners get a rough idea of how much pine straw they can expect to sell from their property. Ranges are usually reported on a bales-per-acre basis, and often do not specify how large a bale is. Because pine straw is harvested using a wide variety of methods and machinery, there is no industry standard for bale sizes or weights (Mills and Robertson 1991). There is a limited amount of academic literature available on pine straw yields for the Southeast. This paper is an attempt to help fill that information gap.

Table 2.1. Pine straw yields reported in various publications

Publication	Location	Criteria	Stand/criteria description	Bales per acre per year	Bale size
Dickens et al. 2005	U.S. Southeast	Species	Loblolly	150-275	NR[1]
			Slash	125-250	
			Longleaf	80-200	
Taylor and Foster 2004	Texas	Basal area	Loblolly, 75 sq.ft./ac.	125	30 lbs
			Loblolly, 125 sq.ft./ac.	175	
Duryea 2000	Florida	Age	Longleaf, 6 years	50-75	NR
			Longleaf, 10 years	125-200	
			Longleaf, 15 years	200-300	
			Longleaf, >15 years	~200	
Hayes et al. 2009	Southeast Georgia	Average	Slash, spacing ranging from 726-807 trees per acre, average over nine years	238	NR
Blevins et al. 2005	North Carolina and South Carolina	Site index and basal area	Longleaf, site index of 60, basal area of 80 sq.ft./ac.	88	25 lbs
			Longleaf, site index of 90, basal area of 180 sq.ft./ac.	192	
Gholz et al. 1985	Northern Florida	Age	Slash, average from 6 to 36 years	115	25 lbs
			Slash, peak age (15 to 16 years)	160	
Gresham 1982	Coastal South Carolina	Average weight of pine foliage[2]	Loblolly, 90 to 100 years old, basal area of 44 sq.ft./ac.	156	NR[3]
			Longleaf, 130 to 140 years old, basal area of 47 sq.ft./ac.	74	

[1]NR=not reported

[2]Excluding wood, fruit, and foliage from other species

[3]Weights given in kilograms per hectare; converted to pounds per acre and divided by 25 to get estimate number of bales

There is a need for information or tools that would allow landowners to conduct more accurate analyses and develop more realistic estimates of the amount of pine straw that can be feasibly harvested (thus, the amount of income that can be reaped). When landowners make investment or land management decisions based on inappropriate information or inaccurate estimations, there is potential for economic as well as ecological harm. For example, if a landowner has unrealistically high expectations regarding the amount of pine straw that a forest stand should yield or does not follow recommended harvesting schedules, he may over-harvest, which can have negative impacts on soil conditions and slow growth of timber.

Dickens et al. (2005) provide some rough estimates for pine straw yields on loblolly, longleaf, and slash stands. The yields reported are based on nine studies in the southeastern United States. The authors state that for longleaf, the common production range is 80 to 200 bales per acre; what size or weight is represented by a bale is not specified. The low range given for longleaf is 60 to 80 bales per acre and the high range is 150 to 250 bales per acre. Common ranges reported for loblolly and slash are 150 to 275 and 125 to 250 bales per acre, respectively.

Some authors provide rough estimates of pine straw production based on stand density. Taylor and Foster (2004) state that stands with approximately 75 square feet per acre of basal area will produce about 125 thirty-pound bales per acre. Stands with a basal area of about 125 square feet per acre will yield approximately 175 thirty-pound bales per acre. Other authors provide production estimates based on stand age. Pine straw yields usually peak well before stands reach rotation age (Gholz et al. 1985), and many authors recommend beginning harvesting operations as early as 7 or 8 years old (Taylor and

Foster 2004, Duryea 2000, Morris et al. 1992). Duryea (2000) estimates that at age 6, yields will be around 50 to 75 bales per acre. At age 10 yields will be between 125 and 200 bales per acre. Maximum yield is reached at age 15, when production reaches 200 to 300 bales per acre. After this age, Duryea says, yield decreases to about 200 bales per acre.

In their study of six slash pine stands planted at two different spacings (amounting to 726 and 807 trees per acre), Hayes et al. (2009) harvested an average 238 bales per acre per year over a period of nine years. The property had been intensively managed with annual herbicide treatments and removal of large woody debris. Prior to pine straw operations, various herbicide treatments were applied and the stands were commercially mowed. In 2006, at age 16 and two years before the final pine straw harvest, basal area on the six stands averaged 126 square feet per acre.

Blevins et al. (2005) present a table of predicted annual longleaf pine straw production (in oven-dry pounds) based on site index (at a base age of 50) and basal area. Oven-dried weight is approximately 20 to 30% lighter than purchased weight. Site indices included in the table range from 60 to 90 (in increments of 10) and basal areas included in the table range from 80 to 180 square feet per acre (in increments of 20). Site index is a measure of the quality of a site and its productivity based on the average heights of the tallest trees in a stand at a given base age. Basal area refers to the area of the cross sections of tree trunks at 4½ feet above the ground and inclusive of the bark. Using Blevins et al.'s (2005) table to predict pine straw production, on a stand with a site index of 80 and a basal area of 100 square feet per acre, it is predicted that the stand would yield approximately 3,300 pounds (132 twenty-five-pound bales) per acre of pine

straw annually. This table was based on data collected from 29 plots in North and South Carolina. This table will provide a basis for comparison later in the paper.

Perhaps one of the more frequently-cited sources on litterfall and needle yield is Gholz et al. (1985). The authors report pine needle yields and needle decomposition rates on slash pine stands in northern Florida. The average dry mass of annual total needlefall for all stands (ranging from age 6 to 36) was 3,218 kilograms per hectare (the equivalent of 2,871 pounds per acre, or 115 twenty-five-pound bales). Needlefall peaked at age 15 to 16 years old, where it reached approximately 3,973 pounds per acre. This is the equivalent of about 160 twenty-five-pound bales per acre. It is important to note, however, that Gholz et al. (1985) do not provide basal areas for the stands.

Peak season for needlefall can vary by local climate conditions. Pote and Daniel (2008) state that peak season occurs in late summer or early fall during dry years, but later during wet years. During the years of their study (1980-1982), Gholz et al. (1985) noted a strong effect of season, stand age, and an interaction between the two variables for needlefall. Needlefall was greatest in the fall (September to November) and lowest in the winter (December to February). Among the older slash pine stands, between 31 and 44% of annual needlefall took place during the three fall months. The authors note that the increase of litterfall in the spring (March to June) corresponded with convectional storms and may have been the result of crown disturbance caused by rain and winds. Drought conditions can also contribute to higher litterfall. Significant seasonal differences were also found in concentrations of nitrogen and phosphorus in needle litterfall, with inputs highest in the fall and lowest in the winter. There were also seasonal effects on decomposition; warmer, wetter periods of the year saw higher levels

of decay. On average, over the 24-month period, there was a 15% mass loss per year of organic matter from decomposing needle litter.

Stand age displayed a strong effect on needlefall. There was a steep increase in needlefall from age 6 to age 15 (Gholz et al. 1985). At age 15, the authors note, is when the stands reached maximum foliage biomass. After age 15, and coinciding with a decline in foliage biomass, needlefall declined before slightly leveling out. For the first 18 months of Gholz et al.'s (1985) study, stand age did not have a significant effect on organic matter losses from decomposition; at 24 months, however, there was a significant stand age effect. Older stands (aged 35 and 27) showed slower mass losses of needles than younger stands (aged 6, 3, and 9). Older stands also showed greater accumulations of phosphorus.

The objectives of this study were to determine pine straw yields on natural longleaf pine stands using more inclusive data than those found in studies cited above. It is unknown exactly how many acres of natural longleaf are found in Alabama, but FIA data approximate that there are more than 765,000 acres of the longleaf/slash pine group in the state (USDA Forest Service 2011). Using regression techniques on data collected from natural longleaf stands, influences on needle yield from independent variables can be observed. This information can be used by landowners to make estimates about the biological potential of their stands to produce pine straw.

2.2. Methods

This study was conducted according to three main tasks:

Task 1. Obtain data, including trees per acre, basal area, site indices, stand locations (by county), and needle fall by weight, for longleaf pine plots throughout the Southeastern United States.

Task 2. Create a dataset and organize information in preparation of analysis.

Task 3. Using SPSS, generate descriptives and conduct statistical analyses to document trends and relationships between variables with needlefall yield as the primary dependent variable.

In the mid-1960s the U.S. Forest Service established the Regional Longleaf Growth Study (RLGS) to track growth and mortality of naturally-regenerated, even-aged longleaf pine (*Pinus palustris* Mill.) stands in five Southeastern states (Mississippi, Alabama, Georgia, Florida, and North Carolina). The study, now in its 45-year re-measurement, includes collection of pine straw yield data (needle fall) on more than 200 plots (Meldahl et al. 1997). The primary silvicultural techniques used in the management of the stands are periodic thinning and prescribed fire. Management plans called for stands to be burned during winter every three years, though depending on the agency and personnel responsible, season and frequency of burns varied (John Kush, Director, Longleaf Pine Stand Dynamics Laboratory, personal communication, January 10, 2012).

During a five-year period of the study, litterfall was collected from a subsample of the RLGS plots in 3 feet by 3 feet traps. There were three to four litter traps per plot (plots were either one-fifth or one-tenth acre in size). For the most part, litter was measured monthly starting in fall of the first year, then ending partway through the fifth year. During winter months (when needlefall declines), litter was collected less frequently. Needles were ovendried at 65 to 70 degrees Celsius for at least 72 hours and

then measured to the nearest 1/100th of a gram. Figure 2.1 shows the locations of pine straw data collection by county.

Figure 2.1. County locations of data collected as part of the Regional Longleaf Growth Study

Task 1 was to obtain data from study plots that included needle fall measurements. Task 2 involved creating a dataset, using Microsoft Excel, and organizing the information in a manner useful for analysis. Measurements were converted to English units, and classes defined for site index, age, basal area, and density (classes are ranges of the number of trees per acre based on square tree spacings). The resulting dataset was imported into SPSS to allow for generation of descriptive statistics and statistical analyses (Task 3). Tests were run to check for correlations between the independent variables and the dependent variable (pine straw yield). Multiple regressions were also run to determine which variables were the strongest predictors of pine straw yield. An alpha level of .05 was used to determine statistical significance. All tests were

run using annual averages on a plot-by-plot basis in order to avoid over-representation of those plots that were measured more times during the five-year study period than others.

2.3. Results

2.3.1. Results for All RLGS Plots

Table 2.2 displays descriptives of the longleaf stands and pine needle yield data generated through the Regional Longleaf Growth Study. There were 201 plots with an average of 38 recordings per plot between 1993 and 1997. All data were recorded in metric units then later converted to English.

Table 2.2. Descriptive statistics of data collected on longleaf stands as part of the Regional Longleaf Growth Study (RLGS), 1993-1997[1]

Variable	Unit	Minimum	Maximum	Mean	Standard Deviation
Age	Years	18	110	51	27
Density	Trees per acre	15	4452	551	800
Basal area	Square feet per acre	22	152	80	36
Site index (base age 50)	Based on height in feet	43	89	70	11
Needle fall	Pounds per acre per year, dry weight	857	6174	3221	1174
Pine straw	Bales per acre per year[2]	46	335	175	64

[1]Data collected on 201 plots between 1993 and 1997

[2]Based on 20-pound green weight bales

Descriptives shown in Table 2.2 were generated based on plot averages across the five years. On average, stands were 51 years old with approximately 551 trees per acre. Basal area averaged 80 square feet per acre and site index averaged 70 feet, with a base age of 50. Mean needle fall (dry weight) was 3,221 pounds per acre per year. This amounts to an average of 175 bales per acre per year, based on 20-pound green-weight

bales. All pine straw yields reported in this chapter are based on the amount of needles caught in study traps. The amount of pine straw that can be feasibly harvested from a stand will vary, but will in any situation be less than the total amount of litter that falls to the forest floor. Morris et al. (1992) reported that in one Georgia study, about 75% of the ground surface is raked during commercial pine straw operations. Therefore, not all pine straw present on the forest floor can be collected, and not all portions of the forest floor are accessible or available for harvesting.

Table 2.3 is a reproduction of the table appearing in Blevins et al (2005) titled "Table 1. Predicted annual longleaf pinestraw production related to stand basal area and site index (in oven-dry pounds)." It is unclear what age the trees were or whether the stands (found on 29 plots in North and South Carolina) were natural or plantations. The data are presented here to provide a basis for comparison between the pine straw yields predicted by the authors and the yields measured as part of the Regional Longleaf Growth Study (RLGS). Table 2.3 also displays pine straw production on the RLGS plots by site index and basal area classes used in Blevins et al. (2005). In the RLGS, there were no plots with basal areas that fell within the 180 square feet per acre class. With the exception of the RLGS plots with site indices in the 90 feet class, all stand density/site quality combinations yielded higher levels of pine straw production than predicted by Blevins et al. (2005). It is important, however, to recognize that other factors affect needle fall besides stand density and site quality. These factors could account for the difference between predicted yields reported by Blevins et al. (2005) and those measured as part of the RLGS.

Table 2.3. Needlefall estimates, in pounds per acre, given by Blevins et al. (2005) compared to needlefall yields of the Regional Longleaf Growth Study (RLGS) data, 1993-1997, by site index and basal area classes

	Site Index Base Age 50			
Basal Area	60	70	80	90
Blevins et al. 2005				
80	2,200	2,500	2,900	3,200
100	2,500	2,900	3,300	3,700
120	2,700	3,200	3,600	4,100
140	2,900	3,400	3,900	4,400
160	3,100	3,600	4,100	4,600
180	3,200	3,700	4,200	4,800
Data from RLGS				
80	2,738	3,609	3,865	2,755
100	3,247	3,747	3,631	N/A
120	4,055	4,192	4,196	3,662
140	4,541	4,250	4,120	N/A
160	3,949	4,272	N/A	N/A
180	N/A	N/A	N/A	N/A
Difference between two				
80	-538	-1109	-965	445
100	-747	-847	-331	N/A
120	-1355	-992	-596	438
140	-1641	-850	-220	N/A
160	-849	-672	N/A	N/A
180	N/A	N/A	N/A	N/A

Needlefall by Month

As noted earlier, Gholz et al. (1985) examined seasonal differences in needlefall, offering possible explanations for these differences. The data collected in the RLGS supports Gholz et al.'s conclusion that needlefall is heaviest in the fall. Figure 2.2 displays weights of dry needles by month for the 201 plots over the five-year study period. October and November had the highest mean weights with 618.05 and 570.29 pounds per acre, respectively. February had the lowest needlefall with 81.15 pounds per acre – about one-seventh the mean weights of the months with the heaviest needlefall.

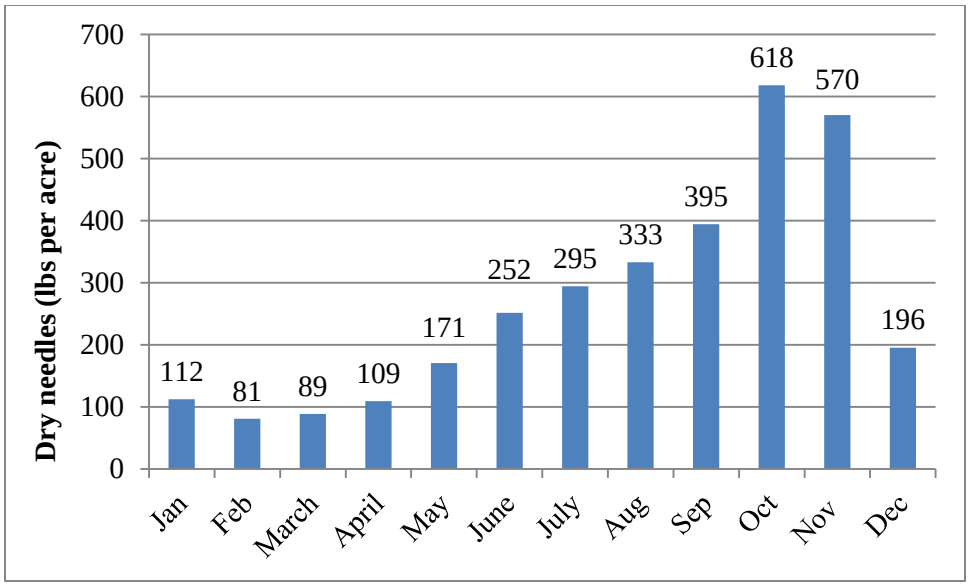

Figure 2.2. Mean needlefall by month, Regional Longleaf Growth Study, 1993-1997

Correlations for All RLGS Plots

Pearson's correlations were run to observe the relationships between the dependent variable (pine needle yield in green bales per acre) and the independent variables (basal area, age, site index, and trees per acre). The results of those tests can be seen in Table 2.4. There were correlations between pine straw yield and each of the four independent variables, all significant at the 0.001 level. Each of the relationships was positive, except between pine straw yield and age. There were also significant relationships between basal area and site index ($p<0.05$) and between basal area and trees per acre ($p<0.001$); these were positive correlations. The relationship between age and trees per acre was negative and significant the 0.001 level.

Table 2.4. Correlations between pine needle yield (in green bales per acre) and independent variables used in analyses for all Regional Longleaf Growth Study (RLGS) plots, 1993-1997 (N=201)

Variable		Basal area	Age	Site index	Trees per acre
Green bales	Pearson's R	0.743	-0.289	0.333	0.428
	P	0.000	0.000	0.000	0.000
Basal area	Pearson's R		0.008	0.150	0.385
	P		0.906	0.034	0.000
Age	Pearson's R			-0.064	-0.559
	P			0.363	0.000
Site index	Pearson's R				-0.081
	P				0.253

A series of column charts were developed to illustrate the relationships between independent variables as they relate to the dependent variable (needle yield in green bales per acre). Mean values are presented based on classes of the independent variables. Age classes are in 20-year increments starting at 20. Basal area classes are in increments of 30 square feet per acre. Site index classes are in increments of 10, starting at 40 (in feet, with a base age of 50). Tree density classes were developed based on tree spacings and typical management scenarios. Different densities and tree spacings offer options in terms of ownership objectives, whether managing for a particular wildlife species or growing certain timber products. For example, a landowner managing for wildlife may opt for wider tree spacings; the wildlife density class ranges from 194 trees per acre (15 feet by 15 feet spacing) to 436 trees per acre (10 feet by 10 feet spacing).

Figure 2.3 shows mean pine straw yield (in green bales per acre per year) by tree density class at various site index classes. At lower densities, pine straw yields were fairly consistent across site index classes. As density increased, stands with higher site indices yielded much higher amounts of pine straw than stands with lower site indices.

There was no statistically significant correlation between the two variables using Pearson's R.

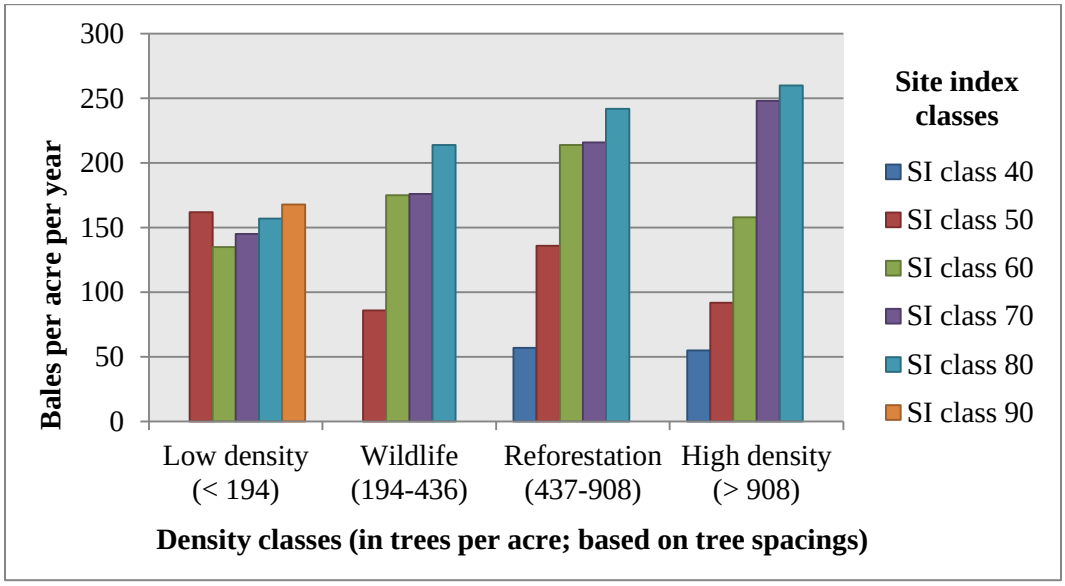

Figure 2.3. Mean pine straw yield, in green bales per acre per year, by tree density class at various site index classes, Regional Longleaf Growth Study, 1993-1997

Pine straw yield (in green bales per acre per year) by basal area class is shown in Figure 2.4. Younger stands (those in the 20 and 40 age classes) had consistently higher yields than older stands across all basal area classes. As basal area increased, so too did pine straw yield. However, once basal area reached about 120 square feet per acre (when looking at 30-square-feet increments), younger stands with lower basal area produced more pine straw than older stands with higher basal area.

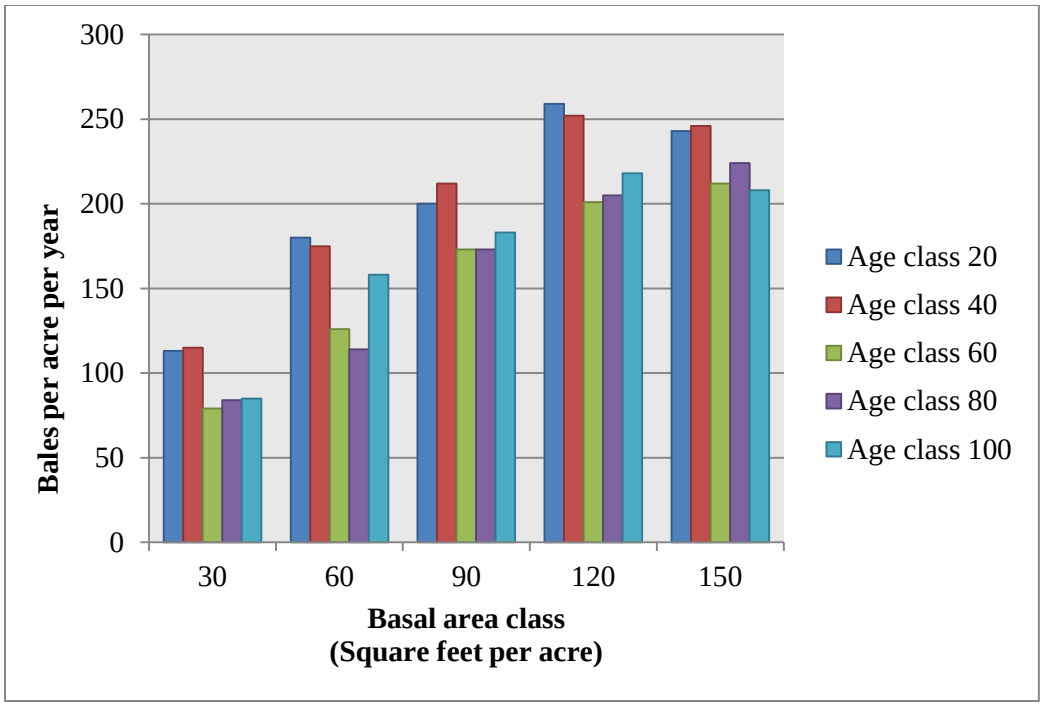

Figure 2.4. Mean pine straw yield, in green bales per acre per year, by basal area class at various age classes, Regional Longleaf Growth Study, 1993-1997

Pearson's R for basal area and site index was significant at the 0.05 level, showing a strong, positive relationship between the two independent variables. Neeldefall yields on stands with the highest site indices appeared low when compared to other site index classes; however, only six plots (with an average TPA of 66) fell in the 90 site index class. For the most part, plots with higher site indices produced more pine straw than plots with lower site indices. This relationship appeared strongest at lower basal areas (Figure 2.5). Once basal area reached about 120 square feet per acre, plots at different site indices produced more equivalent amounts of pine straw. Thus, at higher basal areas site index appears to be less of a factor in determining pine straw yield than it is at lower basal areas, where there is a direct, positive relationship.

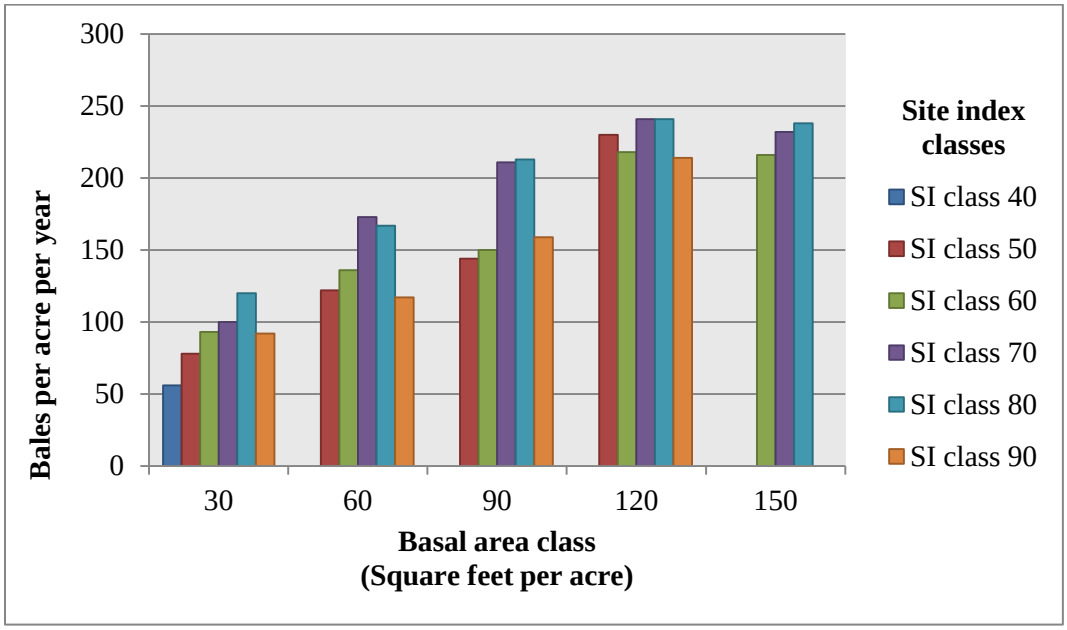

Figure 2.5. Mean pine straw yield, in green bales per acre per year, by basal area class at various site index classes, Regional Longleaf Growth Study, 1993-1997

Figure 2.6 shows mean pine straw yield by basal area class at various tree density classes. The Pearson's correlation between these two independent variables was significant at the 0.001 level. With a couple of exceptions (namely in the 30 square feet per acre basal area class and also in the 90 square feet per acre class), pine straw production generally appeared to increase both as basal area and the number of trees per acre increased. Again, as plots reached around 120 square feet per acre, pine straw production appeared to reach a maximum.

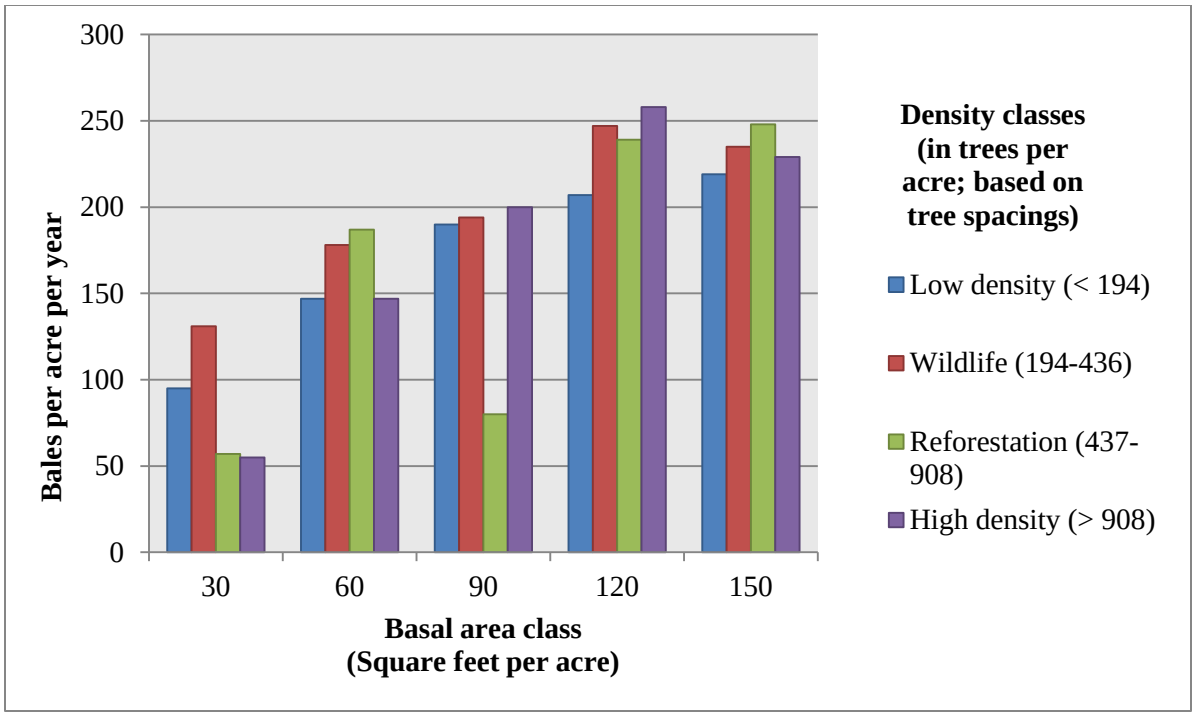

Figure 2.6. Mean pine straw yield, in green bales per acre per year, by basal area class at various tree density classes, Regional Longleaf Growth Study, 1993-1997

The Pearson's correlation between tree density and age was significant at the 0.001 level. While there was a strong relationship between the two independent variables, the impact of this relationship on pine straw production was less clear when looking at the column chart (Figure 2.7). However, at only the lowest density class was all five age classes represented in the data.

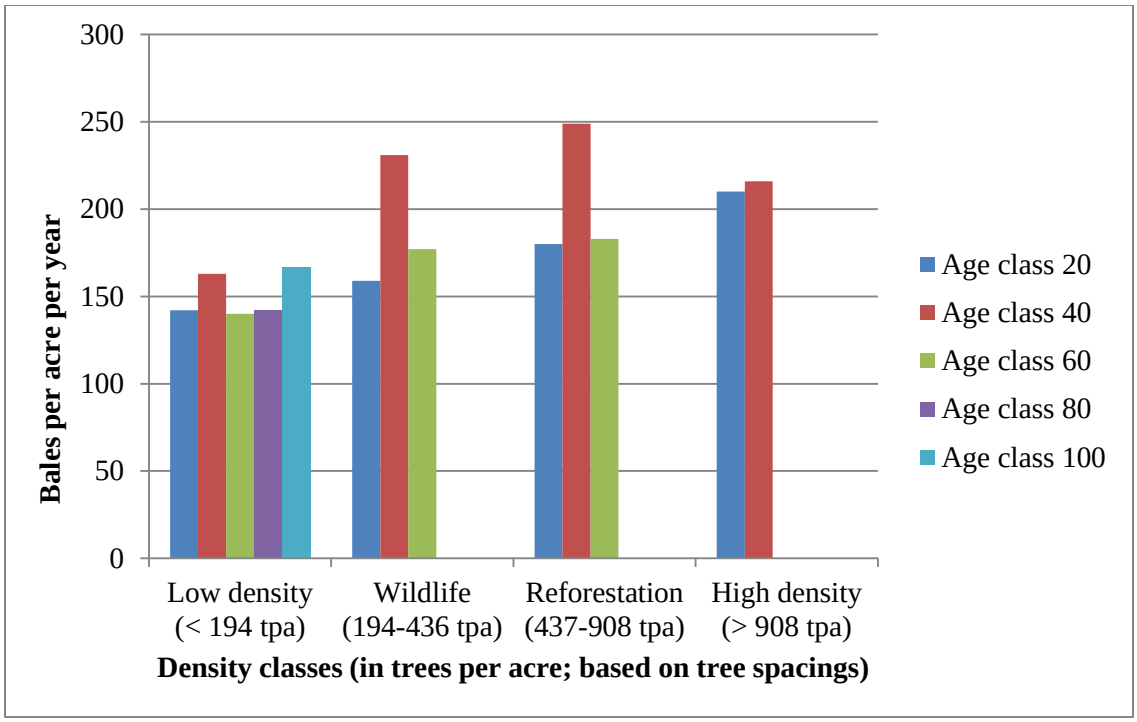

Figure 2.7. Mean pine straw yield, in green bales per acre per year, by tree density classes at various age classes, Regional Longleaf Growth Study, 1993-1997

Pine straw yield by age class at various site index classes is shown in Figure 2.8. There was no statistically significant correlation between these two variables. However, looking at the column chart produced using the RLGS dataset, site index appeared to be a significant factor in the amount of pine straw produced in stands around 20 years old, with stands with higher site indices producing much more pine straw. As stand age increased, however, this relationship became less apparent, with plots at various site indices producing more equivalent amounts of pine straw.

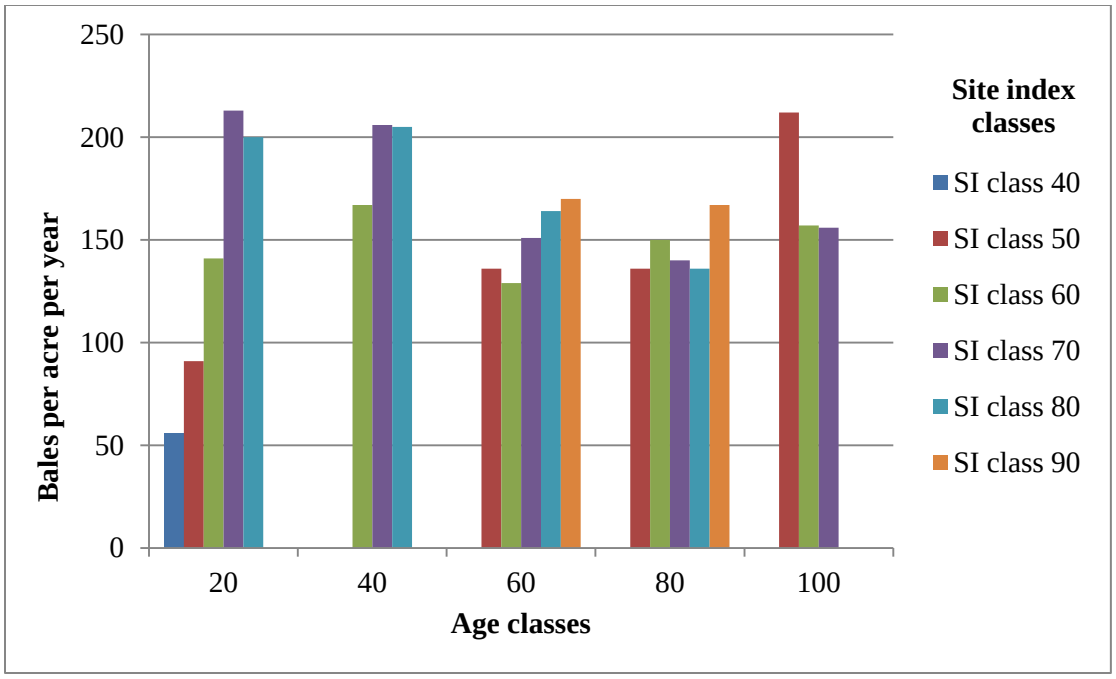

Figure 2.8. Mean pine straw yield, in green bales per acre per year, by age classes at various site index classes, Regional Longleaf Growth Study, 1993-1997

Analyses of Pearson's correlations of needle yield and observed trends of those relationships across independent variable classes show that basal area was a significant determinant of pine straw yield. However, around 120 square feet per acre of basal area was when yields peaked and influences from other variables (e.g. site index and tree density) became less apparent. Site index appeared to have the most influence on pine straw yield in young stands, in those with low basal area (around 30 square feet per acre), and in stands within the higher density classes.

Regressions for All RLGS Plots

Further analyses were conducted using the RLGS data from all 201 plots, including running bivariate and multiple regressions with pine straw yield (in green bales per acre) as the dependent variable. The resulting regression equations can be used to

make estimations of pine straw yield in natural stands using known explanatory variables, such as basal area, stand age, and site index.

Bivariate Regressions

Results of the bivariate regressions run between the dependent variable (pine needle yield in green bales per acre) and each of the independent variables (basal area, age, site index, and trees per acre) can be seen in Table 2.5. Based on these bivariate regressions, basal area appeared to be the strongest predictor of pine straw yield. Approximately 55.2% of the variability in bales per acre could be explained by basal area. The resulting regression equation for this relationship was Y' = (1.318)X + 68.873. So if a landowner has a stand with a basal area of 85 square feet per acre, without taking into account other explanatory variables, he could expect yields of approximately 181 green bales of pine straw per acre per year [Y' = (1.318)85 + 68.873 = 180.90].

Table 2.5. Bivariate regressions for all Regional Longleaf Growth Study (RLGS) plots, 1993-1997, with needle yield as the dependent variable

Independent variable	Regression equation	R square	F	Sig. of F
Basal area	Y' = (1.318)X + 68.873	0.552	245.608	0.000
Age	Y' = (-0.678)X + 209.444	0.083	18.072	0.000
Site index	Y' = (1.967)X + 37.237	0.111	24.869	0.000
Trees per acre	Y' = (0.034)X + 155.943	0.183	44.528	0.000

Age, site index, and trees per acre explained approximately 8.3, 11.1, and 18.3% of the variability in pine straw yield, respectively. F tests for all four bivariate regressions yielded P values of less than 0.001, therefore none of the R squares were likely due to chance. A regression of pine straw yield by age produced the following equation: Y' = (-0.678)X + 209.444. If a stand is 45 years old, one using this equation could expect to get approximately 179 green bales of pine straw per acre per year. Site index produced a bivariate regression equation of Y' = (1.967)X + 37.237. If a

landowner has a stand with a site index of 75 (in feet at a base age 50), he could expect approximately 185 bales per acre per year. A regression of pine straw yield by trees per acre produced an equation of Y' = (0.034)X + 155.943. A stand of 300 trees per acre, without taking into account other explanatory variables, would be expected to yield on an annual basis approximately 166 bales per acre. Table 2.6 shows examples of yield estimates using the bivariate regressions for each of the four independent variables; this allows for comparison to yields reported by others (see Table 2.1).

Table 2.6. Example pine straw yields (green bales per acre per year) determined using bivariate regressions for all Regional Longleaf Growth Study (RLGS) plots, 1993-1997

Independent variable	Example value	Pine straw yield
Basal area	30	108
(sq. ft. per ac.)	60	148
	90	187
	120	227
Age	20	196
(in years)	40	182
	60	169
	80	155
Site index	50	136
(base age 50)	60	155
	70	175
	80	195
Trees per acre	250	164
	500	173
	750	181
	1000	190

Multiple Regressions

The bivariate regression equations presented here may be useful if a landowner only has certain information available about his or her stand. However, needle yields are highly variable and no factor is a single determinant of the amount of pine straw produced on a stand. While basal area produced a large R square (0.552), the other

independent variables accounted for much less of the variability in pine straw yield. It is important to be careful when claiming causality in bivariate correlations; the strong correlations between the four independent variables (see Table 2.4) emphasize the need to eliminate overlapping contributions to the R square.

Multiple regressions were run using both the Enter and Stepwise methods (van Emden 2008). The independent variables were defined as follows: X1=basal area, X2=age, X3=site index, and X4=trees per acre. The Enter method resulted in the following regression equation: Y' = (1.248)X1 + (-0.627)X2 + (1.254)X3 + (0.002)X4 + 17.861. Therefore, if basal area=85 square feet per acre, age=45, site index=75, and trees per acre=300, a stand would yield approximately 190 green bales of pine straw per acre per year. If all stand conditions were kept the same (age=45, site index=75, and trees per acre=300), but basal area was changed to 110 square feet per acre, the stand would yield approximately 222 bales per acre. If basal area were kept at 85 square feet per acre (and site index and trees per acre remained at 75 and 300, respectively), but age was changed to 65, the stand would yield approximately 178 bales per acre.

The R^2 of the model for the Enter method was 68.2%. The F test yielded an F of 104.959 (P=0.000), showing that the R^2 of the overall model (all four independent variables together) was not occurring by chance. The adjusted R^2 of the model using the Enter method was 0.675, which was close to the model R^2, suggesting the model was strong.

The standardized coefficients (Betas) make it clear that basal area was the strongest predictor in the model followed by age and site index. Beta for basal area was 0.704. Betas for age, site index, and trees per acre were -0.267, 0.213, and 0.025,

respectively. The t-tests show that the weights given to the first three independent variables in this model were not occurring by chance; all t-values were significant at the 0.001 level. The last variable (trees per acre) yielded a t-test significance of 0.662. Therefore the slope of this predictor was not significantly different from zero. None of the confidence intervals for B of the first three independent variables contained zero; the confidence interval for B of trees per acre did contain a zero.

The Stepwise method was used to run another regression using the same data. Criteria for this method was that probability of F to enter be less than or equal to 0.05 and probability of F to remove be greater than or equal to 0.10. Three models were produced, all of which had F change significance levels below 0.001. The final model included basal area, age, and site index as predictors; the trees per acre variable was excluded from the model. The resulting regression equation from the Stepwise method (using the same variable definitions) was: $Y' = (1.266)X1 + (-0.661)X2 + (1.228)X3 + 21.043$. Therefore, if basal area=85 square feet per acre, age=45 and site index=75, a stand would yield approximately 191 green bales of pine straw per acre per year. The R^2 of the model for the Stepwise method was 68.1%. The F test yielded an F of 140.459 (P=0.000), showing that the R^2 of the overall model (all three independent variables together) was not occurring by chance. The adjusted R^2 of the model was 0.677.

The Betas show that basal area was the strongest predictor in the model. Beta for basal area was 0.714; for age and site index it was -0.281 and 0.208, respectively. The t-tests show that the weights given to all three independent variables in this model were not occurring by chance; all t-values were significant at the 0.001 level. In other words, the slope for each predictor was significantly different from zero. Also, none of the

confidence intervals for B of the independent variables contained zero, rejecting the null hypothesis that the slope equals zero.

After comparing the results from the two multiple regression procedures, the Stepwise procedure appears most appropriate to predict pine straw yield. The R^2 of the full model with all four independent variables was 68.2% while the R^2 of the stepwise model with three IVs was 68.1%. The impact of losing trees per acre (R^2 change) was 0.001. This R^2 change was likely to happen by chance. The Stepwise procedure is a simpler model that eliminates an independent variable that was not contributing significant uniqueness to the dependent variable.

The correlations and collinearity statistics indicate the ability of each of the predictor variables to uniquely contribute to the dependent variable. The part and partial correlations for this model show that basal area was contributing most uniquely to the dependent variable (basal area partial: 0.781, part: 0.706; age partial: -0.445, part: -0.280; site index partial: 0.342, part: 0.205). However, the tolerance levels for all three variables were high (0.977, 0.996, and 0.973, respectively); equivalently, the variance inflation factors for all three variables were low (1.023, 1.005, and 1.028, respectively), indicating lack of multicollinearity.

2.3.2. Results for Subset of Alabama RLGS Plots

The above descriptives and analyses provide useful information about needlefall patterns and factors that influence those patterns. However, many of the stands included in the RLGS dataset are not typical of those owned by private forestland owners in the U.S. South (for example, the RLGS stands are, on average, much older). If analyzing such data in order to make informed decisions about management of longleaf pine for

commercial pine straw production, it is best to explore needlefall patterns on stands that are more characteristic of those owned by private forestland owners. For these reasons, a data subset was created and includes only data from stands that are age 40 or younger and with 1500 trees or fewer per acre. And because these data are to be used to develop programming for Alabama residents, only plots from Alabama were included. The final subset includes data for 49 plots. Descriptives for this subset can be seen in Table 2.7. On average, stands included in the subset were 30 years old with approximately 484 trees per acre. Basal area averaged 74 square feet per acre and site index averaged 71 feet, with a base age of 50. Mean needle fall (dry weight) was 3,507 pounds per acre per year. This amounts to an average of 190 twenty-pound green-weight bales per acre per year.

Table 2.7. Descriptive statistics of data collected as part of the Regional Longleaf Growth Study (RLGS), 1993-1997, from longleaf stands in Alabama 40 years and younger with 1500 trees or fewer per acre[1]

Variable	Unit	Minimum	Maximum	Mean	Standard Deviation
Age	Years	18	40	30	8
Density	Trees per acre	50	1395	484	363
Basal area	Square feet per acre	30	151	74	34
Site index (base age 50)	Based on height in feet	56	79	71	7
Needle fall	Pounds per acre per year	1880	4932	3507	876
Pine straw	Bales per acre per year[2]	102	267	190	48

[1]Data collected on 49 plots between 1993 and 1997

[2]Based on 20-pound green weight bales

Correlations for Subset of Alabama RLGS Plots

As with the larger dataset, Pearson's correlations were run to observe the relationships between the dependent variable (pine needle yield in green bales per acre) and the independent variables (basal area, age, site index, and trees per acre) of the subset. The results of those tests can be seen in Table 2.8. There were correlations between pine straw yield and two of the four independent variables: basal area and trees per acre; both of which were positive and significant at the 0.001 level. There were also significant relationships between basal area and age (P=0.001) and between basal area and trees per acre ($p<0.001$); these were positive correlations.

Table 2.8. Correlations between pine needle yield (in green bales per acre) and independent variables used in analyses for subset of Alabama Regional Longleaf Growth Study (RLGS) plots, 1993-1997 (N=49)

Variable		Basal area	Age	Site index	Trees per acre
Green bales	Pearson's R	0.739	0.062	0.112	0.649
	P	0.000	0.672	0.442	0.000
Basal area	Pearson's R		0.459	-0.131	0.644
	P		0.001	0.368	0.000
Age	Pearson's R			-0.275	-0.242
	P			0.056	0.094
Site index	Pearson's R				-0.133
	P				0.361

Regressions for Subset of Alabama RLGS Plots

Bivariate Regressions

Results of the bivariate regressions run for the data subset between the dependent variable (pine needle yield in green bales per acre) and each of the independent variables (basal area, age, site index, and trees per acre) can be seen in Table 2.9. Based on these bivariate regressions, basal area appeared to be the strongest predictor of needle yield. Approximately 54.6% of the variability in pine straw yield could be explained by basal

area. The resulting regression equation for this relationship was Y' = (1.031)X + 113.685. If a landowner has a stand with a basal area of 85 square feet per acre, without taking into account other explanatory variables, he could expect yields of approximately 201 green bales of pine straw per acre per year.

Table 2.9. Bivariate regressions for subset of Alabama Regional Longleaf Growth Study (RLGS) plots, 1993-1997, with needle yield as the dependent variable

Independent variable	Regression equation	R square	F	Sig. of F
Basal area	Y' = (1.031)X + 113.685	0.546	56.586	0.000
Age	Y' = (0.386)X + 178.634	0.004	0.181	0.672
Site index	Y' = (0.750)X + 137.009	0.013	0.601	0.442
Trees per acre	Y' = (0.085)X + 149.001	0.422	34.288	0.000

Age, site index, and trees per acre explained approximately 0.4, 1.3, and 42.2% of the variability in bales per acre, respectively. F tests for two of the bivariate regressions (with basal area and trees per acre as predictor variables) yielded P values of less than 0.001. Therefore the R squares of the other two regressions (with age and site index as predictor variables) were likely due to chance. A regression of pine straw yield by trees per acre produced an equation of Y' = (0.085)X + 149.001. A stand of 300 trees per acre, without taking into account other explanatory variables, would be expected to yield on an annual basis approximately 175 bales per acre.

The yield estimates for all four bivariate regressions run using the data subset are higher than those calculated by the bivariate regression equations produced using the larger dataset. These higher yield estimates, when using the predictor variables separately, could be the result of limiting the input data to younger stands (age 40 or younger). However, unlike with the larger dataset (in which all four bivariate regressions had significant F values) only basal area and trees per acre appear appropriate predictors of pine straw yield on stands in Alabama, age 40 or younger, and with 1500 or fewer

trees per acre. And while basal area was the strongest predictor of pine straw yield for both datasets (producing R squares of 55.2 and 54.6%), trees per acre was a much stronger predictor for the subset (R^2 of 42.2%) than for the larger dataset (R^2 of 18.3).

Multiple Regressions

As with the larger dataset, multiple regressions were run for the data subset using both the Enter and Stepwise methods. The independent variables were defined in the same manner as they were for the larger dataset: X1=basal area, X2=age, X3=site index, and X4=trees per acre. The Enter method resulted in the following regression equation: Y' = (1.162)X1 + (-1.615)X2 + (1.068)X3 + (0.009)X4 + 71.955. Therefore, if basal area=85 square feet per acre, age=35, site index=75, and trees per acre=300, a stand would yield approximately 197 green bales of pine straw per acre per year. The R^2 of the model for the Enter method was 66.4%. The F test yielded an F of 21.751 (P=0.000), showing that the R^2 of the overall model (all four independent variables together) was not occurring by chance. The adjusted R^2 of the model using the Enter method was 0.634.

The standardized coefficients (Betas) make it clear that basal area was the strongest predictor in the model. Beta for basal area was 0.833. Betas for age, site index, and trees per acre were -0.260, 0.160, and 0.071, respectively. The t-tests show that the weight given to the basal area in this model was not occurring by chance; the t-value was significant at the 0.001 level. The other three variables (age, site index, and trees per acre) yielded t-test significances of 0.164, 0.120, and 0.732, respectively. Therefore the slopes of these predictors are not significantly different from zero. Also, the confidence intervals for B of these three variables all contain zero.

The Stepwise method was used to run another regression. Criteria for this method was that probability of F to enter be less than or equal to 0.05 and probability of F to remove be greater than or equal to 0.10. Two models were produced, both of which had F change significance levels at or below 0.001. The final model included basal area and age as predictors; site index and trees per acre were excluded from the model. The resulting regression equation from the Stepwise method was: Y' = (1.256)X1 + (-2.188)X2 + 162.250. Therefore, if basal area=85 square feet per acre and age=35, a stand would yield approximately 192 green bales of pine straw per acre per year. The R^2 of the model for the Stepwise method was 64.4%. The F test yielded an F of 41.575 (P=0.000), showing that the R^2 of the overall model (both independent variables together) was not occurring by chance. The adjusted R^2 of the model was 0.628.

The Betas show that basal area was again the strongest predictor in the model. Beta for basal area was 0.901; for age it was -0.352. The t-tests show that the weights given to both predictor variables in this model are not occurring by chance; t-values were significant at the 0.001 level. In other words, the slope for each predictor was significantly different from zero. Also, neither of the confidence intervals for B of the two independent variables contained zero, rejecting the null hypotheses that their slopes equal zero.

After comparing the results from the two multiple regression procedures, the Stepwise procedure appears most appropriate to predict pine straw yield. The R^2 of the full model with all four independent variables was 66.4% while the R^2 of the Stepwise model with two IVs was 64.4%. The impact of losing site index and trees per acre (R^2

change) was 0.020. The Stepwise procedure eliminates two independent variables that were not contributing significant uniqueness to the dependent variable.

The correlations and collinearity statistics indicate the ability of each of the predictor variables to uniquely contribute to the dependent variable. The part and partial correlations for this model show again that basal area was contributing most uniquely to the dependent variable (basal area partial: 0.802, part: 0.800; age partial: -0.464, part: -0.312). However, the tolerance levels for both variables (both 0.789) are high (equivalently, the variance inflation factors for both variables – 1.267 – are low), indicating lack of multicollinearity.

2.3.3. Application of Regression Equations

All regression equations reported in this chapter apply to pine stands included in the Regional Longleaf Growth Study. Therefore, if the equations are applied in real-world scenarios, it must be done to stands that are fairly similar to those of the RLGS. In other words, these equations are best used for natural, even-aged longleaf pine stands located in one of the study states (or in Alabama, when using the equations generated by the subset). Data for each independent variable must fall within the ranges given for the datasets. For the equation generated by the larger RLGS dataset, X1 (basal area) must be between 22 and 152 square feet per acre, X2 (age) must be between 18 and 110 years, X3 (site index, base age 50) must be between 43 and 89, and X4 (tree density) must be between 15 and 4452 trees per acre. Given that the equation generated by the stepwise method eliminated the trees per acre variable, landowners with stands that fall within the ranges for the other three variables may find the equation appropriate and useful. For the equation generated by the RLGS Alabama subset, X1 (basal area) must be between 30

and 151 square feet per acre, X2 (age) must be between 18 and 40 years, X3 (site index, base age 50) must be between 56 and 79, and X4 (tree density) must be between 50 and 1395 trees per acre. The stepwise method using the data subset only retained the basal area and age variables, therefore landowners with stands that fall within the given ranges for these variables may apply the stepwise regression equation to their stands.

Because of the limits presented by these regression techniques, landowners with younger stands or plantations would need to exercise caution when applying these equations. If a broader range of data were available, other regression techniques may be more appropriate. For example, when evaluating pine straw yields on younger stands (those that have not yet reached the peak needlefall age) a curvilinear regression may prove more useful.

2.4. Discussion and Conclusion

There are a number of publications that provide general ranges of pine straw yields based on a variety of factors. The information found in such publications may be useful to someone hoping to get an idea of how much pine straw to expect from a pine plantation with a given stand age or basal area. However, relying on broad estimations based on a single species or growth variable can be misleading if they are used to develop management plans or make investment decisions. With so many variables affecting needlefall and efficiency of harvesting operations, landowners need to exercise caution when making decisions. The publications cited in this paper do not paint a complete picture. The results presented in this chapter represent a start to completing a picture of pine straw production in natural, even-aged longleaf stands managed with fire. Data

collected from 201 plots throughout the Southeast, and regressions, using multiple variables, illustrate needlefall trends and relationships.

Data collected from the Regional Longleaf Growth Study showed that needlefall was highest during the fall months, with stands producing an average of 618.05 pounds per acre in October and 570.29 pounds per acre in November. Monthly needlefall trends are worth observing because management decisions, such as when to harvest, may be made based on short-term needlefall patterns. For example, if a landowner or pine straw producer wants to harvest the maximum amount of freshly-fallen needles, it may be best to do so in December, immediately after peak needlefall, when yields drop drastically (mean weight for December was approximately one-third of that for November). However, if a landowner has concerns about ecological impacts of harvesting, and wants to harvest earlier in the season to allow for litter buildup between rakings, it may be best to rake in October, thus capturing some of the peak needlefall, but ensuring the November needlefall will provide some ground cover. Market demand for pine straw is highest in spring, when homeowners often engage in landscaping activities. And while needlefall is lowest right before temperatures begin to rise, yields start to creep back up in the late spring and early summer months when gardeners may need mulch for their flower beds or vegetable gardens.

Based on regressions (bivariate and multiple) of the full RLGS dataset as well as the subset of Alabama RLGS plots, basal area was the strongest predictor of pine needle yields. Higher basal areas, up to 120 square feet per acre, produced larger amounts of pine straw. Pearson's correlations of the datasets show that basal area was influenced by the other independent variables, but most strongly by trees per acre. Age was also a

strong predictor of pine straw yields, with younger stands (in the 20 and 40 age classes) producing higher amounts, and older stands producing less pine straw.

For bivariate regressions of the data subset (which included a limited number of plots – all of which were age 40 or younger), basal area and trees per acre were the most appropriate predictors of pine straw yield. This is likely because these variables are directly related to stocking levels and the total leaf area of the stand. Age and site index, while factors in the amount of needles on the ground, do not play as strong a role in the amount of wood present – or the amount of needles needed to sustain growth of that wood.

Based on the findings from both datasets, landowners with pine straw as a primary objective should consider ways to boost basal area early in the life of their stands. Silvicultural practices (e.g. application of fertilizer) may be used to achieve such goals. If a landowner is able to get a stand to reach 120 square feet per acre of basal area by age 20, using the regression equation generated by the stepwise method using the data subset (Y' = [1.256]X1 + [-2.188]X2 + 162.250), he would yield approximately 269 green bales of pine straw per acre per year.

There is a need for more research and data similar to those collected as part of the Regional Longleaf Growth Study. In particular, data are needed on needlefall yields in plantation systems and from stands of other species, such as loblolly. Information is also needed about the impact of fertilizer and other treatments on pine straw yields.

CHAPTER 3

Market Demands and Characteristic Preferences for Pine Straw in Alabama

3.1. Introduction

Pine straw is bulky and can be difficult to transport, and the informal networks that comprise the industry operate in a fairly limited geographic region. Yet, especially in the U.S. South, it remains competitive relative to other types of mulch. The cost of pine straw compares favorably to other mulches, including pine bark, cypress, cedar, red mulch, and pine nuggets (Texas AgriLife Extension System n.d.). A feasibility study conducted by Glacierland Resource Conservation and Development (RC&D) in Wisconsin examined consumer preferences for various mulches, including pine straw, pine bark, wheat straw, recycled paper pellets, and recycled paper crumble. Findings show that of the various mulches presented, respondents ranked pine straw second behind pine bark as the preferred mulch, both following an initial application and six weeks later (Peterson n.d.).

In general, longleaf pine straw is considered to be the most popular (see e.g. Mills and Robertson 1991, Duryea 2000, Mance n.d., Nix 2011, Minogue et al. 2007). Longleaf trees produce longer needles that, because of a heavier waxy coating, are brighter in color and tend to last longer than those of other species (Nix 2011). However, some pine straw buyers prefer loblolly or slash because the needles lay flatter and retain their initial appearance (rather than settling over time).

Little research has been done to understand what characteristics buyers of pine straw are looking for and what land management practices landowners can implement to better meet market demands. Wolfe et al. (2005) examined pine straw characteristic preferences among buyers of pine straw; however, their study was limited in size (20 respondents) and geographic scope (within a 60-mile radius of Eufaula, Alabama). The strongest characteristic preference among respondents was that pine straw be free of sticks and cones (90%), followed by free of leaves (75%). Findings such as these have implications for landowners, who are expected by pine straw dealers to maintain clean, flat stands with little herbaceous material (Taylor and Foster 2004). More information is needed about pine straw buyer demands (e.g. volumes, discounts for bulk purchases, delivery, and timing of harvests) and preferences for species or bale characteristics (e.g. shape of the bale, material used for binding, and needle length and color).

Information collected on product preferences and market demands can be used by pine straw producers who may be interested in expanding operations or need guidance determining pricing schedule or marketing channels. An analysis of the pine straw market can help answer questions about whether there is room for more producers to enter the market and whether forestland owners would benefit from developing management regimes (e.g. use of herbicide) geared toward pine straw production and harvesting. Survey results can be used to raise awareness among buyers of variability in pine straw quality, as well as provide information about how landowners and suppliers can produce a higher-quality, more reliable product.

3.2. Methods

Four main tasks were associated with this portion of the study:

Task 2.1. Review literature related to pine straw markets, in particular reports on markets in Southeastern U.S.

Task 2.2. Develop questionnaire aimed at assessing volume demand, seasonality, and market structure of pine straw as well as characteristic preferences of buyers.

Task 2.3. Using Dillman's Tailored Design Method, conduct survey of retailers, landscapers, lawn maintenance specialists, landscape suppliers, and nurseries in six metropolitan regions in Alabama.

Task 2.4. Using SPSS, calculate descriptives and perform statistical analyses of survey results to identify relationships between variables.

Task 2.1 involved a thorough review of literature related to pine straw markets, with an emphasis on markets in the Southeastern U.S. The information served as the basis for the questionnaire developed in Task 2.2 (see Appendix A). It was expected that the mail survey would take approximately 10 to 15 minutes to complete. Questions were multiple choice or simple fill-in-the-blank, though respondents were given the opportunity to make comments or provide additional information regarding pine straw sales in their region. The questionnaire was designed to elicit the maximum amount of information while requiring a minimal amount of effort from the recipient. The questionnaire, all accompanying documents, and survey protocol were given approval by the University's Institutional Review Board.

In Task 2.3, the mail survey was administered according to Dillman's (2000) Tailored Design Method (TDM), which calls for four mailings (a prenotice letter, a first-

round survey, a follow-up postcard, and a second-round survey). The survey was printed and mailed by a digital resource center located on Auburn University's campus. The participant population for the survey was business owners or managers of retailers, landscapers, lawn maintenance specialists, landscape suppliers, and nurseries in Alabama. These types of businesses buy and sell pine straw. Owners and managers of such companies can provide insight to the pine straw market and identify consumer preferences, while providing data on sales volume and prices. Those selected for the study have operations in six metropolitan regions in Alabama (Huntsville/Madison, Birmingham, Montgomery, Mobile, Tuscaloosa, and Dothan). These regions were selected because they are in the top ten metro regions of the state and are geographically diverse.

When running statistical analyses of the survey results data, the six regions were collapsed into four regions based on proximity to one another and on proximity to southwest Georgia and the Florida panhandle (where there is a stronger pine straw market). The north region represents surveys received from Huntsville, the central region includes responses from Tuscaloosa and Birmingham (the cities are located in contiguous counties), the south-central region includes surveys from Montgomery, and the south region includes responses from Mobile and Dothan (cities located in the southern-most corners of the state and in close proximity to the Florida panhandle). While loblolly and longleaf pine can be found growing in all of the surveyed regions, slash is most likely to be found in the south region, and longleaf is a major timber component in the south and south-central (Montgomery) regions.

In fall 2010 a prenotice letter (Appendix B) was sent to 198 businesses in six Alabama metro regions. Names and addresses for survey subjects were selected from a listing provided by the executive director of the Alabama Nursery and Landscape Association (ALNLA). Additional names and addresses were taken from publicly-available listings of businesses (such as the Yellow Pages). This prenotice letter notified the recipients of the research project and invited them to participate in the forthcoming mail questionnaire. Approximately a week later, the survey was mailed to those same people, along with a cover letter (Appendix C) that included the IRB protocol number and dates. The cover letter contained more detailed information about the study and ensured respondents that their participation was entirely voluntary and that responses would remain confidential. A few days after that, a follow-up postcard (Appendix D) was mailed, thanking those who participated and asking those who had not completed the survey to do so. A few weeks after that, a second copy of the survey was mailed to those who did not return the first. The letter that was sent with the first copy of the survey accompanied the second-round survey as well. At the end of the survey, respondents were told that if they were interested in providing more detailed information, they could contact Dr. Becky Barlow by phone or email. As completed surveys were received, number codes printed on the survey were used to remove recipient names and addresses from the mailing list. These code numbers were also used to identify which of the six metropolitan regions in the state the participant's business was in. Survey results were coded and entered into an Excel spreadsheet. After accounting for bad addresses and for those recipients that do not buy or sell pine straw, a response rate of 42% was attained. Missing data from returned surveys were excluded from each analysis.

For Task 2.4, survey results were summarized and analyzed using multiple functions in Predictive Analytics Software (PASW), using a 0.05 alpha level to determine statistical significance. A number of tests were used and were selected based on the level of measurement (i.e. nominal, ordinal, interval, or ratio) being analyzed (Dytham 2011). One-way ANOVAs and pairwise comparisons were used to test for differences between groups regarding interval data while one-sample t-tests were used to observe differences across all respondents. Chi-square goodness of fit tested for differences among all respondents regarding nominal or ordinal data. Pearson's chi-square was used to test for differences between groups regarding nominal data. Kruskal-Wallis was used to test for differences in ordinal responses between groups. Mann-Whitney U tests checked for differences in ordinal responses between dichotomous groups.

3.3. Results

3.3.1. Respondent Types and Purchase Volumes

In total, there were 66 respondents. The majority were landscape contractors (47%), followed by retailers (29%), and then lawn maintenance specialists (17%). The remaining respondents were categorized as "other." These respondents identified themselves as follows: a wholesale nursery, a wholesaler of plants and supplies, a plant grower and a "pine straw re-wholesaler," and a tree service. Table 3.1 shows the number of bales of pine straw purchased by respondents, both on an annual basis and at a single time. Responses are given by respondent type and by bale shape. Pine straw is considered a seasonal product, but can be harvested year-round.

There is little information on how much pine straw is purchased (on average) by businesses, especially with regard to bale shape. Information collected on volume

demands can be used by pine straw producers who may be interested in expanding operations or need guidance determining marketing channels. For all respondents, the mean number of round bales purchased annually was 5,900 (Table 3.1). The mean number of round bales purchased at a single time was approximately 400.

More landscape contractors purchased round bales than other respondent types; they also reported purchasing higher quantities on an annual basis, with a mean of more than 10,000 bales. All respondents, on average, were buying more than 8,000 square bales per year and about 600 square bales at a single time. Retailers and "other" respondents purchased the highest numbers of square bales on an annual basis (approximately 16,100 and 16,900, respectively). However, the number of square bales purchased by retailers annually ranged widely, from 100 to 100,000. Landscape contractors and "other" respondents purchased the highest numbers of square bales at a single time (both buying an average of more than 700 bales).

One-sample t-tests were run to observe whether the volumes purchased by respondents differed significantly across the whole state. There was a difference ($P=0.001$) in volumes of square bales purchased on an annual basis among respondents, as well as in volumes of square bales purchased at a single time ($P<0.001$). There was not a significant difference in volumes of round bales purchased annually ($P=0.189$). Volumes of round bales purchased at a single time, however, did vary among respondents ($P=0.002$). Further analyses were conducted to determine where these differences lie among the buyer type groups.

Table 3.1. Number of bales of pine straw purchased annually and at a single time, by respondent type and bale shape, reported by respondents of 2010 survey of retailers, landscapers, lawn maintenance specialists, landscape suppliers, and nurseries in six metropolitan regions in Alabama (N=66)

	Mean	Median	Minimum	Maximum	SD
All respondents (N=66)					
Annually					
Square (N=56)	8,272.3	2,000	50	100,000	17,839.7
Round (N=6)	5,900.0	2,000	100	25,000	9,500.9
At a single time					
Square (N=58)	634.5	325	10	7,500	1,046.6
Round (N=7)	401.4	400	100	650	205.9
Landscape contractor (N=31)					
Annually					
Square (N=26)	4,423.1	2,250	50	26,000	5,691.0
Round (N=3)	10,033.3	5,000	100	25,000	13,191.0
At a single time					
Square (N=27)	726.6	200	10	7,500	1,451.2
Round (N=4)	325.0	275	100	650	239.8
Retailers (N=19)					
Annually					
Square (N=16)	16,100.0	3,000	100	100,000	29,434.6
Round (N=2)	2,000.0	2,000	1,500	2,500	707.1
At a single time					
Square (N=17)	636.5	400	12	1,450	511.4
Round (N=2)	440.0	440	400	480	56.6
Lawn maintenance specialists (N=11)					
Annually					
Square (N=9)	2,405.6	800	200	10,000	3,371.4
Round (N=1)	1,300.0	1,300			
At a single time					
Square (N=9)	311.1	175	25	1,200	370.0
Round (N=1)	630.0	630			
Other respondents (N=4)					
Annually					
Square (N=4)	16,875.0	8,500	500	50,000	23,023.1
Round (N=0)					
At a single time					
Square (N=4)	766.3	762.5	40	1,500	615.4
Round (N=0)					

One-way ANOVAs were run on purchase volumes of pine straw by buyer type. Testing annual purchases of square bales by buyer type [with (3,51) degrees of freedom] yielded an F value of 2.163 and a significance of 0.104. Pairwise comparisons were also run to determine significant differences between pairs of buyer types. The only pair to reveal a significant difference was retailers and landscape contractors (P=0.040); on an annual basis, retailers purchased more pine straw than landscape contractors. However, Levene's statistic for the ANOVA test of annual purchases of square bales was 7.787, yielding a significance value of less than 0.001. Thus, homogeneity of variance cannot be assumed. We cannot be certain that the differences observed between the buyer types are attributable to the conditions of each group; there may be an interaction effect from some exogenous variable.

The one-way ANOVA of single-time purchases of square bales by buyer type used (3,53) degrees of freedom and yielded an F value of 0.358 (P=0.784). Levene's statistic was 1.038 (P=0.383); homogeneity of variance can be assumed. Pairwise comparison tests did not reveal any statistically significant differences among the respondent types. Thus, when looking at single-time purchase volumes of square bales of pine straw, the respondent types did not vary significantly. Pairwise comparison tests of single and annual purchases of round bales did not reveal significant differences among buyer types.

Although the one-sample t-tests suggest variability in the volumes purchased annually and at a single time for square bales, and at a single time for round bales, further analyses did not provide much indication that these differences are due to buyer type. It appears, however, that retailers purchase significantly more square bales of pine straw on

an annual basis, even if volumes of single-time purchases are almost equal to the mean volumes purchased by all respondents.

Respondents were also asked to rank each month of the year in terms of seasonality as a buyer of pine straw, with 1=busiest to 4=least busy. Results revealed that the busiest months are in spring (March, April, and May) while the least busy months are in winter (December, January, and February). Most harvesting occurs around the time when (or shortly after) needle fall is highest, typically in September, October, and November. Therefore, straw is frequently harvested a full six months before demand peaks.

3.3.2. Pine Straw Species and Origins

All respondents were asked "What species of pine straw do you usually purchase?" Responses were not mutually exclusive (all possible combinations for which responses were received are reported in Table 3.2). Approximately 43% of the respondents purchased longleaf, about 38% purchased slash, and about a fourth reported buying loblolly. Eighteen percent of respondents said they did not know what kind of pine straw they buy. Table 3.2 shows the number of respondents buying each species (or combination of species) of pine straw by region. Almost half of the respondents from the north region did not know what species of pine straw they purchased. In the south region, on the other hand, only two respondents (10.5%) did not know. In this region, which is the region closest to more established pine straw markets in southwest Georgia and the Florida panhandle, 84% of respondents reported buying slash, longleaf, or both. Only one respondent reported buying loblolly, but in combination with slash and longleaf. In the central region (Birmingham and Tuscaloosa) respondents reported

buying each of the species, with loblolly and/or slash yielding slightly higher responses. In the south-central region, most respondents reported buying longleaf, though several reported buying loblolly or slash.

Table 3.2. Cross-tabulation of species of pine straw purchased, by region, reported by respondents of 2010 survey of retailers, landscapers, lawn maintenance specialists, landscape suppliers, and nurseries in six metropolitan regions in Alabama[1,2]

		Region				
Species purchased		North (N=8)	Central (N=25)	South-Central (N=13)	South (N=20)	Total
Loblolly only	Count	1	7	1	0	9
	Std. residual	0.0	2.0*	-0.6	-1.7	
Slash only	Count	0	5	2	5	12
	Std. residual	-1.2	0.2	-0.2	0.7	
Longleaf only	Count	2	5	4	7	18
	Std. residual	0.0	-0.7	0.2	0.6	
Loblolly and slash	Count	0	3	0	0	3
	Std. residual	-0.6	1.8	-0.8	-1.0	
Slash and longleaf	Count	0	0	1	4	5
	Std. residual	-0.8	-1.4	0.0	2.0*	
Loblolly, slash and longleaf	Count	1	0	1	1	3
	Std. residual	1.1	-1.1	0.5	0.1	
Unknown	Count	3	3	3	2	11
	Std. residual	1.5	-0.6	0.6	-0.8	
Total	Count	7	23	12	19	61

[1]Standardized residuals are given as a Z score; with an alpha of 0.05, the critical value is +/- 1.96

[2]X^2=27.302, P=0.074

* P≤0.05

A chi-square goodness of fit test was conducted to see if there were significant differences among all respondents in terms of what species they purchased, with expected frequencies evenly distributed among the various species, species combinations, and

"unknown" response category. The test yielded a chi-square statistic of 20.820 and a P value of 0.002. Further tests were run to determine where these differences among respondents lie.

Pearson's chi-square tests were run to determine significant differences among the regions in their responses to whether they purchased the species or species combination (or if the species they purchased was unknown). There were no statistically significant differences observed between the regions; however, differences among the regions is suggested by the low, albeit nonsignificant, probability level (P=0.074). It is likely the sample is too small (or the number of possible species groupings too high) to verify differences at a statistically significant level. Standardized residuals are included in the cross-tabulation in order to identify where strong differences lie. Two cells proved significant: respondents in the central region buying loblolly and respondents in the south region buying slash and longleaf. In both cases, the observed frequencies were significantly higher than expected frequencies.

Respondents were also asked to rank each species in terms of preference with 1=most desired, 2=second most desired, and 3=least desired. There was a strong preference among respondents for longleaf (of the valid responses for the species, 89% ranked it as the "most desired" species). Approximately 16 and 13% of respondents ranked slash and loblolly as the "most desired" species, respectively. Note that some respondents gave more than one species a "most desired" ranking. Approximately 45% of respondents ranked slash as the "least desired" species, while 38% said loblolly was the least desired. Approximately 19% of valid responses expressed no preference.

The species preferences variables were analyzed as ordinal (ranked from 1 to 3, with 1 indicating strongest preference), and Mann-Whitney U tests were run to evaluate stated preferences by species purchased (three dichotomous variables). The results are shown in Table 3.3; analyses of these results can provide insight to whether purchases are being made based on preferences or market availability. Those who purchased loblolly pine straw were statistically more likely (at the 0.05 significance level) to state a preference for loblolly than those who did not purchase loblolly. Those who purchased slash were statistically less likely (at the 0.05 significance level) to state preference for loblolly, but more likely (at the 0.001 significance level) to state a preference for slash. Buyers of longleaf were more likely to express a preference for the species than those who did not buy longleaf, but this relationship was not statistically significant.

Respondents were asked to estimate the distance between the origin (i.e. the forest) of the pine straw they purchase and their place of business. Overall, more than one-fourth of all respondents did not know where their pine straw was coming from. Approximately one-third of respondents reported buying their pine straw from more than 150 miles away. Several respondents wrote in responses, saying they purchased their straw from southwest Georgia or the Florida panhandle. A chi-square goodness of fit test was run to see if there were differences among respondents with regard to distance from where the pine straw they purchased comes from. Expected frequencies of responses from those who knew the origin of the straw they purchased were evenly distributed among three categories (less than 50 miles, 51 to 150 miles, and more than 150 miles). A chi-square statistic of 7.087 was produced with a P value of 0.029. Further tests were run to determine where the differences lie among respondents.

Table 3.3. Mann-Whitney U tests of differences in preference for pine straw species between buyers and nonbuyers of species, reported by respondents of 2010 survey of retailers, landscapers, lawn maintenance specialists, landscape suppliers, and nurseries in six metropolitan regions in Alabama[1]

		Preference for loblolly			Preference for slash			Preference for longleaf		
		N	Mean Rank	P	N	Mean Rank	P	N	Mean Rank	P
Loblolly	Purchase	13	15.35		11	22.91		9	20.28	
	Do not purchase	30	24.88	0.012*	32	21.69	0.763	31	20.56	0.910
	Total	43			43			40		
Slash	Purchase	17	26.94		24	28.50		15	21.93	
	Do not purchase	26	18.77	0.022*	19	13.79	0.000***	25	19.64	0.295
	Total	43			43			40		
Longleaf	Purchase	21	23.81		21	25.33		22	18.93	
	Do not purchase	22	20.27	0.312	22	18.82	0.065	18	22.42	0.102
	Total	43			43			40		

[1]The test statistic (U) is converted to a Z score; with an alpha of 0.05, the critical value is +/- 1.96.

* P≤ 0.05, ** P≤ 0.01, *** P≤ 0.001

Table 3.4 displays responses of those who know the origin of the pine straw, given by region. Half of the respondents from the north region did not know the origin of the pine straw they purchased. In contrast, the majority of respondents in the south region knew the origin of the pine straw and reported buying straw sourced from forests within 50 miles. Buyers in the central and south-central regions appear for the most part to be buying pine straw from farther distances (more than 150 and 50 miles, respectively).

Table 3.4. Cross-tabulation of known distance of business from pine straw origin (i.e. forest), by region, reported by respondents of 2010 survey of retailers, landscapers, lawn maintenance specialists, landscape suppliers, and nurseries in six metropolitan regions in Alabama[1]

	Region				
Distance (miles)	North (N=8)	Central (N=25)	South-Central (N=13)	South (N=20)	Total
<10 to 50	1	4	2	11	18
51 to 150	0	0	4	3	7
>150	2	13	4	2	21
Total	3	17	10	16	46

[1]Kruskal-Wallis X^2=12.178, P=0.007**

A Kruskal-Wallis test was performed to observe differences between regions with regard to distance of origin of pine straw; the test used only responses from those who knew the origin of the pine straw they purchased. A chi-square value of 12.178 (P=0.007) demonstrated that the differences observed among regions based on reported distance to origin of pine straw are unlikely to be due to chance.

Because the Kruskal-Wallis test gave a significant result, it was followed by pairwise Mann-Whitney U tests to determine which regions differ. Four of the region pairs (north and central, north and south-central, north and south, and central and south-

central) did not prove to be statistically different. The other two pairs yielded significant differences: central and south (Z=-3.238, P=0.001), and south-central and south (Z=-2.352, P=0.019). It is clear when observing mean ranks produced by the Mann-Whitney U tests that buyers in the south region (Mobile and Dothan) purchased their pine straw from shorter distances than buyers in the central (Birmingham and Tuscaloosa) and south-central (Montgomery) regions. It is likely that there were too few responses from the north region (only three respondents reported distances) to yield significant results from pairwise comparisons with other regions.

3.3.3. Characteristic Preferences

Respondents to the mail survey were asked to express their preferences in terms of bale shape, binding, and method used to bale pine straw. Response categories were mutually exclusive with a "no preference" response option given. Seventy-seven percent of respondents preferred square bales, 13% preferred round bales, and 10% expressed "no preference" for either bale shape.

When it came to bale binding, there was a strong preference for bales bound with twine – 85%. Seven percent preferred bales bound with wire and 8% expressed "no preference." Issues associated with wire binding include difficulty of removal and risks associated with leaving cut wires lying on the ground. Wolfe et al. (2005) found that buyers had a preference for hand-baled pine straw because of ease of application. However, our respondents appeared to feel differently – 53% preferred machine-baled pine straw. Only 20% expressed a preference for straw baled by hand. Approximately 27% stated "no preference" when it came to baling method.

Respondents were also asked to rank the level of importance that the pine straw they purchase possess a number of characteristics. Respondents ranked each of the 12 characteristics listed as "not important," "somewhat important," or "very important." Results can be seen in Figure 3.1. The strongest characteristic preference among respondents in Wolfe et al.'s (2005) study of pine straw buyers was that pine straw be free of sticks and cones (90%), followed by free of leaves (75%).

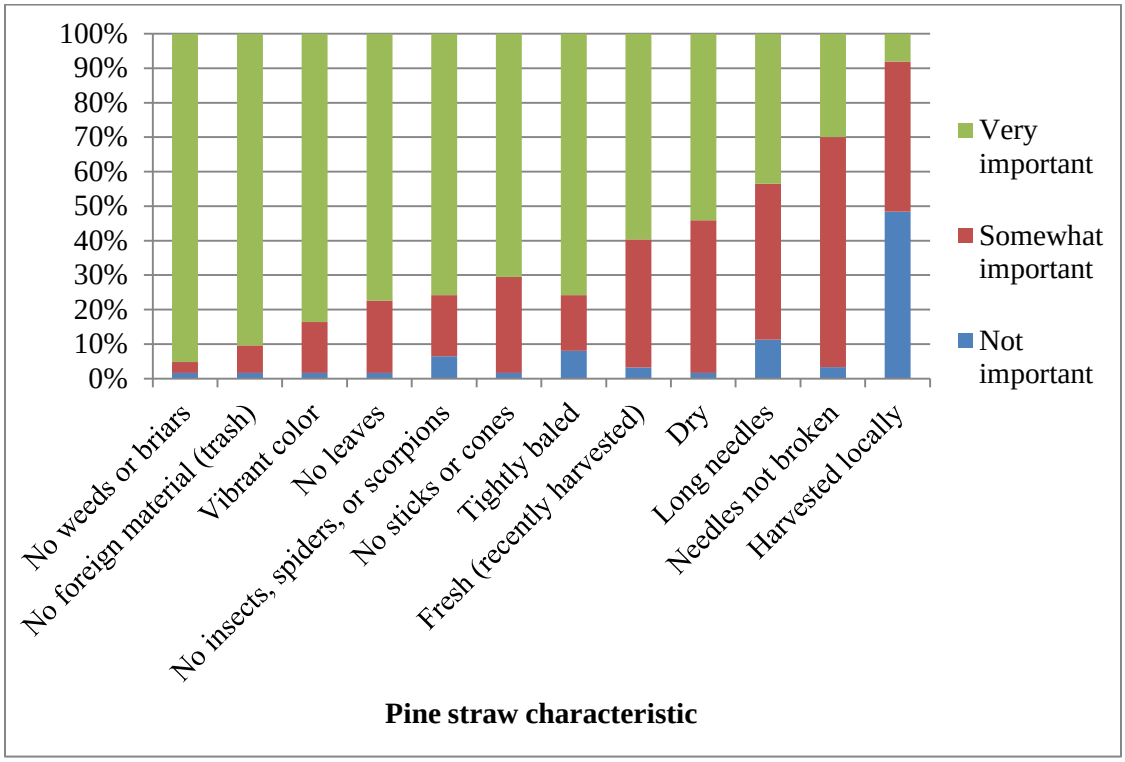

Figure 3.1. Levels of importance of various pine straw characteristics reported by respondents to 2010 survey of retailers, landscapers, lawn maintenance specialists, landscape suppliers, and nurseries in six metropolitan regions in Alabama

The pine straw characteristic most important to respondents in this study was "no weeds or briars," with 95% of respondents reporting this as "very important." The second most important characteristic was "no foreign material (trash)." Less than half of

the respondents stated that “long needles” was a “very important” characteristic; 11% stated the characteristic was “not important.” Only 30% of respondents reported “needles not broken” as “very important;” however, 67% stated this characteristic was “somewhat important.” Almost half of the respondents (48%) stated that it was “not important” that the pine straw they purchase be “harvested locally;” only 8% considered this as “very important.”

3.4. Discussion and Conclusion

Landowners’ pine straw operations may be better suited to meet the demands of particular buyer types, depending on quantity of straw available, consistency of availability, harvesting methods used (i.e. mechanical or manual), and timing of harvests. Landscape contractors buy higher numbers of round bales while retailers appear to need higher numbers of square bales throughout the year. It is likely that retailers purchase more pine straw on an annual basis than other buyers (while buying comparative amounts on a single-time basis) because their demand comes from a broader, more diverse clientele. Landscape contractors and lawn maintenance specialists probably experience more seasonality in demand for their services than home and business owners, who may be purchasing pine straw (albeit, in smaller quantities) to fulfill a myriad of needs throughout the year.

The lack of significant differences (using pairwise comparison tests) among buyer types regarding purchase volumes of round bales was probably largely due to the low numbers of respondents who reported purchasing pine straw in round bales. It is interesting to note that fewer respondents reported purchase volumes for round bales than expressed preference for round bales. Round bales, which are harvested mechanically by

special balers, may be less available in certain markets. Though there are no industry standards regarding bale size, round bales are generally much larger than square bales (Nix 2011); an internet search of businesses that sell pine straw reveals that round bales usually weigh approximately 40 pounds and measure about 18 inches in diameter. Therefore, though respondents reported purchasing fewer round bales on average (both annually and at a single time), it is likely that these purchases represent greater volumes of pine straw than for square bales.

That the percent of respondents who expressed no preference in species (19) is only slightly higher than the percent of respondents who did not know what species of pine straw they were purchasing (18) suggests that those who are familiar with the three species have preferences. Though buyers of longleaf were more likely to express a preference for the species than those who did not buy longleaf, this relationship was not statistically significant, suggesting less of a difference in terms of preference for the species between buyers and non-buyers of longleaf. One possible explanation for this finding may be that longleaf is not accessible to all survey respondents and those who lack access (thus are buying other species) would buy longleaf if it were available to them. That less than half of the respondents stated that "long needles" was a "very important" characteristic (and 11% stated the characteristic was "not important") was surprising given the strong preference among respondents for longleaf pine straw. Perhaps other characteristics of longleaf (such as its lasting color or structural longevity), rather than needle length, are what make it more desirable.

Results from the 2010 mail survey of landscapers, retailers, lawn maintenance specialists, and others show that many buyers do not know what kind of straw they are

buying or where it comes from. However, those respondents that are more aware expressed a preference for longleaf pine straw and often purchase pine straw from more than 150 miles away. Despite expressed preference for species with longer needles, respondents prioritized cleanliness of straw over needle length. The results presented here are important to note because of the implications for landowners considering how best to utilize resources and prepare a site for pine straw harvesting operations. Based on respondents' strong preferences for straw that is free of foreign material as well as weeds and briars, keeping a clean stand and applying herbicide are clearly important components of a site preparation plan. Also, if needle length is less of a concern, then mechanical baling (which can cause breakage) can be a better option because it is less expensive than hand baling.

This study is an attempt to fill an information gap in the literature about pine straw and consumer demands. Like those surveyed by Wolfe et al. (2005), respondents stated preferences for bales bound with twine and for straw that is clean. There were differences between the two respondent groups in terms of other pine straw characteristic preferences; however, those in Wolfe et al.'s (2005) study did not specify what species they purchased. Further research could shed light onto how characteristic preferences or importance placed on certain qualities varies based on species purchased. Another study with larger sample sizes may also allow for more in-depth exploration of differences among buyer types and by regions.

Findings presented here suggest there may be more room in the market for round bales of pine straw and that year-round availability of pine straw may be more of an issue for retailers than for other buyer types. Test results of species preference by species

purchased suggest that purchases are not strictly driven by availability. The strong overall preference for longleaf pine straw (even among non-buyers) suggests there is a market for this species, even in regions where it appears less available. However, stated preferences for loblolly and slash among those who are already purchasing these species show there remains a market for them as well, which is good news for landowners who may already have loblolly and slash stands and are not interested in converting to or intensively managing longleaf.

If opportunities for landowners and product selection for buyers are to expand and improve, there needs to be an increased awareness among stakeholders at both ends of the commodity chain of variations in product quality and the practices used to produce, harvest, and market pine straw. Landowners need to be aware when beginning pine straw operations of site preparation requirements and how management practices might impact product quality or prices paid for their straw. Outreach programming by the Extension personnel and landowner organizations could help disseminate such information.

Based on the wide ranges of purchase volumes reported, the long distances from which many respondents buy pine straw, and stated preferences for all three species, there is room for more Alabama producers to enter the market. The demand for longleaf pine straw in particular – as well as the price premium paid for this species – suggests there may be lucrative market opportunities for landowners, especially in south Alabama. This non-timber forest product may provide enough short-term income to allow landowners to keep (or put) their lands in longleaf and manage on longer rotations, thus conserving this ecologically-important species.

CHAPTER 4

Landowner Interest in Agroforestry, Production of Non-Timber Forest Products, and Pine Straw Harvesting

4.1. Introduction

4.1.1. Forestry Ownership Objectives in the U.S. South

Forest management behavior is driven by landowner motivation (Arano and Munn 2006). Everything from sustainability of ecosystems to quantity and quality of timber outputs is determined by a heterogeneous group of landowners. As different objectives are pursued by these different owners, it is expected that input levels vary as well. Surveys have shown non-industrial private forest (NIPF) owners to be interested in a number of stewardship objectives incorporating both commodity or product values and noncommodity values, such as aesthetics and wildlife. Maximizing growth and yield often take a backseat to other management objectives.

Many private landowners in Alabama own and manage their forests to fulfill non-economic objectives (Zhou 2010). Ownership objectives often correlate with tract size; Zhou (2010) reports that large-scale landowners in Alabama are more interested in timber production. Ownership objectives and management activities are also related to the type of forest landowner. Arano and Munn (2006) provide a comparison among major forest landowner types found in Mississippi. The authors focus on differences in forest management intensity, determined by examining management activities and expenditures, which indicate willingness to invest in timber production. For their study,

they categorize landowners as public ("state") or private; private landowners are further subdivided into one of three groups: industrial, timber investment management organization (TIMO), or non-industrial private forest (NIPF) owner.

Arano and Munn (2006) found that industrial landowners and TIMOs did not differ significantly in terms of silvicultural expenditures and proportion of timberland area treated (with silvicultural practices such as mechanical or chemical site preparation, prescribed burning, and fertilization). A significantly higher proportion of plantation pine was owned by these two owner types than by NIPF owners. Proportion of total pine was found to be positively related to silvicultural spending as well; i.e. the higher proportion of timberland in pine, the higher the per-hectare spending on silvicultural activities. Industrial owners and TIMOs spent much more on silvicultural activities (three times more than NIPF owners), including on site preparation and for planting and intermediate treatment activities. The majority of spending by NIPF owners was on fixed costs that do not affect timber growth, like property taxes and professional services fees. Industrial owners and TIMOs also treated a higher proportion of their lands with silvicultural activities on an annual basis; industrial landowners treated 11.53%, TIMOs treated 25.22%, and NIPFs treated 5.95%. The authors conclude that as the size of ownership increases, so too does the tendency to manage more intensively, especially among NIPF owners. "With NIPF," the authors state, "the larger the ownership, the more likely they are to have profit maximization as a primary goal" (Arano and Munn 2006:245). As a whole group, however, NIPF owners are heterogeneous and their objectives are more complex than other private landowner types.

4.1.2. Alternative Forestry and Production of Non-Timber Forest Products in the South

Workman et al. (2003) conducted a mail survey of landowners to gauge interest in agroforestry and barriers to implementation of practices. Agroforestry systems involve growing trees and agricultural crops or livestock on the same land, and have been shown to provide multiple benefits, both ecological and economic. Agroforestry practices seek to maximize productivity of or benefits from different components on the same piece of land (Workman et al. 2006). In their survey, Workman et al. (2003) found that 67% of landowners in Alabama and Florida were familiar with non-timber forest products (NTFPs), but only 18% of Alabama landowners engaged in forest farming. Forest farming involves the intentional manipulation of the forest to produce specific non-timber products (Hill and Buck 2000). Harvesting or cultivation techniques are usually introduced into existing forest systems. More than 40% of Alabama landowners expressed interest in learning about forest farming and production of non-timber forest products (Workman et al. 2003). When asked about benefits of agroforestry regimes, Alabama landowners ranked wildlife habitat, soil conservation, and aesthetic value as the most important potential benefits. Top rated obstacles among respondents were lack of equipment, component competition, lack of land area, and lack of demonstrations. Land use professionals in Alabama and Florida cite lack of familiarity with the practices and lack of demonstrations as obstacles to agroforestry (Workman et al. 2003). While demonstration projects are a useful outreach tool, Hauff (1998) says, they must be scale-appropriate and provide flexibility to meet personal circumstances.

Table 4.1 shows the number of non-timber forest products (NTFPs) enterprises (including landscape enterprises) for the 13 Southern states that make up U.S. Forest

Service Region 8 in the contiguous United States. While the data are not current or especially solid (they are based on Extension agent answers to surveys, for which response rates varied widely among states), they provide insight to how Alabama compares to other states in the region in terms of number of enterprises and prominence of landscape enterprises. Landscape enterprises are those that involve collection of pine straw or native plants from the wild (Chamberlain and Predny 2003).

Table 4.1. Number of non-timber forest product (NTFP) and landscape enterprises in the Southern states as perceived by county Extension agents

	Total NTFP enterprises		Landscape enterprises		Landscape enterprises as percentage of total	
	Total Number	Ranking	Total Number	Ranking	Percentage	Ranking
Alabama	1,411	7	377	5	26.7	4
Arkansas	1,060	9	120	11	11.3	11
Florida	1,412	6	837	3	59.3	1
Georgia	1,974	4	1,086	2	55.0	2
Kentucky	4,921	2	373	7	7.6	13
Louisiana	551	13	81	12	14.7	10
Mississippi	900	10	192	10	21.3	6
North Carolina	6,357	1	1,326	1	20.9	7
Oklahoma	577	11	65	13	11.3	12
South Carolina	556	12	216	8	38.8	3
Tennessee	2,572	3	593	4	23.1	5
Texas	1,071	8	196	9	18.3	9
Virginia	1,945	5	376	6	19.3	8

Source: Hartsell and Johnson (2005); Chamberlain and Predny (2003)

Of the 13 states, Alabama is ranked 7th for total NTFP enterprises. Those states home to Appalachian forests (North Carolina, Kentucky, and Tennessee) had the highest numbers of total NTFP enterprises. Alabama is ranked 5th for number of landscape enterprises, following North Carolina, Georgia, Florida, and Tennessee, respectively. However, when looking at landscape enterprises as a percentage of the total NTFP

enterprises, Alabama ranked 4th. In other words, though there are not as many enterprises in the state, landscape enterprises play a more dominant role.

Research of alternative forest management regimes provides insight to why landowners are not engaging in such practices. Workman et al. (2003) cite poor market development and inadequate education of the public and of land use professionals as constraints to agroforestry development (including forest farming). Access and distance to markets is an important factor in the successful implementation of alternative forestry systems (Hauff 1998).

Workman et al.'s (2003) findings provide a starting point for this research project. Yet, many questions remain regarding the 40% of Alabama landowners who expressed interest in NTFPs. Information is needed about their ownership objectives, current management practices, environmental concerns, market awareness, and interest in harvesting pine straw. There is also a need for information about the pine straw market and consumer demands.

4.1.3. Pine Straw Market and Economics

Despite pine straw's mulching benefits and its popularity in landscaping, the market is not well-developed in Alabama. As shown in Chapter 3, buyers (garden centers, landscapers, and nurseries) often purchase pine straw from more than 200 miles away, usually from Florida or southwest Georgia. For reasons both economic and legal, the pine straw industry is an informal network of dealers, forest labor contractors, harvesters, and landowners. In her work, Casanova (2007) explains how relationships (direct and indirect) form between these stakeholders and the role of migrant labor in the commodity chain (see Figure 4.1 in Casanova 2007). Pine straw raking is often done by

crews of workers from Mexico and Central America recruited by forest labor contractors through the H2B guest worker program (McDaniel and Casanova 2005). These migrant workers are paid on a per-bale basis; the more – and the faster – they bale, the more money they make. Many fledgling pine straw businesses fold within a year (Casanova 2007). Yet, Casanova states, "Maintaining pine straw harvesting as an informal activity thus ensures the survival of the industry" (2007:59). This is largely in part due to the industry's reliance on immigrants to conduct low-cost, intensive labor.

Pine straw harvesting occurs on privately-owned land and access is largely unregulated. In 1989 Georgia legislature enacted a statute (Title 12, Chapter 6, Article 4) stating that a landowner must obtain and present to a pine straw dealer a certificate of harvest, valid for one year, granting permission for harvesting to occur. This document is signed by the landowner and includes the date and location of the harvest. However, despite this law, few dealers or landowners have heard of a certificate of harvest, thus many do not use it (Casanova 2007). Casanova states: "Private property and personal profit are the true regulators of access" (2007:55). For undocumented workers, their future is uncertain. This uncertainty along with short-term access to private property, Casanova (2007) says, leads to indiscriminate harvesting of the resource. Ecological concerns (such as slowed tree growth or impacts on soil nutrients or infiltration rates) are usually secondary to economic ones.

Revenues from pine straw operations vary depending on a wide range of factors, including species, quality, and costs associated with preparing a site for harvesting. Landowners who choose to lease their land for pine straw operations are typically paid on either a per-bale basis or a per-acre basis. Taylor and Foster (2004) estimate that if paid

on a per-bale basis, landowners in East Texas can expect to receive approximately $0.10 to $0.25 per bale; these 25- to 50-pound bales of pine straw sell wholesale for $5 to $10. Another source cites higher estimates of $0.50 to $0.65 per bale for pine straw in Georgia (Cassanova 2007). If paid on a per-acre basis, landowners in East Texas get approximately $12.50 to $30 per acre (Taylor and Foster 2004). In Florida, leases may range from $70 to more than $100 per acre (Minogue et al. 2007). Per-acre payments for pine straw compare favorably with hunting leases and do not preclude that revenue stream. In one study of hunting leases on public lands in Mississippi (which tend to cost more due to competitive bids), such agreements yielded an average of $8.73 per acre (Rhyne et al. 2009). Other studies have valued per-acre hunting leases at around $5 per acre (see, e.g., Jones et al. n.d.).

One of the first questions landowners ask when considering any new management regime is: What are the associated costs? When managing a stand for pine straw operations, the answer to this question is dependent on a number of factors. Such factors include site conditions, site quality, whether the stand is natural or planted, stand age, previous silvicultural treatments, and whether the straw will be baled by hand or using mechanical processes. One Extension source estimates that the cost of an initial cleaning of an existing stand of loblolly pine in preparation for mechanical baling is between $180 and $250 per acre (Texas AgriLife Extension Service n.d.). But often it is more than just site preparation costs that determine whether a landowner is willing to harvest pine straw.

Grado and Husak (2004) state that when deciding whether to invest in a land-use system, landowners are heavily influenced by two factors: experience with multiple land-use options and flexibility regarding the length of time before an investment matures. In

other words, those landowners who have experience with multiple-use systems and who can afford to wait on an investment to mature are more likely to engage in such alternative practices. The authors use cash flow models to analyze the economic benefits associated with incorporating pine straw production into pine plantation and silvopasture systems. Grado and Husak (2004) report land expectation value (LEV), equivalent annual income (EAI), and rate of return (ROR) for the production systems at three different interest rates (5, 7, and 9%). Cash flow models of the pine plantation and silvopasture systems incorporated supplemental income from hunting leases and pine straw production.

Assuming a 9% interest rate, when the silvopasture system (with a 30-year production period) incorporated pine straw production, it yielded 6.0% more value per acre (reported as LEV and EAI) than the silvopasture system that did not incorporate any supplemental income. At a 9% interest rate, when both hunting leases and pine straw production were incorporated into the silvopasture system, LEV and EAI were 15.2% higher than the conventional silvopasture system. The cash flow model for the pine plantation (with a 35-year production period) followed a similar trend when supplemental incomes were included. At a 9% interest rate, the pine plantation with income from pine straw yielded a LEV and an EAI 8.0% higher than the same system without supplemental income. A pine plantation incorporating both pine straw and hunting leases was valued at 30.2% more per acre.

Even at lower interest rates, LEVs and EAIs were greater for the two systems when incorporating supplemental incomes. When using a 5% interest rate, pine straw yielded 0.4% more value per acre in a silvopasture and 2.1% more in a pine plantation.

Pine straw production and hunting leases combined yielded 8.3% and 9.4% higher per-acre values for the silvopasture and pine plantation, respectively. "In down markets," the authors conclude, "the addition of this supplemental income may help to defer expenses, ultimately allowing the landowner the luxury of waiting for a market up-turn" (Grado and Husak 2004:52). Despite the positive gains in per-acre values, however, they caution that more research needs to be done on the increasing popularity of pine straw. In particular, they note a need for exploration of how promotion and harvesting of pine straw impact site quality and wildlife.

Dickens et al. (2007) also conducted an economic analysis of pine straw production, examining nine scenarios for 24-year-rotation on loblolly and slash pine stands. These scenarios varied in terms of thinning regimes (thin or no thin), fertilization (at 6 years, 16 years, 6 and 16 years, or none), pine straw harvesting schedule (rake from years 8 through 14, 8 through 23, 8 through 14 and 17 through 23, or no harvests), and pine straw revenues (either $50 per acre or $100 per acre). Net revenues and internal rates of return were calculated using three different per-acre site preparation and planting costs ($125, $250, and $375). For the highest establishment cost ($375 per acre), only when income from pine straw raking was realized did the scenarios achieve an internal rate of return of 8% or better.

4.1.4. Pine Straw Production: Issues Affecting Landowners

Costs and revenues associated with pine straw operations vary widely depending on a number of factors, including site preparation, labor requirements, and harvesting processes. These too vary widely and are specific to individual sites and ownership objectives. Although it is difficult to say how pine straw operations "normally" operate,

landowners need to be aware of the various options and how their ownership objectives may affect those decisions.

Pine straw can be harvested any time of year, but is usually done so after the main needle drop in fall. It is best to harvest straw when it is dry; wet straw is heavier and can mold when baled and stored. Pine straw is harvested either by hand or mechanically. If it is harvested by hand, workers rake the straw into piles, pick out debris such as limbs and pine cones, pack the straw tightly into box balers, and then bind the bales with twine. Bales are loaded onto trailers where they remain until hauled to the retailer or other sale point. One source estimates that manual baling yields about 250 to 300 bales per day (Nix 2011). Wallace and Ward (2011) estimate that an individual using a box baler can produce between 100 and 200 bales per day.

Mechanical harvesting of pine straw usually occurs in plantations. The straw is first raked into windrows – either by hand or with a tractor-mounted straight-bar rake – down the middle of the rows between the trees. Harvesters pick out debris and then a tractor drives along the rows pulling a baler, which scoops the pine straw up and forms bales (either square or round, depending on the equipment). In some cases, mini hay roll balers are used because they are small, fit on existing farm equipment, and can maneuver through narrow row plantings (Nix 2011). According to Nix (2011) and Wallace and Ward (2011), mechanical baling can yield up to 1000 bales per day. The primary concern regarding mechanical harvesting, however, is potential damage to trees by the machinery, causing reduced growth and increased susceptibility to pests and disease (Wallace and Ward 2011).

In most cases, contracts between landowners and pine straw dealers are either done on a per-bale basis or a per-acre basis. The amount a landowner is paid may vary depending on the level of involvement by the landowner and his or her willingness to prepare and maintain the stand. Oftentimes there is heavy site preparation involved; therefore profits from the first baling (if there are any at all) might be slim. Subsequent balings are likely to be much more profitable (Nix 2011). Preparing a site for pine straw harvesting can be an extensive process and may take up to two years (Wallace and Ward 2011). It can include a prescribed burn several years prior to first harvest (Nix 2011). Regular burning may also continue during pine straw harvest years (for example, to promote grass growth for wildlife). If properly timed, burning can help control growth of unwanted species (such as hardwoods) and also promote needle drop.

Winter burns can help encourage growth of legumes and forbs favored by wildlife species (DeVos n.d.). If scheduled late enough in the season, a winter burn should not affect pine straw raking. Spring burns are often conducted to reduce hardwood species and likely would not interfere with raking operations. Late summer burns are used to control competition and, occasionally, prepare a site for natural seedling establishment (McNabb 2001); a burn at this time may also clear the forest floor before needle fall.

Good competition control is necessary to keep raked stands clean, and herbicide is often a necessary component of site prep and stand maintenance. Early herbicide treatments ensure that a landowner can harvest needles from a higher percentage of the stand. It is applied prior to harvest and often reapplied if there is re-growth of briars or weeds. When pine straw is harvested, it opens up the forest floor, facilitating new undergrowth. Therefore, a herbicide regime may be necessary to control herbaceous

material and hardwoods in order to maximize quality pine straw production. Minogue et al. (2007) offer guidelines for what herbicide to apply (and how), depending on the target species.

Mowing is often a regular part of site maintenance during pine straw harvest years, the timing of which depends on harvest schedules and other landowner objectives (e.g. wildlife). Hardwoods need to be cleared out. Also, limbs need to be removed from the trees (especially if baling is to be done mechanically). This pruning may be done with a tractor-mounted blade (Texas AgriLife Extension Service n.d.), but to protect health and quality of standing trees, it is recommended that this pruning be done by hand. Pruning may also increase the value of the trees themselves. To reduce labor costs, collected debris may be deposited every sixth or seventh row (Wallace and Ward 2011).

There are negative impacts associated with pine straw harvesting that landowners need to be aware of as well. Such impacts discussed in the literature include: slowed tree diameter growth, increased weed growth, decreased water infiltration rates, increased runoff volume, greater sediment loads, increased erosion, disrupted nutrient cycles, relative species losses of floras, and decreased nutrient availability (Wallace and Ward 2011, Dickens et al. 2005, Hayes et al. 2009, Kelly et al. 2002, Pote et al. 2004, Lopez-Zamora et al. 2001). Yet, through proper management, there are ways to minimize negative impacts caused by pine straw harvesting.

Best management practices (BMPs) can be employed, along with less-frequent harvesting schedules. Landowners should avoid harvesting pine straw from sites with high erosion potential or susceptibility to compaction. To avoid the risk of increased drought damage, dry sites should also be excluded from harvesting operations (Zwolinski

and Quicke 1998). Other recommendations for landowners include leaving organic material on the soil surface as undisturbed as possible during raking, raking every other year or every two years, and raking earlier in the season (for example, in October) so additional straw can accumulate post-harvest and provide cover until the next harvest (Pote et al. 2004). To reduce negative impacts of harvesting, Pote and Daniel (2008) recommend hand raking with at least two year intervals between harvests. For stands that are mechanically raked, the authors recommend at least three years between harvests. For less productive stands or sites that are environmentally sensitive, longer 3- to 4-year intervals are recommended (Wallace and Ward 2011). During the intervals between pine straw harvests, cover crops (for example, of cool season grasses) can be planted (Pote and Daniel 2008). This helps to protect the soil, suppress growth of weeds, and add soil organic matter. It can also serve as livestock forage.

4.1.5. Pine Straw Production: Potential for Conservation of an Important Ecosystem

The potential rewards for landowners interested in harvesting pine straw from their property are clear: short-term income, compatibility with other land uses, and production of a commodity that (in most cases) requires little direct effort from the landowner. Pine straw holds potential even for those for whom timber is not a primary ownership objective. Pine straw operations require a clean understory, meaning they can complement plans already managing for aesthetics. Through careful management of livestock, pine straw operations can also be incorporated into silvopasture systems (Wallace and Ward 2011). Multiple-use management can benefit more than just the landowner – it can have broader implications for communities and the environment.

Longleaf pine once dominated the landscape of the southeastern U.S. Longleaf forests are home to a high diversity of plants and animals. This hardy species has been shown to be more resistant to pests (e.g. pine bark beetle), disease (e.g. fusiform rust), and weather-related damage (e.g. high winds from hurricanes) than other southern pines (Franklin 2008). Yet, due to demand for timber at the time of European settlement and the exclusion of fire from the landscape, longleaf acreage has dwindled to less than 3% of its original range. Much of its natural range now stands in loblolly or (to a lesser extent) slash plantations (Franklin 2008).

In Alabama and other southern states there is a push among conservation organizations to restore the longleaf forest ecosystem. Progress has been made, with a substantial increase of longleaf pine acreage on public lands in recent decades. On private lands, however, there has been a decline, especially in natural longleaf pine acreage (John Kush, Director, Longleaf Pine Stand Dynamics Laboratory, personal communication, February 12, 2012). This decline is the result of decades of mismanagement of longleaf pine and misconceptions among landowners about longleaf growth rates and marketability. Advocates of longleaf restoration argue that the species is well-suited to private landowners with varying ownership objectives. They realize, however, that significant gains in longleaf pine acreage may require a fundamental shift in landowner perspectives. Barlow et al. state: "Sustaining the interest of the nonindustrial private forest landowners in longleaf pine management must ultimately overcome the cash flow problem associated with longer rotations" (2011:53).

One such approach is the introduction of alternative enterprises into management plans of non-industrial private forestland (NIPF) owners. Income from nontraditional

forest products and values (such as wildlife) provide opportunities for landowners to manage longleaf pine over longer rotations (Barlow et al. 2011). Therefore, pine straw not only holds potential for individual private landowners who may be encouraged to keep lands in forests and trees "on the stump," but this NTFP may have long-term benefits if it results in the conservation and restoration of this important ecosystem.

The overall goal of the portion of this study covered in this chapter was to gauge the potential for higher involvement of Alabama forestland owners in a pine straw market. Mail survey results were used to assess landowner interest and knowledge of agroforestry systems and, more specifically, production of NTFPs. Those who own forestland with pine were asked "willingness to accept" (WTA) questions in order to determine an approximate expected price range for pine straw based on various factors (such as respondent location and pine species). Such information can be used to help develop programming for landowners aimed at expanding market opportunities.

4.2. Methods

Four main tasks were associated with this portion of the study:

Task 1. Review literature related to private forestland owners and willingness to engage in alternative practices and markets.

Task 2. Develop questionnaire aimed at understanding landowner management practices, ownership objectives, awareness of – and interest in – agroforestry practices (including production of non-timber forest products), perceived costs and benefits of such practices, and needs for technical assistance or incentive programs.

Task 3. Using Dillman's Tailored Design Method, conduct survey of owners of forestland in six counties in Alabama.

Task 4. Perform statistical analyses of survey results to identify (1) trends among Alabama forestland owners, (2) correlations between independent variables, and (3) causal relationships between landowner or site characteristics and interest in production of NTFPs (including pine straw).

Task 1 involved reviewing literature on alternative forest enterprises and landowner willingness to engage in such markets. Findings from the literature review provided a basis for development (Task 2) of a survey (Appendix E) mailed (Task 3) to 798 private owners of 10 or more acres of land in six Alabama counties. Pine straw and other non-timber forest products (NTFPs) are primarily harvested from non-industrial private forestland. Therefore, I was interested in knowing whether non-industrial private forestland owners are interested in harvesting NTFPs, and under what circumstances. Only owners of 10 acres or more were surveyed because harvesting operations on parcels smaller than that are unlikely to be cost-efficient. Addresses of landowners came from publicly-available tax records. The counties chosen (Jackson, Shelby, Autauga, Baldwin, Houston, and Pickens) were selected because of their close proximity to the metropolitan areas selected for the survey administered as part of the pine straw buyer study (Figure 4.1).

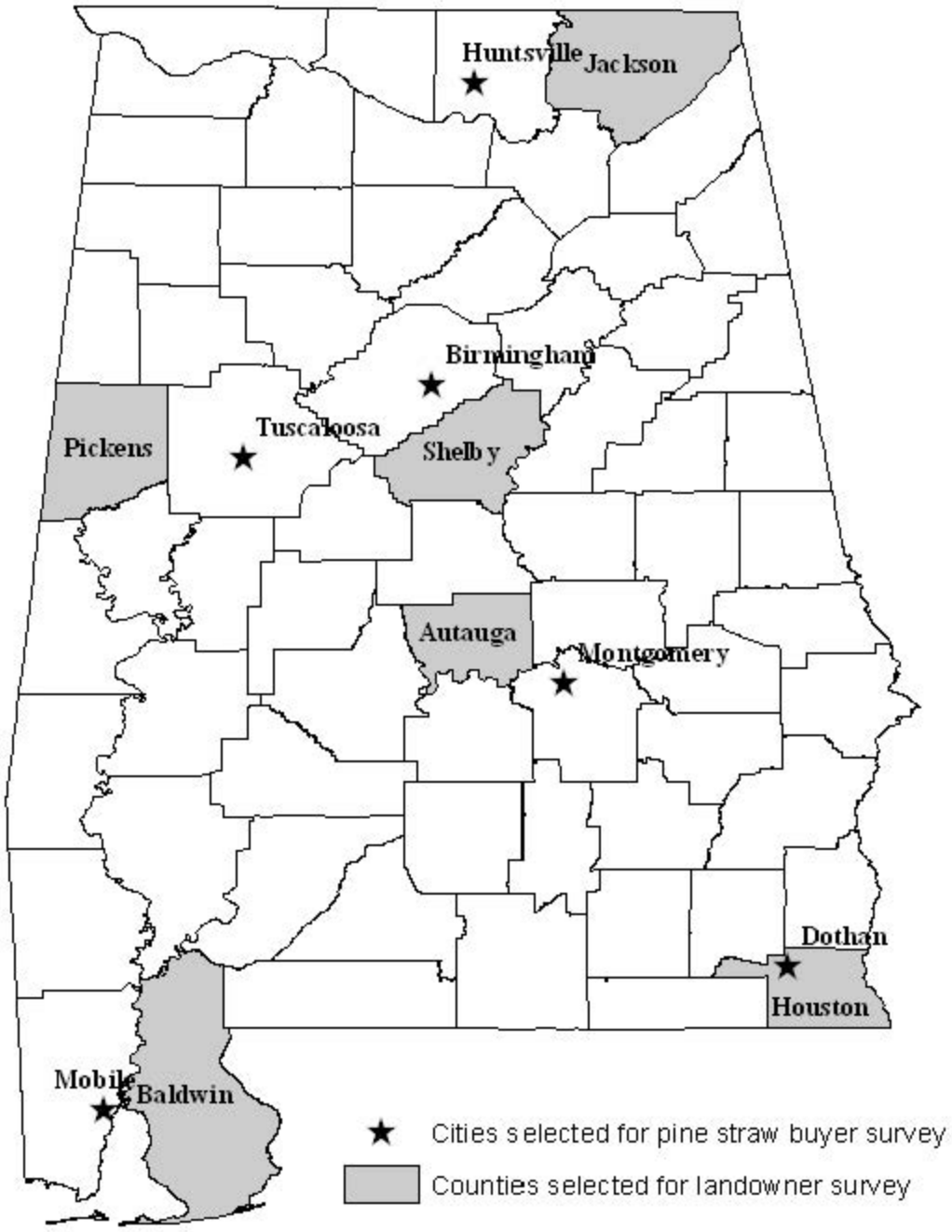

Figure 4.1. Locations chosen for the 2011 landowner survey and the 2010 survey of retailers, landscapers, lawn maintenance specialists, landscape suppliers, and nurseries in Alabama

It was expected that the mail survey would take approximately 10 to 15 minutes to complete. Questions were multiple choice or simple fill-in-the-blank, though respondents were given the opportunity to elaborate on their responses if they wish. Survey questions were designed to elicit information that would provide insight to the potential for forestland owners in the region to meet the market demands of pine straw (and other NTFP) buyers in the adjacent urban area.

The survey was printed and mailed by CopyCat, a copy and digital document center on the campus of Auburn University. An initial pre-notice letter (Appendix F) was sent in February, 2011, to those landowners randomly selected from the sample frame (property tax assessment records of six study counties). The letter notified the recipient of the research project and invited him or her to participate in the forthcoming mail questionnaire. The survey, which was mailed several days after the pre-notice letter, contained another letter (Appendix G) with more detailed information about the study (including the IRB protocol number and dates) and ensured respondents that their participation was entirely voluntary and that responses would remain confidential. The survey concluded with an invitation to provide more detailed information. Those survey respondents who were interested in doing so were invited to contact Dr. Becky Barlow by phone or email. Accompanying the survey was a sticker with an agroforestry-themed image (see Appendix H), which served as an incentive to the recipient to fill out the survey.

A follow-up postcard (Appendix I) was mailed a few days later, thanking those who participated and asking those who had not completed the survey to do so. Finally, a second copy of the survey was mailed a few weeks later to those who did not return the

first. The second copy of the survey was accompanied by another letter (Appendix J), expressing the urgency of their response and appreciation for their time.

As completed surveys were received, number codes printed on the survey were used to remove recipient names and addresses from the mailing list. These code numbers were also used to identify which of the six counties in the state the participant's land is in. Knowing this, differences in potential NTFP availability across the state can be determined. Survey results were coded and entered into an Excel spreadsheet. For Task 4, results were summarized and analyzed using multiple functions in SPSS, using a 0.05 alpha level to determine statistical significance. The primary dependent variable was landowner interest in harvesting pine straw from their land.

Surveys that were returned because of incorrect addresses or deceased recipients totaled 49 and 10, respectively, leaving 739 valid recipients. Twenty-two respondents actively refused (either by phone call, mailed note, or returning a blank survey) to participate in the survey, but were not removed from the valid recipients list. Also, there were seven respondents who answered only the first question ("Do you own forestland?"), but left the remainder of the survey blank; these respondents were not removed from the valid recipients list either. Of the 739 valid recipients, 282 questionnaires were returned completed, yielding a 38% response rate.

4.3. Results

4.3.1. Respondent Demographics and Forest Landowner Characteristics

Table 4.2 displays the demographics of those who responded to the mail survey sent to landowners in Alabama (N=282).

Table 4.2. Descriptives of respondents to 2011 survey of landowners in six Alabama counties

Demographic	Percent of N
Response County (N=282)	
Autauga	13.8
Baldwin	18.1
Houston	22.0
Jackson	14.5
Pickens	16.0
Shelby	15.6
Own forestland (N=281)	
Yes	70.1
No	29.9
Gender (N=274)	
Male	70.8
Female	29.2
Race or ethnicity (N=266)	
Black or African American	3.0
White or Caucasian	96.6
Hispanic or Latino(a)	0.0
Other	0.4
Education (N=263)	
Some high school or less	3.8
High school graduate	23.6
Some college/technical	24.0
College graduate	28.9
Some graduate school	1.1
Master's degree or higher	18.6
Income (N=225)	
Less than $20,000	5.3
$20,000 to $29,999	5.8
$30,000 to $39,999	10.7
$40,000 to $59,999	18.2
$60,000 to $99,999	26.7
$100,000 or more	33.3
Age (N=265)	
Under 25	0.0
25-34	0.4
35-44	3.0
45-54	10.6
55-64	34.0
65 or older	52.1

Most of these respondents were over age 55, classified themselves as White or Caucasian, were well-educated (49% have at least one college degree), and received a high income (33% earn a household income of $100,000 or more). Seventy percent of the respondents owned forestland and 71% were male. Responses were received from all six counties, with the highest percentage (22%) from Houston County in southeast Alabama, and the lowest percentage (13.8%) from Autauga County in central Alabama.

Table 4.3 displays the ownership and management characteristics of those respondents who owned forestland (N=197).

Table 4.3. Ownership and management characteristics of respondents to 2011 survey of landowners in six Alabama counties (N=197)

Variable	Percent
Management practices used in last 10 years	
Thinning	45.1
Planting	37.3
Prescribed burning	28.0
Clearcutting	23.8
Chemical site preparation	23.3
Mechanical site preparation	21.2
Other	11.4
Timber Inventory	8.3
Fertilization	7.8
Pruning	5.7
Resident of county where majority of forestland is located	
Yes	70.3
No	29.7
Percentage of household income (10 year average) that comes from forestland activities	
None	61.3
Less than 25%	35.6
More than 25%, but less than 50%	2.6
More than 50%, but less than 75%	0.5
More than 75%	0.0
Has used services of a consulting forester during past 10 years	
Yes	34.0
No	66.0

Seventy percent of those respondents lived in the county in which the majority of their forestland was located. Most did not earn an income from activities on their forestland; 35.6% stated that less than 25% of their household income came from forestland activities. Approximately one in three respondents stated that he or she has used the services of a consulting forester during the past 10 years. When asked about forest management, the most popular practice used among respondents was thinning; 45.1% of respondents had thinned their forests within the past 10 years. The second most popular practice used was planting, with 37.3%.

Survey respondents who owned forestland were asked to rank the level of importance that various factors play when making decisions about their property. Response options given were "Very important," "Somewhat important," "Slightly important," and "Not important." The results of those questions are displayed in Figure 4.2. It is clear that leaving a legacy for heirs was a high priority among respondents; 53.8% stated this was "very important" and 28.3% stated this was "somewhat important." This factor was closely followed in importance levels by other non-pecuniary concerns: emotional/intrinsic value (44.7% stated this was "very important"), environmental stewardship (41.6% stated this was "very important"), and personal recreation (40.2% stated this was "very important"). A significant number of respondents also placed a high level of importance on "Don't want to clearcut." Although "income from timber sales" ranked much lower in level of importance than many of the other factors, 46.3% of respondents still stated that it was either somewhat or very important. Two other income factors, income from other activities and income from hunting leases, ranked very low,

with only 5.0% and 5.5% of respondents stating these were “very important,” respectively.

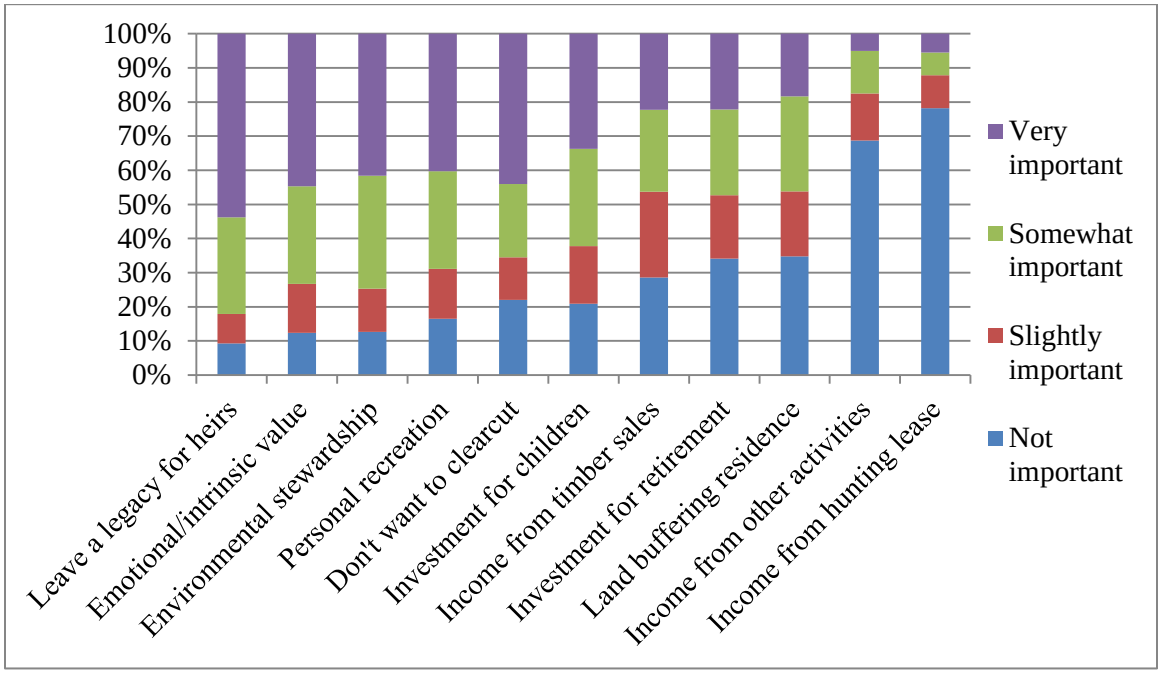

Figure 4.2. Respondents' reported levels of importance of factors in making decisions about forestland, 2011 landowner survey

Patterns of species and acreage can account for differences in management. Among forest types, for example, pine is generally associated with more intensive management and characterized as being more productive (Arano and Munn 2006). Table 4.4 displays the forestland ownership of respondents by species and regeneration method. More than half of the survey respondents owned natural hardwood forests, with ownership averaging 232 acres. The largest mean acreages, however, were in planted loblolly (one-third of respondents owned planted loblolly averaging 557.2 acres) and in planted slash (8.1% of respondents owned planted slash averaging 449.7 acres). Among naturally-regenerated pine species, loblolly had the highest percentage of owners (27.4)

and the highest mean acreage (85.4). Approximately 14% of forestland owners reported having naturally-regenerated longleaf, with an average acreage of 76.7.

Table 4.4. Forestland ownership, by species and method of regeneration, of respondents to 2011 survey of landowners in six Alabama counties

Regeneration method and species	N	Percent of forestland owners	Minimum (acres)	Maximum (acres)	Mean (acres)
Natural Pine					
Loblolly	54	27.4	1	600	85.4
Longleaf	28	14.2	1	600	76.7
Slash	16	8.1	1	100	36.1
Other	22	11.2	1	400	64.5
Planted Pine					
Loblolly	66	33.5	1	20,000	557.2
Longleaf	34	17.3	1	400	84.4
Slash	16	8.1	12	3,500	449.7
Other	6	3.0	6	400	88.8
Natural Hardwood	101	51.3	1	10,000	231.5
Planted Hardwood	15	7.6	1	300	51.0
Natural Mixed	120	60.9	2	8,000	167.1

4.3.2. Analyses of Knowledge of and Interest in Agroforestry and NTFPs

A number of figures were developed to illustrate respondents' familiarity with and interest in agroforestry systems, reasons given for considering practicing and for choosing *not* to practice agroforestry, and interest in production of NTFPs.

The agroforestry system with which survey respondents were most familiar was windbreaks (see Figure 4.3). Almost half of the respondents were either "somewhat familiar" or "very familiar" with this practice; approximately one-third of respondents were "not at all familiar." Slightly more than half of respondents had some level of familiarity with riparian buffers. Half (50.6%) of respondents were not at all familiar with silvopasture; only 8.0% consider themselves "very familiar" with the practice. The two agroforestry systems that respondents were least familiar with were forest

farming/NTFPs and alley cropping. In both cases, only about 5% of respondents considered themselves "very familiar" with the practice.

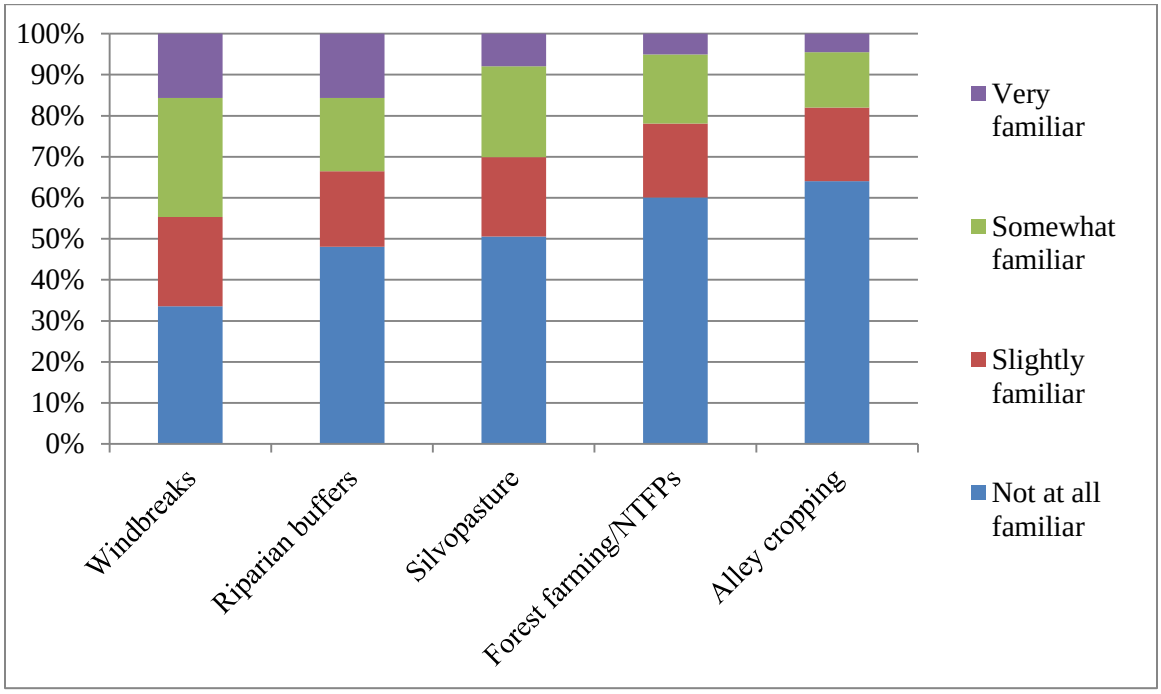

Figure 4.3. Respondents' reported levels of familiarity with agroforestry systems, 2011 landowner survey

As shown in Figure 4.4, the agroforestry system that respondents expressed the highest levels of interest in was the one they stated the second highest level of familiarity with: riparian buffers; 17.9% of respondents stated they were "very interested" in this practice. Following that, however, windbreaks, forest farming/NTFPs, and silvopasture yielded similar levels of interest, with 10.9, 10.4, and 11.5% of respondents stating that they were "very interested" in these practices. The practice in which respondents expressed the least amount of interest was alley cropping; 61.8% of respondents stated they were "not at all interested."

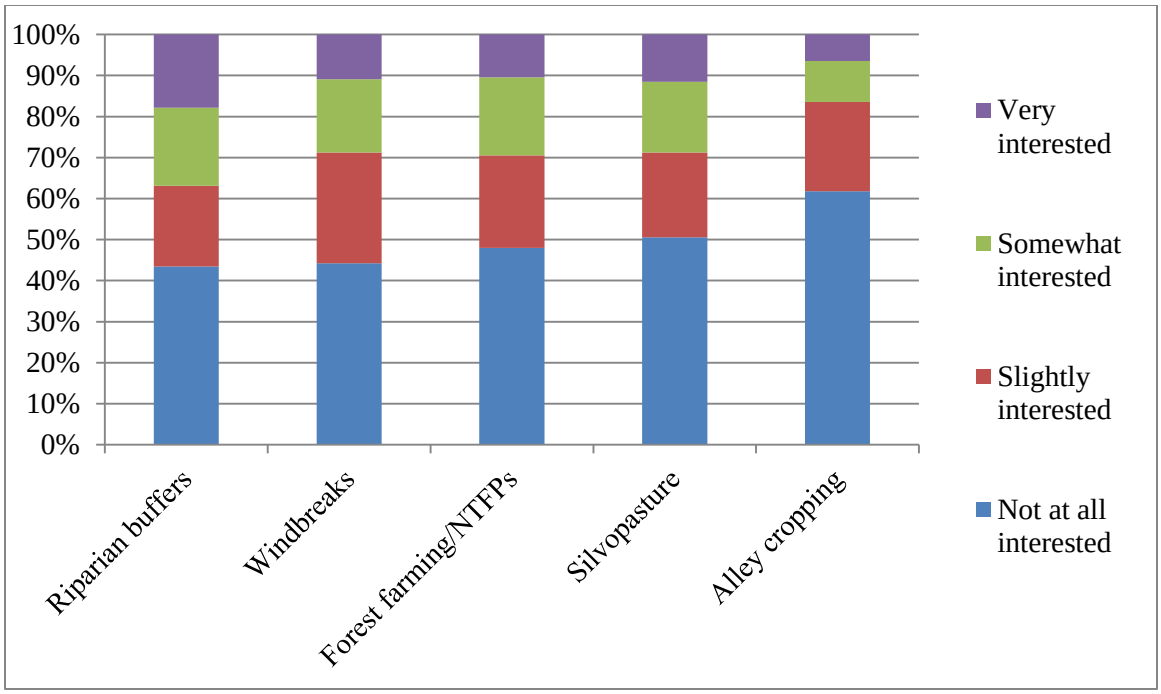

Figure 4.4. Respondents' reported levels of interest in agroforestry systems, 2011 landowner survey

Respondents were asked to rate the level of importance of a number of reasons that would lead them to consider practicing agroforestry on their land. Many of the reasons provided to respondents were similarly worded to those benefits of agroforestry that appeared in the survey conducted by Workman et al. (2003). Similar to results reported by Workman et al. (2003), landowners placed high levels of importance on improving wildlife habitat and on soil conservation, with 44.7 and 41.5% of respondents, respectively, stating that these reasons were "very important" (see Figure 4.5). However, the reason with the second-highest response rate of "very important" was increased land value. Also very important among respondents as a reason to consider agroforestry was improved water quality, with more than 60% ranking it somewhat or very important.

Support from a co-op was the factor ranked lowest among respondents in terms of importance.

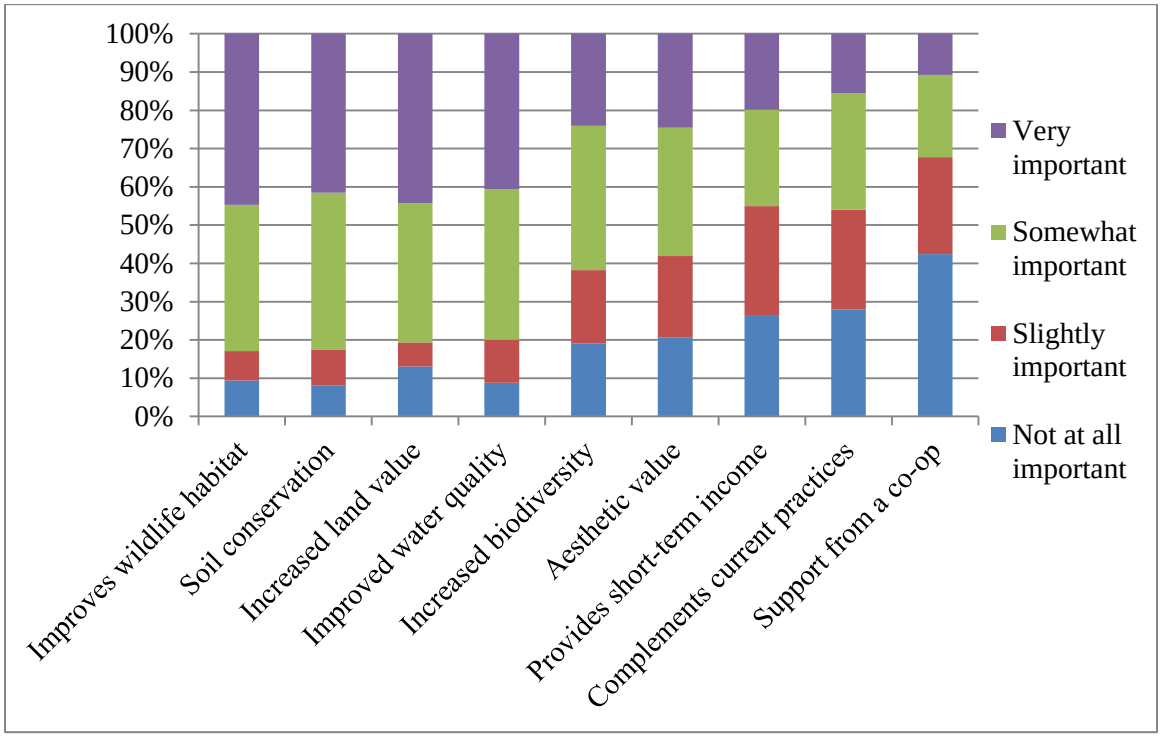

Figure 4.5. Respondents' reported levels of importance of reasons to consider practicing agroforestry, 2011 landowner survey

Survey respondents were also asked to rank the importance of reasons *not* to practice agroforestry. In other words, why might landowners decide against engaging in these alternative forestry practices? The results of this question can be seen in Figure 4.6. The two reasons ranked highest in importance were pecuniary: high investment costs and high maintenance costs. These were followed closely by impacts on wildlife habitat. Reasons that were not ranked highly in terms of importance were component competition for resources, lack of demonstration sites, and "not interested." In other words, for most

respondents, a lack of interest was not a major factor in their choosing not to engage in agroforestry.

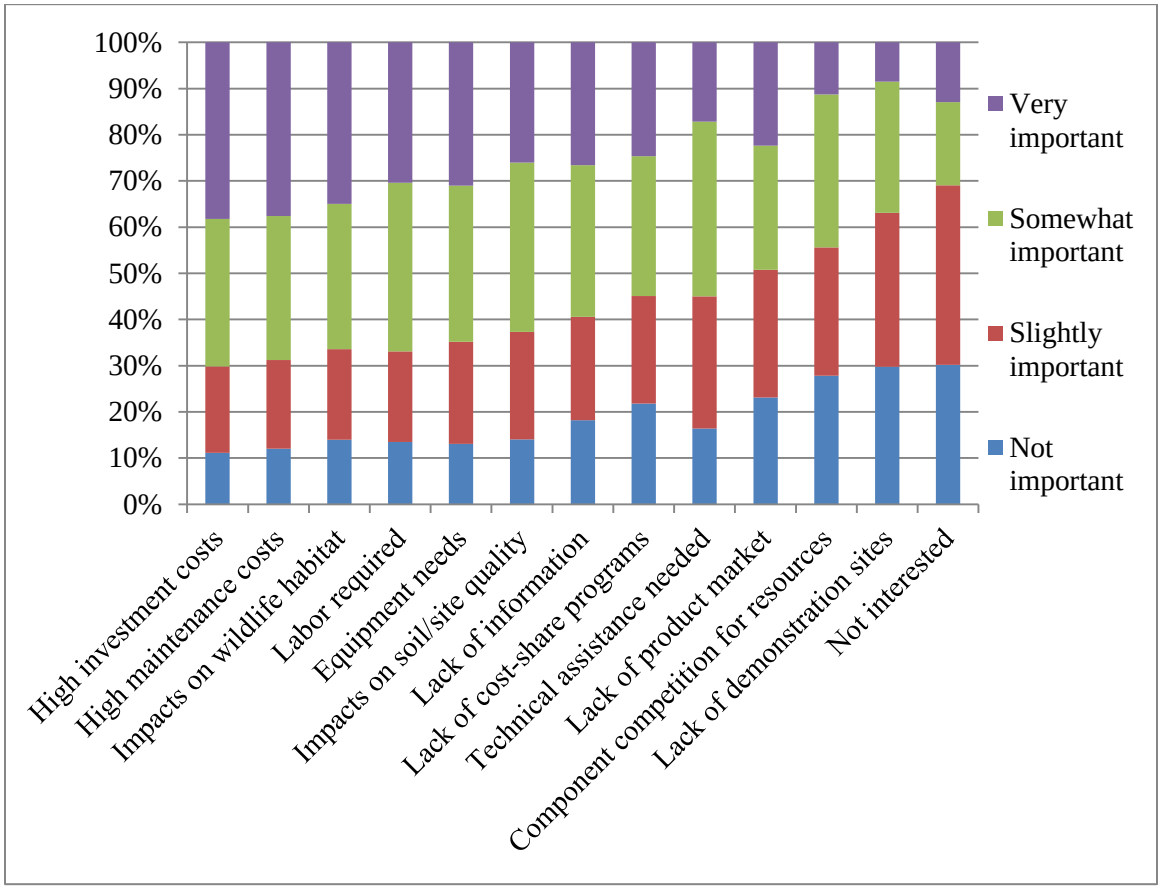

Figure 4.6. Respondents' reported levels of importance of reasons to *not* practice agroforestry, 2011 landowner survey

Lastly, respondents were asked to rank their interest in production of non-timber forest products by the different NTFP categories. They were first given a brief description of each category. As shown in Figure 4.7, interest levels remained relatively consistent across all five categories of NTFPs. However, the NTFP category that survey respondents were most interested in was landscape. This includes products that grow in the understory, such as shrubs, grasses, and ferns, as well as material that can be collected

from the understory, such as pine straw and soil amendments. More than 13% of respondents stated they were "very interested" in producing landscape NTFPs. The category yielding the most "not at all interested" responses (with 61.2%) was floral/decorative.

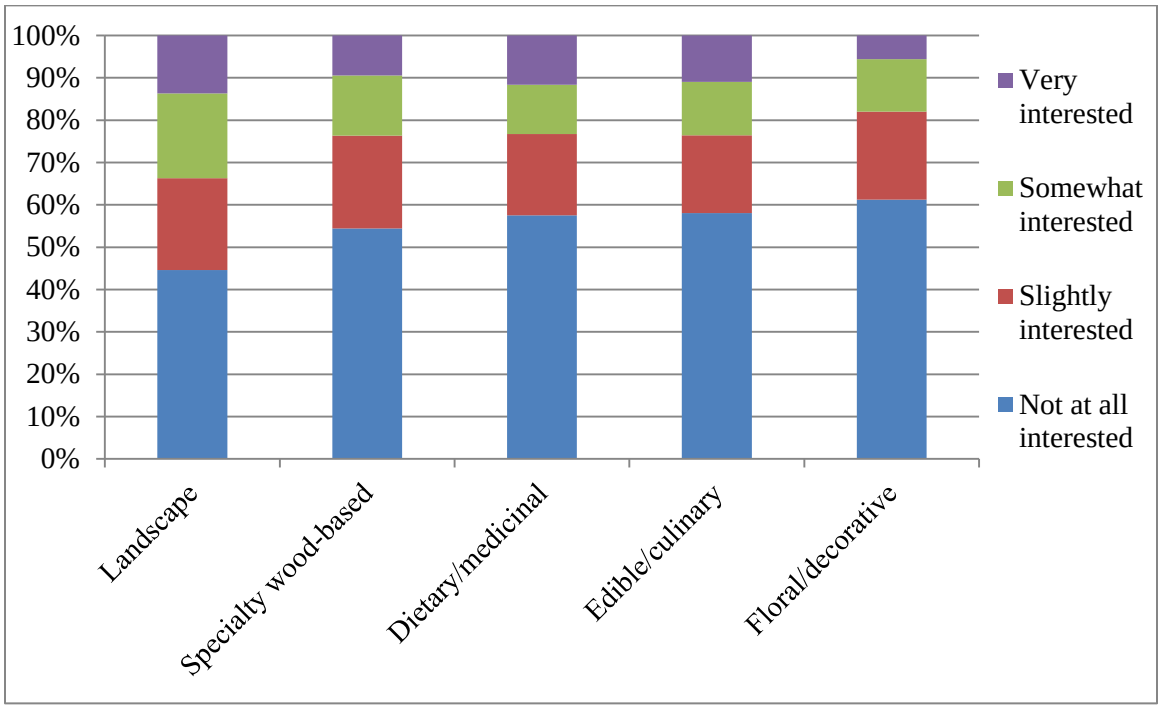

Figure 4.7. Respondents' reported levels of interest in production of non-timber forest products (NTFPs), 2011 landowner survey

4.3.3. Analyses of Interest in Production of Pine Straw

Survey respondents were asked whether the trees on their land produce pine straw. Approximately 72% stated "yes." These respondents (N=136) were then asked two questions that provide the primary dependent variables for analysis in this chapter. The first question (#17 in the survey; see Appendix E) stated: "Please rate your level of interest in harvesting pine straw from your land." Approximately 39% of respondents

stated they were “not at all interested;” 26.9% stated they were “slightly interested,” 20.1% stated they were “somewhat interested,” and 14.2% stated they were “very interested.”

Table 4.5 displays relationships between a number of independent variables and landowner interest in harvesting pine straw. There was no significant difference among landowners in different parts of the state with regard to their interest in pine straw. Although it was only significant at the 0.10 level, it is apparent when observing mean ranks produced by the Mann-Whitney U test that those who lived outside the county in which the majority of their forestland was located expressed higher levels of interest in harvesting pine straw than those who lived in the county. Those respondents who had used a consulting forester in the past 10 years expressed significantly (at the 0.05 level) higher levels of interest in harvesting pine straw than those who had not used a consulting forester.

Spearman’s rho was used to assess the relationships between interest in harvesting pine straw and forestland acreages owned by respondents, including by species and regeneration method. There was a positive, statistically significant relationship (at the 0.01 level) between level of interest and amount of total acreage owned (all hardwood and pine species). Positive, statistically significant relationships were also observed between interest level and amount of natural pine acreage (at the 0.05 level) and amount of planted pine acreage (at the 0.001 level).

Table 4.5. Relationships of independent variables to level of interest in harvesting pine straw, 2011 survey of landowners in six Alabama counties

			Mann-Whitney U			
	N	Kruskal-Wallis, X^2	Mean Rank	Z-Score	Direction	Spearman's Rho
Location	134	6.653				
Residence	133					
Not in county (NIC)	37		76.07	-1.765^{+}	NIC > IC	
In county (IC)	96		63.51			
Consulting forester	134					
Not used forester (NUF)	84		62.21	-2.142^{+}	NUF < UF	
Used forester (UF)	50		76.39			
Total acreage	120					0.242**
Total natural pine acreage	123					0.178*
Total planted pine acreage	124					0.377***
Natural loblolly acreage	123					0.059
Natural slash acreage	123					0.071
Natural longleaf acreage	123					0.043
Planted loblolly acreage	124					0.303***
Planted slash acreage	125					0.198*
Planted longleaf acreage	126					0.235**

Note: $^{+}$p≤.1, *p≤.05, **p≤.01, ***p≤.001

Planted acreages of each of the three pine species displayed positive, statistically significant relationships with the dependent variable; loblolly at the 0.001 level, slash at the 0.05 level, and longleaf at the 0.01 level. Naturally-regenerated acreages of the three pine species did not display statistically significant relationships with level of interest in harvesting pine straw.

Logistic regression was used to analyze which variables impacted the probability of a landowner expressing interest in harvesting pine straw. For the models, the dependent variable was a dummy-coded variable in which 1 represented the two response options indicating higher levels of interest, "somewhat interested" or "very interested." Responses from those who said they were "not at all interested" or only "slightly interested" were given a 0. The independent variables used for the logistic regression were all dummy coded as well. The variables were whether the respondent had used a consulting forester during the past 10 years (CONSUL), whether the respondent lived in the county in which the majority of his forestland was owned (RESIDE), whether the respondent reported owning any acreage of loblolly established through planting (PL_LOB), whether the respondent reported owning any acreage of slash established through planting (PL_SL), and whether the respondent reported owning any acreage of longleaf established through planting (PL_LONG). For all five independent variables 1 indicated "yes" and 0 indicated "no." A null model in which none of the independent variables was included produced an overall percentage of 66.1%. Of the variables not included in the null model, three (CONSUL, PL_LOB, and PL_LONG) were significant at the 0.05 level and one (PL_SL) was significant at the 0.10 level.

A logistic regression was conducted using the Enter method with the five dummy-coded IVs. The results can be seen in Table 4.6. Entering the five IVs yielded a model with an overall percentage of 69.4, which was an improvement of 3.3% over the null model. The model chi-square was 15.416 (P=0.009), indicating that adding these five variables improved the model beyond chance (i.e. more frequencies were predicted correctly). The Hosmer and Lemeshow test produced a chi-square that was not significant at 0.05 (P=0.400), indicating that there was a good fit between the predicted frequencies and observed frequencies. The confidence intervals for two IVs (PL_LOB and PL_LONG) did not contain 1. In order to predict log-odds, the following equation can be used: Y' = (0.030)CONSUL – (0.237)RESIDE + (0.971)PL_LOB + (1.062)PL_LONG + (0.635)PL_SL – 1.303.

Table 4.6. Multiple logistic regression results (Enter method) showing effects on level of interest in harvesting pine straw, 2011 survey of landowners in six Alabama counties

	B	SE	OR	95% CI
Intercept	-1.303			
Use of consulting forester	0.030	0.500	1.031	0.387, 2.747
Reside in county	-0.237	0.454	0.789	0.324, 1.922
Have planted loblolly	0.971*	0.439	2.640	1.116, 6.244
Have planted slash	0.635	0.697	1.887	0.482, 7.393
Have planted longleaf	1.062*	0.541	2.891	1.002, 8.343
Model Chi-square			15.416**	
Overall percent of cases correctly predicted by model (improvement over null model)			69.4 (3.3)	

Note: *p≤.05, **p≤.01

A Backward Stepwise logistic regression was conducted next, which produced four models, all of which were significant at the 0.05 level. The first three models all produced overall percentages of 69.4. The fourth model produced the highest overall

percentage (71.0) which was an improvement of 4.9% over the null model. In this model only two IVs remained: PL_LOB and PL_LONG.

Finally, a Forward Stepwise regression was run. PL_LOB and PL_LONG both had score statistics large enough to be added to the model. In both cases, their addition had an impact that was better than chance. However for the first step (in which PL_LONG was added), the Hosmer and Lemeshow test chi-square equaled zero. The overall percentage for this step was 69.4 (a 3.3% improvement over the null model). In the second step (in which both PL_LONG and PL_LOB were added), the chi-square significance was greater than 0.05, indicating a good fit with the observed data. As produced by the final model in the Backward Stepwise regression, the overall percentage for this step was 71.0. Other variables not in the equation for the second step had a high probability of impacting the model just by chance. The log-odds equation yielded by the final models of the two stepwise regressions is as follows: Y' = (1.002)PL_LOB + (1.239)PL_LONG – 1.451.

Based on the results of the regressions, the strongest predictors of whether a forestland owner expressed higher levels of interest in harvesting pine straw were (1) whether he or she owned planted longleaf and (2) whether he or she owned planted loblolly.

4.3.4. Analyses of Pine Straw Interest and Reasons Given for Not *Participating in Agroforestry*

Also observed were relationships between level of interest in harvesting pine straw and reasons given for not participating in agroforestry. This was done to provide insight to the question: what might be stopping those who express an interest?

Spearman's rho was used to determine statistically significant relationships; the results of the correlations can be seen in Table 4.7. Among all respondents, high investment costs and high maintenance costs were the two reasons for not participating in agroforestry that yielded the highest levels of importance (see Figure 4.6). These two factors are also strongly correlated with high levels of interest in harvesting pine straw (both are significant at the 0.01 level). Reasons for not practicing agroforestry that demonstrated significant relationships with level of interest at the 0.05 level were equipment needs, lack of cost-share programs, component competition for resources, and lack of demonstration sites. The reasons for not practicing agroforestry that demonstrated the highest levels of statistical significance with the dependent variable (both significant at the 0.001 level) were lack of information and lack of product market.

Table 4.7. Correlations between level of interest in harvesting pine straw and level of importance of reasons to *not* practice agroforestry, 2011 survey of landowners in six Alabama counties

	Spearman's Rho
High investment costs	11.419**
High maintenance costs	14.931**
Impacts on wildlife habitat	1.760
Labor required	5.186
Equipment needs	8.535*
Impacts on soil/site quality	1.935
Lack of information	24.988***
Lack of cost-share programs	9.988*
Technical assistance needed	5.353
Lack of product market	18.107***
Component competition for resources	9.791*
Lack of demonstration sites	10.513*
Not interested	4.160

Note: *p≤0.05, **p≤0.01, ***p≤0.001

In other words, those who expressed higher levels of interest in harvesting pine straw also expressed more concern with lack of available information and market

demand. And though there is much in the literature about the potential for pine straw operations to negatively impact soil and wildlife habitat (see, e.g., Kelly et al. 2002, Pote et al. 2004, and Lopez-Zamora et al. 2001), these two concerns did not show significant relationships with levels of interest in pine straw harvesting among survey respondents.

4.3.5. Analyses of Willingness to Accept (WTA)

Question 18 of the survey asked respondents to state the minimum amount they would accept for the pine straw on their land. For several reasons, rather than have respondents provide an amount, they were given 10 response options, as well as an "other" response (in which they were asked to specify an amount). They were also provided a formula, based on an assumption that an average pine plantation yields about 125 bales per acre. The 10 options presented were based on this estimate and given on both a per-bale basis and a per-acre basis. The options ranged from $0.05/bale (or $6.25/acre) to $1.50/bale (or $187.50/acre), with increments between response options ranging from $0.05 to $0.50. Of the 136 respondents who stated that their land produces pine straw, only 77 chose to answer this question by checking a provided response; 10 checked "other" and 49 did not answer the question at all. Most of those who checked "other" explained that they are unwilling to sell their pine straw at any price. Two respondents chose to write in prices, with one stating he would expect $150 or $200 per acre and other stating that he would expect $250 per acre. The frequencies of the 77 respondents who selected provided response options can be seen in Table 4.8.

More than half of the respondents expected at least $1.00 per bale (or $125 per acre), with the $1.00/bale response option yielding the highest response rate (41.6%).

The second highest response option was $0.50/bale (or $62.50/acre), with 20.8%. Only a handful (9.1%) stated they were willing to accept less than $0.50 per bale.

Table 4.8. Response frequencies (N=77) for question about willingness to accept payment for pine straw, 2011 survey of landowners in six Alabama counties

	N	Percent
$0.05/bale = $6.25/acre	0	0.0
$0.10/bale = $12.50/acre	1	1.3
$0.15/bale = $18.75/acre	1	1.3
$0.20/bale = $25.00/acre	0	0.0
$0.25/bale = $31.25/acre	1	1.3
$0.35/bale = $43.50/acre	4	5.2
$0.50/bale = $62.50/acre	16	20.8
$0.75/bale = $93.75/acre	11	14.3
$1.00/bale = $125.00/acre	34	41.6
$1.50/bale = $187.50/acre	11	14.3

A number of tests were conducted to see what factors might influence the prices landowners are willing to accept for their pine straw. As shown in Table 4.9, no relationships were significant at the 0.05 level. Because south Alabama is home to significantly higher acreages of longleaf pine, the straw of which fetches premium prices, it might be presumed that landowners in this part of the state would expect higher prices for their pine straw. However, there was no relationship observed between location and willingness to accept (WTA). Although it was only significant at the 0.10 level, it is apparent when observing mean ranks produced by the Mann-Whitney U test that those who lived outside the county in which the majority of their forestland was located were willing to accept lower amounts for their pine straw.

Table 4.9. Relationships of independent variables to willingness to accept payment for pine straw, 2011 survey of landowners in six Alabama counties

			Mann-Whitney U			
	N	Kruskal-Wallis, X^2	Mean Rank	Z-Score	Direction	Spearman's Rho
Location	77	2.838				
Residence	77					
Not in county (NIC)	21		31.74	-1.825^{+}	NIC < IC	
In county (IC)	56		41.72			
Consulting forester	77					
Not used forester (NUF)	45		40.68	-0.817	NUF > UF	
Used forester (UF)	32		36.64			
Total acreage	71					-0.121
Total natural pine acreage	73					-0.029
Total planted pine acreage	72					-0.182
Natural loblolly acreage	73					-0.049
Natural slash acreage	73					0.162
Natural longleaf acreage	73					0.042
Planted loblolly acreage	72					-0.049
Planted slash acreage	73					-0.082
Planted longleaf acreage	73					-0.173

Note: $^{+}p \leq 0.10$

In general, those who had used a consulting forester in the past 10 years were willing to accept lower prices for their pine straw than those who had not used a consulting forester; however, this difference between the two groups was not statistically significant.

Spearman's rho was used to assess the relationships between WTA and forestland acreages. No statistically significant relationships were detected. However, in general, those with higher acreages were willing to accept lower prices. The only exception to this was acreages of naturally-regenerated slash and longleaf.

Though there were no statistically significant relationships using non-parametric measures of bivariate relationships, logistic regression was used to analyze which variables impacted the probability of a landowner's willingness to accept a given amount per bale of pine straw. For the models, the dependent variable was a dummy-coded variable in which 1 represented the response options to Question 18 of $1.00 per bale or $1.50 per bale. Responses from those who said they were willing to accept less than $1.00 per bale were given a 0. The independent variables used were the same as those included in the logistic regressions discussed in the previous section (CONSUL, RESIDE, PL_LOB, PL_LONG, and PL_SL). A null model in which none of the IVs was included produced an overall percentage of 59.7%. Of the variables not included in the null model, only one (RESIDE) was significant at the 0.05 level.

A logistic regression was run using the Enter method with the five dummy-coded IVs. The results can be seen in Table 4.10. Entering the five IVs yielded a model with an overall percentage of 68.1, which was an improvement of 8.4% over the null model. However, the model chi-square was 6.417 (P=0.268), indicating that adding these five

variables did not improve the model beyond chance. The Hosmer and Lemeshow test produced a chi-square that was not significant at 0.05 (P=0.794), indicating that there was a good fit between the predicted frequencies and observed frequencies. The confidence intervals for all of the IVs contained 1, suggesting none of the variables was significant. In order to predict log-odds, the following equation can be used: Y' = (-1.219)CONSUL + (0.928)RESIDE - (0.233)PL_LOB - (0.444)PL_LONG - (0.376)PL_SL + 0.140.

Table 4.10. Multiple logistic regression results (Enter method) showing effects on willingness to accept $1 or more for pine straw, 2011 survey of landowners in six Alabama counties

	B	SE	OR	95% CI
Intercept	0.140			
Use of consulting forester	-0.219	0.622	0.803	0.237, 2.720
Reside in county	0.928	0.567	2.529	0.832, 7.683
Have planted loblolly	-0.233	0.539	0.792	0.275, 2.276
Have planted slash	-0.367	0.773	0.687	0.151, 3.122
Have planted longleaf	-0.444	0.649	0.642	0.180, 2.288
Model Chi-square		6.417		
Overall percent of cases correctly predicted by model (improvement over null model)		68.1 (8.4)		

A Backward Stepwise logistic regression was run next, which produced five models. The first two models produced overall percentages of 68.1, however, neither model had a significant chi-square. The fourth and fifth models both produced overall percentages of 65.3 (an improvement of 5.6% over the null model). The fourth model (which contained RESIDE and PL_LONG) had an overall model chi-square significant at the 0.10 level. The fifth model (which contained only RESIDE) was significant at the 0.05 level.

Finally, a Forward Stepwise regression was run. The only variable with a large enough score statistic to be included in the model was RESIDE. The addition of this variable had an impact better than expected by chance (chi-square of the model was

4.427, P=0.035). However, the Hosmer and Lemeshow test yielded a chi-square of 0, suggesting the overall model, with just the one predictor, did not fit well with the observed data. As produced by the final model in the Backward Stepwise regression, the overall percentage for this step was 65.3. Other variables not in the equation for the second step had a high probability of impacting the model just by chance. The log-odds equation yielded by the final models of the two stepwise regressions is as follows: Y' = (1.128)RESIDE – 0.405.

Based on the results of the regressions, the strongest predictor of whether a forestland owner was willing to accept the given amount ($1.00) per bale of pine straw was whether he or she resided in the county where the majority of his or her forestland was located. In general, those who live in the same county as their forestland are less willing to accept lower prices for their pine straw.

4.4. Discussion and Conclusion

Respondents to the 2011 landowner survey were mostly older, white males who did not earn an income from their land (or, if they did, they earned only a small percentage of their income from land-based activities). Non-pecuniary factors strongly influenced the management decisions made by forestland owners who responded to the 2011 landowner survey. Approximately 60% of respondents who owned pines expressed at least a slight interest in pine straw harvesting operations. Correlations show that those who had used consulting foresters and who did not reside in the county where their forestland was located had higher levels of interest in pine straw production, as did those with higher acreages of planted pine, in particular loblolly and longleaf.

When given reasons *not* to practice agroforestry, those with high levels of interest in harvesting pine straw were largely concerned with (aside from money issues) lack of information and lack of product market. They were less concerned with impacts on soil and wildlife habitat.

Most landowners who had pines stated they were willing to accept $0.50 to $1.50 per bale for their pine straw. A possible explanation for why there were few statistically significant relationships with WTA is that landowners lack knowledge about what to expect in terms of prices. Many of the landowners who were more likely to express interest in pine straw (those with higher acreages and those who had used a consulting forester or lived outside the county) appeared willing to accept lower prices than other respondents. This willingness to accept lower prices suggests that the value placed on forest resources by these landowners differs from the value placed by owners of smaller acreages who are not managing intensively and who live in close proximity to the property. The management objectives and practices of the latter group may reflect their cultural or social differences. Any programming geared toward such landowners must recognize these differences and be aware of varying perceptions of resource value.

The findings of the landowner survey support many of those presented by Arano and Munn (2006), Zhou (2010), Workman et al. (2003) and many others. Respondents to the survey had varying objectives, many of which are geared toward stewardship and enhancement of noncommodity values. Management activities and intensities differed among forestland owners, as did interest in and willingness to engage in agroforestry practices and production of NTFPs. Similar to the responses received by Workman et al. (2003) interest among landowners in the 2011 study is largely driven by perceived

benefits to wildlife and soil conservation, while concerns about agroforestry centered around economics.

This study builds on the work of others, however, by looking into more specific factors (e.g. forest types owned and whether the owner lives in the same county) affecting interest in a particular activity (i.e. production of pine straw). Further research can be conducted using the data collected (or by collecting more data from a larger sample population) to observe relationships between various variables. The work of Arano and Munn (2006), who looked at forest management intensity among forest landowner types, can provide a framework for investigation into how ownership type (e.g. public versus private), acreage sizes, and management intensity (e.g. use of specific silvicultural practices) influence willingness to engage in alternative forestry practices, such as agroforestry or production of NTFPs. By observing these kinds of relationships, outreach programming and informational materials can better target those landowners most likely to significantly contribute to an improved market for forest commodities in Alabama.

CHAPTER 5

Conclusion

Alabama is ranked number two in the nation in terms of the amount of privately-owned forest acreage (Alabama Forestry Commission 2011). The state's Development Office reports that forestry is Alabama's largest manufacturing industry, employing (directly or indirectly) one-tenth of the total work force (Alabama Development Office n.d.). But demand for timber has fallen in recent years and forestland ownership is becoming increasingly fractionated (Zhang et al. 2005). Though many landowners have a strong desire to maintain ownership for future generations, higher costs of living (and doing business) and fewer opportunities in the traditional timber market have led to divestment of large amounts of privately-owned forestland. Alternative forestry practices and multi-use land management offer landowners ways to earn an income from their property while keeping the land in trees.

Increasingly, institutions (academic, governmental, and corporate) are realizing the value of diversification of forest products markets and the need for increased market opportunities for small and limited-resource landowners. From discussions with public land managers and agency personal, it is clear there is an interest in incorporating non-traditional forestry operations, such as pine straw, into the management regimes of public lands. Pine straw is one opportunity with significant potential, as exhibited by the rapid growth of markets in other states, such as Georgia, Florida, and North Carolina. Pine

straw offers an opportunity for landowners (both public and private) to diversify income streams while reducing on-site fuel loads.

Analyses of data collected as part of the Regional Longleaf Growth Study show that significant amounts of pine straw can be found on the floors of natural, longleaf forests throughout the Southeast. Needle yields are impacted by a number of factors, with basal area appearing to be the strongest contributor. Findings such as these can be used by landowners to manage existing stands as well as provide guidelines for establishment of stands with pine straw as one management objective.

The 2010 survey of retailers, landscapers, lawn maintenance specialists, landscape suppliers, and nurseries in Alabama show there is a demand for all three species of pine (loblolly, slash, and longleaf) as long as it is clean. Longleaf pine straw, however, is the most popular, and the most frequently purchased species among respondents in the southern half of the state. Many survey respondents did not know what species they purchased or where it came from. There is a need for greater awareness of product characteristics. A more discerning clientele would likely improve market opportunities for landowners willing to carefully manage pine stands to produce clean, quality straw.

Possible areas for future investigation of pine straw market demands include exploration of how industry standards and landowner organizations can help solidify the commodity chain and improve market access for pine straw producers. Currently, the pine straw market is informal in nature. While this may work to the advantage of some in the industry, it likely contributes to information gaps among many with the potential to boost industry presence in Alabama. It is unknown how establishing industry standards (e.g. standard bale sizes) or stricter regulations may affect markets. Formation of

landowner associations or industry organizations that create and clarify linkages between participants in the commodity chain may help to solidify the market and allow entry by smaller producers and dealers.

The 2011 survey of landowners in Alabama showed that among landowners (especially those with large acreages of planted loblolly and longleaf) there is interest in harvesting pine straw. Concerns among landowners are largely economic in nature, as well as about lack of information and markets.

Production of NTFPs and implementation of other alternative forestry practices provide incentives to landowners to put or keep their lands in longleaf, an ecologically important species. There is a need for information about alternative enterprises and resources available to interested landowners, such as conservation cost-share programs or cooperative organizations. Developing product markets and clarifying commodity chains can lead to entry by more producers and by owners of small landholdings who face limited opportunities in such an informal market structure. Because economics was a primary concern among landowners, there needs to be more research on economics of various land use systems and management activities. Cash flow models can help landowners make decisions about investments in land, labor, equipment and other expenses.

Improved NTFP market conditions have potential impacts beyond providing short-term income for landowners. Non-industrial private forestland (NIPF) owners control the majority of the South's timberland base (Wear and Greis 2002); therefore, their management of those lands has significant implications for timber supply. It is unknown how enhanced market opportunities for NTFPs might indirectly affect future

timber supply. Alternative markets may provide incentive to keep lands in trees, continue forest ownership, and extend rotation lengths – all of which have potential impacts on the traditional forest products industry.

Outreach programming and formation of cooperative organizations can lead to awareness among landowners about pine straw operations and marketing outlets. Extension offices, state agencies, and universities can provide information to landowners about management practices, economics associated with natural resource enterprises, small business opportunities, and market demands for non-timber forest products. Such efforts, leading to a more robust pine straw market in Alabama, have the potential to affect both commercial and public sectors. Increased awareness of the pine straw market, its demands, and how to manage forestland effectively to meet those demands, can lead to technical, economic, social, and ecological benefits. An expanded pine straw market could allow more opportunities for entry by landowners, harvesters, and retailers. Extra income earned from selling pine straw can be used by landowners to cover living expenses, property taxes, or to further invest in land management. An expanded market could facilitate establishment of bulk buying collection points and boost demand for equipment (box balers, mechanized balers, tractors, and other machinery used in site preparation). Consulting foresters may be able to expand available services to integrate pine straw operations into management plans. Demand for seasonal storage facilities and trucking services may increase. All of these changes can lead to more jobs for the state of Alabama.

An improved market for pine straw could provide incentive for landowners to put (or keep) their land in longleaf pine. Preservation of the longleaf ecosystem could have

positive impacts on wildlife and understory, especially if silvicultural practices are used to eradicate invasive species or other unwanted understory vegetation. Traditional timber markets could benefit as well if rotation lengths are extended and trees managed to produce quality timber.

Cost-share programs are available that provide financial assistance to help cover costs associated with site preparation, tree seedlings, and planting of longleaf. However, these programs often prohibit landowners from harvesting pine straw. Such restrictions on these and other conservation programs (such as CRP), limit the numbers of acres – and in some cases, the numbers of willing landowners – available for pine straw production. Perhaps policies could be changed to allow pine straw harvesting on enrolled acreage. Such exemptions could be made as along as landowners agree to follow guidelines to ensure stands are not overharvested; for example; harvesting every other year and only five times during the rotation. Such allowances might encourage enrollment in the program by those who are often underserved by cost-share or conservation programs and give a boost to the state's pine straw market – all without increasing the costs to taxpayers.

Another restriction on cost-share programs targeted toward restoring longleaf pine that might affect landowner willingness to enroll is the limit put on the number of trees allowed planted on a per-acre basis. Programs typically limit the number of trees planted in an attempt to mimic the wide spacing seen in older forests and favored by many wildlife species. However, this wide spacing occurs on natural stands after decades of stem exclusion; it is not the result of regeneration of fewer trees. If stands are planted with lower numbers of longleaf, not only will their growth be different from the target

"old growth" forest, but landowners' options to engage in practices such as pine straw harvesting in later years will be limited. Again, policies need to be evaluated to determine ways to better meet the needs of participants and make the benefits reaped by enrollees more accessible to limited-resource and underserved landowners.

This study is one step toward understanding ways to improve the pine straw market in Alabama. Further research is needed on a number of topics in order to answer questions of many landowners. Such topics include: how yields of both litterfall (needles on the forest floor) and straw that can feasibly be collected through harvesting operations might vary by different silvicultural treatments (e.g. fire, fertilizer, thinning) as well as under different multiple-use management regimes (e.g. silvopasture); the impact of street vendors selling pine straw but not paying taxes; the impacts of recent immigration laws on available labor; and ways landowner or cooperative organizations can restructure the commodity chain to allow entry by more producers, especially limited-resource or smallholders.

Programming with a goal of boosting the pine straw industry in the short-term should be geared toward those identified thus far as having the most interest and those willing to accept more reasonable prices for their pine straw: owners of larger acreages, particularly of planted loblolly and longleaf, and those who have used consulting foresters. In terms of developing a solid pine straw market over time – one with a reputation for producing a clean, quality product – outreach efforts should focus on educating landowners about the potential associated with longleaf pine straw production. This would require helping private landowners see past misconceptions about longleaf (e.g. that it is a slow grower or needs to be planted at low densities) and explaining the

benefits of managing simultaneously for timber (e.g. production of high-value pole material) and of maintaining a clean, open understory (e.g. promoting native understory, grasses and quality wildlife habitat). Along with solidifying connections among stakeholders throughout the commodity chain, understanding that landowners have various ownership objectives and tailoring outreach efforts to help them meet varying goals – even non-pecuniary ones – is vital in ensuring a stable and sustained pine straw market in Alabama.

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Appendix A

«CODE»

Pine Straw in Alabama: What are Your Demands and Preferences?

A survey of landscapers, nurseries, retailers, and lawn maintenance companies

School of Forestry and Wildlife Sciences
Auburn University
Auburn, AL 36849-5418

Funding for this survey provided by McIntire-Stennis



Thank you in advance for completing this survey. Your responses will remain anonymous. If there are questions you prefer not to answer, that is fine – just leave them blank.

Your answers to this survey will help us understand your needs and preferences as a buyer or seller of pine straw, and how outreach services can better help landowners manage their pine straw operations to meet your demands.

1. Do you or your company **buy OR sell** pine straw as part of your normal business operations?
☐ Yes
☐ No ➔ *Thank you for your time. Please leave the remainder of the survey blank, and return it in the envelope provided.*

2. Which of the following best describes your company? *Please check one*
☐ Retailer
☐ Landscape contractor
☐ Lawn maintenance specialist
☐ Wholesale pine straw producer/supplier
☐ Other ➔ *Please specify* _____

PART 1: BUYING PINE STRAW

3. Do you buy pine straw as part of your normal business operations?
☐ Yes
☐ No ➔ *Please proceed to Part 2, Question 16.*

4. On average, how many bales of pine straw do you purchase annually?
_____ square bales
_____ round bales

5. On average, how many bales of pine straw do you purchase at a single time?
_____ square bales
_____ round bales

6. From whom do you usually purchase your pine straw? *Please check one*
☐ Retailer
☐ Wholesale pine straw producer/supplier
☐ Directly from landowner
☐ Other ➔ *Please specify* _____

7. What is the distance between the origin of the pine straw (the forest) and your business location?
☐ Less than 10 miles
☐ 10-25 miles
☐ 26-50 miles
☐ 51-75 miles
☐ 76-100 miles
☐ 101-150 miles
☐ 151-200 miles
☐ More than 200 miles
☐ I don't know

8. What species of pine straw do you usually purchase?
☐ Loblolly
☐ Slash
☐ Longleaf
☐ I don't know

9. As a buyer of pine straw, please rank the months in terms of how busy they are, with 1=busiest (when you buy the most pine straw), 2=second busiest, 3=third busiest, 4=least busy (when you buy the least amount).

For instance, in the following example, March, April and November are the busiest months, followed by May, June, and October, then July, August, and September. The least busy months are December, January and February.

	Months											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Ranking	4	4	1	1	2	2	3	3	3	2	1	4

EXAMPLE EXAMPLE EXAMPLE

Please write your own ranking in the following table:

	Months											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Ranking												

10. As a buyer of pine straw, please rank the following factors in terms of how important they are in your decision to purchase pine straw from a particular vendor, with 1=most important, 2=second most important, 3=third most important.

___ Price

___ Quality (color, cleanliness, etc.)

___ Availability (can get pine straw when I need it)

11. Please choose which of the following best describes your relationship with the pine straw harvester:

☐ I always buy my straw from the same harvester

☐ Sometimes I buy my straw from the same harvester, but other times I will purchase it elsewhere

☐ I buy my straw from whoever has pine straw available at the cheapest price

☐ I do not deal directly with the harvester

12. On average, how much do you pay per bale for pine straw?

Square bales:	**Round** bales:
☐ Less than $1.00	☐ Less than $1.00
☐ $1.00 - $2.00	☐ $1.00 - $2.00
☐ $2.01 - $2.50	☐ $2.01 - $2.50
☐ $2.51 - $3.00	☐ $2.51 - $3.00
☐ $3.01 - $3.50	☐ $3.01 - $3.50
☐ $3.51 - $4.00	☐ $3.51 - $4.00
☐ $4.01 - $4.50	☐ $4.01 - $4.50
☐ $4.51 - $5.00	☐ $4.51 - $5.00
☐ $5.01 - $5.50	☐ $5.01 - $5.50
☐ $5.51 - $6.00	☐ $5.51 - $6.00
☐ $6.01 - $7.00	☐ $6.01 - $7.00
☐ $7.01 - $8.00	☐ $7.01 - $8.00
☐ $8.01 - $9.00	☐ $8.01 - $9.00
☐ $9.01 - $10.00	☐ $9.01 - $10.00
☐ More than $10.00	☐ More than $10.00

13. Do you receive a volume discount for pine straw?

☐ Yes

☐ No ➔ *Please proceed to Part 2, Question 16.*

14. How many bales must be purchased at a single time in order to receive a volume discount?

_____ square bales

_____ round bales

15. On average, how much of a discount do you receive? *Please report as a percentage **OR** in dollars on a per-bale basis*

_____ percent for square bales **OR** $_____ per bale for square bales

_____ percent for round bales **OR** $_____ per bale for round bales

PART 2: SELLING PINE STRAW

16. Do you sell pine straw as part of your normal business operations?
☐ Yes
☐ No ➔ *Please proceed to Part 3, Question 31.*

17. On average, how many bales of pine straw do you sell annually?
_____ square bales
_____ round bales

18. On average, how many bales of pine straw do you sell at a single time?
_____ square bales
_____ round bales

19. To whom do you sell your pine straw? *Please check all that apply for each bale type*

Square bales:
☐ Large retailer (for example: Lowe's, Home Depot, Tractor Supply Company)
☐ Local retailer (for example: home improvement or farm supply store)
☐ Local nursery or garden center
☐ Landowners/homeowners
☐ Landscape contractors
☐ Lawn maintenance specialists
☐ Other ➔ *Please specify*
_____

Round bales:
☐ Large retailer (for example: Lowe's, Home Depot, Tractor Supply Company)
☐ Local retailer (for example: home improvement or farm supply store)
☐ Local nursery or garden center
☐ Landowners/homeowners
☐ Landscape contractors
☐ Lawn maintenance specialists
☐ Other ➔ *Please specify*
_____

20. How does pine straw fare as part of your business operations? *Please check one*
☐ The business earns a profit from selling pine straw ➔ *Please proceed to Question 22.*
☐ Pine straw is sold at-cost
☐ Pine straw is sold at a loss to the business

21. If pine straw is sold at-cost or at a loss to the business, do you continue to sell it because of the potential for sale of other items that do earn a profit?
☐ Yes
☐ No ➔ *Please specify reason for continued sale* _____

22. As a seller of pine straw, please rank the months in terms of how busy they are, with 1=busiest (when you sell the most pine straw), 2=second busiest, 3=third busiest, 4=least busy (when you sell the least amount).

For instance, in the following example, May and June are the busiest months, followed by March, April, and July, then August, September, October and November. The least busy months are December, January and February.

	Months											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Ranking	4	4	**2**	**2**	**1**	**1**	**2**	**3**	**3**	**3**	**3**	4

Please write your own ranking in the following table:

	Months											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Ranking												

23. What is the distance between the origin of the pine straw (the forest) and your business location?

☐ Less than 10 miles
☐ 10-25 miles
☐ 26-50 miles
☐ 51-75 miles
☐ 76-100 miles
☐ 101-150 miles
☐ 151-200 miles
☐ More than 200 miles
☐ I don't know

24. Do you offer a volume discount for pine straw?

☐ Yes
☐ No ➔ *Please proceed to Question 27.*

25. How many bales must be purchased at a single time in order to receive a volume discount?
_____ square bales
_____ round bales

26. On average, how much of a discount do you offer? *Please report as a percentage **OR** in dollars on a per-bale basis*
_____ percent for square bales **OR** $_____ per bale for square bales
_____ percent for round bales **OR** $_____ per bale for round bales

27. Do you offer delivery services?
☐ Yes
☐ No ➔ *Please proceed to Part 3, Question 31.*

28. What is the minimum load required for delivery?
_____ square bales
_____ round bales

29. What is the maximum distance you will deliver?
_____ miles for square bales
_____ miles for round bales

30. What do you charge for delivery? *Please indicate if charge is per mile or per trip*
$_____ per _____ for square bales
$_____ per _____ for round bales

PART 3: PINE STRAW PREFERENCES

31. For each of the following categories, please indicate your preference.

a. Bale shape:	☐ Square bale	☐ Round bale	☐ No preference
b. Bale binding:	☐ Wire	☐ Twine	☐ No preference
c. Baling:	☐ Machine-baled	☐ Hand-baled	☐ No preference
d. Color:	☐ Red	☐ Brown	☐ No preference

32. Please rank the following species of pine in terms of your preference, with 1 = most desired species, 2 = second most desired, and 3 = least desired. If you do not have a preference, check "no preference."

____ Loblolly
____ Slash
____ Longleaf
☐ No preference

33. For each of the following, please rate the level of importance that pine straw possesses these characteristics:

	LEVEL OF IMPORTANCE		
	Not Important	Somewhat important	Very important
a. Tightly baled	☐	☐	☐
b. Vibrant color	☐	☐	☐
c. No sticks or cones	☐	☐	☐
d. No foreign material (trash)	☐	☐	☐
e. No weeds or briars	☐	☐	☐
f. No leaves	☐	☐	☐
g. Fresh (recently harvested)	☐	☐	☐
h Dry	☐	☐	☐
i. Long needles	☐	☐	☐
j. Needles not broken	☐	☐	☐
k. No insects, spiders, or scorpions	☐	☐	☐
l. Harvested locally	☐	☐	☐

34. Any other comments you would like to make or information you would like to give regarding pine straw sales in your region?

Appendix B

AUBURN
UNIVERSITY

SCHOOL OF FORESTRY
AND WILDLIFE SCIENCES

October 4, 2010

«Name»
«Business»
«Street»
«City»

Dear «Name»,

I am writing to ask for your help with an important study being conducted by Auburn University to understand the pine straw market in Alabama. In a few days, you will receive a request to participate in this project by answering questions about your business operations. The information will be used to help develop outreach programming geared toward landowners and producers of pine straw in Alabama. A better understanding of your demands and preferences for pine straw can help improve product quality and market opportunities.

I would like to do everything that I can to make it easy and enjoyable for you to participate in the study. I am writing in advance because many people like to know ahead of time that they will be asked to fill out a questionnaire. Further information will come attached to the questionnaire.

I hope you will take 10-15 minutes of your time to help us. I also hope that you enjoy the questionnaire and the opportunity to voice your thoughts and opinions about the pine straw market. This research can only be successful with the generous help of people like you.

Sincerely,

Dr. Becky Barlow
Assistant Professor
School of Forestry and Wildlife Sciences
(334) 844-1019
rjb0003@auburn.edu

The Institutional Review Board has approved this document from August 31, 2010 to August 30, 2011. Protocol #10-247 EX 1008

3301 FORESTRY AND
WILDLIFE SCIENCES BUILDING
AUBURN, AL 36849-5418

www.auburn.edu

Appendix C

AUBURN
UNIVERSITY

SCHOOL OF FORESTRY
AND WILDLIFE SCIENCES

October 8, 2010

«Name»
«Business»
«Street»
«City»

Dear «Name»,

We are asking for your help in a study on the pine straw market in Alabama. We are also interested in buyer preferences, sales volumes and seasonality, marketing channels and pricing. As a business in Alabama, your opinion is important to us. Please take a few minutes to fill out the enclosed survey, returning it in the postage-paid envelope provided. The questionnaire should only take about 10 to 15 minutes to complete. Your answers are completely confidential. After the survey is returned to us, your name will be removed from our list and never connected to your answers. We ask that you do not write your name or other information associated with you or your business on the questionnaire.

If you do not buy or sell pine straw as part of your normal business operations, please answer only the first question, and return the survey in the postage-paid envelope.

Your decision about whether or not to participate will not jeopardize your future relations with Auburn University or the School of Forestry and Wildlife Sciences. If you have any questions about this survey, please call Dr. Becky Barlow, by telephone at (334) 844-1019 or by email at rjb0003@auburn.edu. If you have any questions about your rights as a research participant, you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by telephone at (334) 844-5966 or by email at hsubjec@auburn.edu.

By taking a few minutes to share your experiences, you will be helping us out a great deal. The information you share with us can be used to help develop the pine straw industry in Alabama and provide income opportunities for forestland owners. I hope that you enjoy completing the questionnaire and look forward to receiving your responses.

Sincerely,

Dr. Becky Barlow
Assistant Professor
School of Forestry and Wildlife Sciences
(334) 844-1019
rjb0003@auburn.edu

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE, THE DATA YOU PROVIDE WILL SERVE AS YOUR AGREEMENT TO DO SO. THIS LETTER IS YOURS TO KEEP.

The Institutional Review Board has approved this document from August 31, 2010 to August 30, 2011. Protocol #10-247 EX 1008

3301 FORESTRY AND
WILDLIFE SCIENCES BUILDING
AUBURN, AL 36849-5418

www.auburn.edu

Appendix D

October 15, 2010

Dear «Name»,

Several days ago you received a brief survey about pine straw in Alabama.

If you have already completed and returned the questionnaire, thank you! You have helped me and my colleagues to gauge preferences for pine straw and ways landowners can better meet market demands. If you have not yet completed the questionnaire, please do so. We rely on research participation from people like you to help guide outreach programming statewide.

If you did not receive a questionnaire, or if it was misplaced, please contact me at (334) 844-1019 or rjb0003@auburn.edu and I will mail another one to you. Thank you again for your participation.

Sincerely,

Dr. Becky Barlow
Assistant Professor
School of Forestry and Wildlife Sciences

Appendix E

«CODE»

Forestland and Agroforestry Practices: What are Your Interests and Management Goals?

A survey of Alabama forestland owners

School of Forestry and Wildlife Sciences
Auburn University
Auburn, AL 36849-5418

Funding for this survey provided by McIntire-Stennis



Thank you in advance for completing this survey. Your responses will remain anonymous. If there are questions you prefer not to answer, that is fine – just leave them blank.

Your answers to this survey will help us understand landowner objectives and motivations, and how outreach services can better help landowners manage their forestland and implement agroforestry practices.

PART 1: YOUR LAND AND MANAGEMENT OBJECTIVES

1. Do you own forestland?

☐ Yes
☐ No ➔ *Please proceed to Question 29, and complete only Parts 5 and 6 of the survey*

2. Please estimate the number of acres you own in each of the following vegetation types:

Pine established through *natural regeneration*

Loblolly _____ ACRES
Longleaf _____ ACRES
Slash _____ ACRES
Other _____ ACRES

***Planted* pine**

Loblolly _____ ACRES
Longleaf _____ ACRES
Slash _____ ACRES
Other _____ ACRES

Hardwood established through *natural regeneration* _____ ACRES

***Planted* hardwood** _____ ACRES

Mixed pine and hardwood established through *natural regeneration* _____ ACRES

3. In which Alabama county is your forestland? *(If you own land in more than one county, please list the county in which the majority of your forestland is owned.)* _____ COUNTY

4. Do you live in this county?

☐ Yes ☐ No

5. Please indicate the forest management practices that you have used in the past 10 years: *(Check as many as apply)*

☐ Site preparation - **mechanical** treatment (example: disking)
☐ Site preparation - **chemical** treatment (example: herbicide)
☐ Prescribed burning
☐ Planting
☐ Fertilization
☐ Thinning
☐ Pruning
☐ Clearcutting
☐ Timber inventory
☐ Other ➔ *Please specify* _____

6. Please estimate the percentage of your household income (10 year average) that comes from logging or any other activity related to the forestland you own: *(Check one)*

☐ None
☐ Less than 25%
☐ More than 25%, but less than 50%
☐ More than 50%, but less than 75%
☐ More than 75%

7. Have you used the services of a consulting forester during the past 10 years?

☐ Yes ☐ No

8. Please rate the <u>importance</u> of the following factors in making decisions about your forestland. *(Check one for each)*

	Not at all important	Slightly important	Somewhat important	Very important
a. Income from timber sales	☐	☐	☐	☐
b. Income from hunting lease	☐	☐	☐	☐
c. Income from other activities	☐	☐	☐	☐
d. Investment for retirement	☐	☐	☐	☐
e. Investment for children	☐	☐	☐	☐
f. Environmental stewardship	☐	☐	☐	☐
g. Land buffering residence	☐	☐	☐	☐
h. Don't want to clearcut	☐	☐	☐	☐
i. Emotional/intrinsic value	☐	☐	☐	☐
j. Personal recreation	☐	☐	☐	☐
k. Leave a legacy for heirs	☐	☐	☐	☐

PART 2: AGROFORESTRY AND YOUR THOUGHTS

Please read the following information before answering the questions in Part 2:

Agroforestry involves growing trees and agricultural crops, livestock, or non-timber forest products (NTFPs) on the same land. Complementary combinations of trees, shrubs, crops, and animals can allow landowners to optimize space and secure a more regular income. There are five main agroforestry systems:

Alley cropping is the practice of planting wide rows of trees between which agricultural or horticultural crops are grown; alley cropping systems are designed to meet both production and conservation objectives.

Forest farming involves cultivation or collection of specialty crops or NTFPs under the forest canopy.

Riparian forest buffers are areas of trees and other vegetation adjacent to water bodies that are maintained to reduce impacts of upland sources of pollution and to supply wildlife habitat.

Silvopasture combines production of timber, forage, and livestock. Forest and pasture are managed as an integrated system, with trees providing shade, shelter, and ecological benefits.

Windbreaks are rows of trees planted, often around homesteads, farms or fields, to provide shelter from wind and wildlife habitat, and to prevent erosion. Non-timber and wood products can be grown in windbreaks.

9. Please rate your level of familiarity of each of the following agroforestry systems: *(Check one for each)*

	Not at all familiar	Slightly familiar	Somewhat familiar	Very familiar
a. Alley Cropping	☐	☐	☐	☐
b. Forest Farming/NTFPs	☐	☐	☐	☐
c. Riparian Buffers	☐	☐	☐	☐
d. Silvopasture	☐	☐	☐	☐
e. Windbreaks	☐	☐	☐	☐

10. Please rate your level of interest in each of the following agroforestry systems: *(Check one for each)*

	Not at all interested	Slightly interested	Somewhat Interested	Very interested
a. Alley Cropping	☐	☐	☐	☐
b. Forest Farming/NTFPs	☐	☐	☐	☐
c. Riparian Buffers	☐	☐	☐	☐
d. Silvopasture	☐	☐	☐	☐
e. Windbreaks	☐	☐	☐	☐

11. Please rate the importance of the following reasons that would lead you to consider practicing agroforestry on your land: *(Check one for each)*

	Not at all important	Slightly important	Somewhat important	Very important
a. Aesthetic value	☐	☐	☐	☐
b. Improves wildlife habitat	☐	☐	☐	☐
c. Soil conservation	☐	☐	☐	☐
d. Increased biodiversity	☐	☐	☐	☐
e. Increased land value	☐	☐	☐	☐
f. Improved water quality	☐	☐	☐	☐
g. Provides short-term income	☐	☐	☐	☐
h. Support from co-op*	☐	☐	☐	☐
i. Complements current management practices	☐	☐	☐	☐

*A co-op (or cooperative) is a commercial enterprise owned jointly by growers or landowners and is operated for their mutual benefit. Members often pool their resources to help reduce costs.

12. Please rate the importance of the following reasons that would lead you to choose **NOT** to practice agroforestry on your land: *(Check one for each)*

	Not at all important	Slightly important	Somewhat important	Very important
a. Not interested	☐	☐	☐	☐
b. Lack of product market	☐	☐	☐	☐
c. High investment costs	☐	☐	☐	☐
d. High maintenance costs	☐	☐	☐	☐
e. Labor required	☐	☐	☐	☐
f. Technical assistance needed	☐	☐	☐	☐
g. Lack of information	☐	☐	☐	☐
h. Lack of cost-share programs	☐	☐	☐	☐
i. Lack of demonstration sites	☐	☐	☐	☐
j. Equipment needs	☐	☐	☐	☐
k. Impacts on wildlife habitat	☐	☐	☐	☐
l. Impacts on soil/site quality	☐	☐	☐	☐
m. Component competition for resources	☐	☐	☐	☐

PART 3: NON-TIMBER FOREST PRODUCTS AND YOUR THOUGHTS

Please read the following information before answering the questions in Part 3:

Non-Timber Forest Products (NTFPs) are plants, plant parts, fungi, or other botanical material collected from within or along the edges of a forest (natural or plantation). Products usually fall under five classifications:

Floral and decorative NTFPs come from plant parts used in decorative arrangements or craft items (such as baskets and wreaths).

Specialty wood-based NTFPs are produced from parts of trees, but not from commercially sawn wood. They include walking sticks and musical instruments.

Edible and culinary NTFPs include berries, nuts, mushrooms, and honey (because it is produced jointly by plants and insects).

Dietary and medicinal NTFPs include various plants and plant parts that are used to treat medical conditions or provide dietary supplements to maintain healthy body systems. Examples are ginseng, goldenseal, and bloodroot.

Landscaping NTFPs include pine straw and ferns.

13. Have you cultivated or collected any NTFPs from your land during the past 10 years for personal use?

☐ No ☐ Yes ➔ *Please specify* _____

14. Have you cultivated or collected any NTFPs from your land during the past 10 years to be sold?

☐ No ☐ Yes ➔ *Please specify* _____

15. Please rate your level of interest in production of items from each of the following NTFP categories to be sold: *(Check one for each)*

	Not at all interested	Slightly interested	Somewhat Interested	Very interested
a. Floral/decorative	☐	☐	☐	☐
b. Specialty wood-based	☐	☐	☐	☐
c. Edible/culinary	☐	☐	☐	☐
d. Dietary/Medicinal	☐	☐	☐	☐
e. Landscape	☐	☐	☐	☐

PART 4: PINE STRAW - PRODUCTION

16. Do the trees on your land produce pine straw?

☐ Yes

☐ No ➔ *Please proceed to Question 29, and complete Parts 5 and 6 of the survey*

17. Please rate your level of interest in harvesting pine straw from your land:

Not at all interested	Slightly interested	Somewhat Interested	Very interested
☐	☐	☐	☐

18. On average, pine plantations yield about 125 bales of pine straw per acre per year. If a landowner is paid $1.00 per bale, this would amount to $125 per acre ($1.00/bale x 125 bales/acre = $125/acre). Based on this formula, what is the **minimum** amount you would accept for your pine straw?

☐ @ $0.05/bale = $6.25/acre

☐ @ $0.10/bale = $12.50/acre

☐ @ $0.15/bale = $18.75/acre

☐ @ $0.20/bale = $25.00/acre

☐ @ $0.25/bale = $31.25/acre

☐ @ $0.35/bale = $43.50/acre

☐ @ $0.50/bale = $62.50/acre

☐ @ $0.75/bale = $93.75/acre

☐ @ $1.00/bale = $125.00/acre

☐ @ $1.50/bale = $187.50/acre

☐ Other ➔ *Please specify* _____

19. Is pine straw currently removed from your land?

☐ Yes

☐ No ➔ *Please proceed to Question 29, and complete Parts 5 and 6 of the survey*

20. How is pine straw removed from your land? *(Check as many as apply)*

☐ By hand using a box baler

☐ Using a mechanical baler

☐ Other ➔ *Please specify* _____

21. Who removes the pine straw from your land and what method is used? *(Check as many as apply)*

☐ I remove the straw myself, by hand using a box baler
☐ I remove the straw myself, using a mechanical baler
☐ A privately-hired worker removes the straw, by hand using a box baler
☐ A privately-hired worker removes the straw, using a mechanical baler
☐ A worker under contract removes the straw, by hand using a box baler
☐ A worker under contract removes the straw, using a mechanical baler
☐ Other ➔ *Please specify* _____

22. In what form is the pine straw when it leaves your land? *(Check as many as apply)*

☐ In square bales
☐ In round bales
☐ Other ➔ *Please specify* _____

23. What do you do with pine straw that is removed from your land? *(Check as many as apply)*

☐ Keep for personal use
☐ Sell directly to consumers
☐ Trade or exchange the pine straw for other goods or services
☐ Sell to landscaping company or supplier
☐ Other ➔ *Please specify*

_____

24. If you sell or trade, which of the following describes your situation?

☐ I produce as much as I can sell
☐ I produce more than I can sell
☐ I produce less than what I can sell

25. Do you keep track of how much pine straw is harvested each year from your land?

☐ No
☐ Yes ➔ *Please estimate the number of bales* ***per acre*** *per year* _____
and specify bale type (*circle one:* round or square)

26. How much do you currently get paid for your pine straw? *Please indicate if this amount is per bale or per acre. If it is per bale, specify whether it is for round bales or square bales (circle one).*
$_____ per _____ (*circle one:* round or square)

27. Considering the types of costs associated with harvesting pine straw (labor costs, equipment repair and maintenance, transportation), which of the following statements is true:
☐ My expenses are larger than the revenue I generate from sales
☐ My expenses are the same as the revenue I generate from sales
☐ My expenses are less than the revenue I generate from sales
☐ I do not sell the pine straw

28. Please estimate the percentage of your household income that comes from pine straw harvested from your land: *(Check one)*
☐ None
☐ Less than 25%
☐ More than 25%, but less than 50%
☐ More than 50%, but less than 75%
☐ More than 75%

PART 5: PINE STRAW - CONSUMPTION

29. Do you use pine straw as part of your landscaping?
☐ Yes
☐ No ➔ *Please proceed to Question 35, and complete Part 6 of the survey*

30. Where or from whom do you **usually** purchase your pine straw?
☐ Large home improvement retailer (for example: Lowe's, Home Depot)
☐ Large farm and ranch supply retailer (for example: Tractor Supply Company)
☐ Local home improvement or hardware store
☐ Local farm supply store
☐ Local nursery or garden center
☐ Wholesale supplier
☐ Local road-side vendor
☐ Other ➔ *Please specify* _____

31. In what form do you prefer pine straw?

☐ Square bales
☐ Round bales
☐ No preference

32. How much do you pay, on average, for your pine straw?

$_____ per (square or round – *circle one*) bale

33. Please indicate the maximum total you would be willing to pay per bale of pine straw **before going without it, or switching to an alternative product**. *(Specify bale type:* round or square – *circle one)*

☐ $4.00
☐ $4.50
☐ $5.00
☐ $5.50
☐ $6.00
☐ $6.50
☐ $7.00
☐ $7.50
☐ $8.00
☐ Other ➔ *Please specify* $_____

34. Please indicate the maximum total you would be willing to pay per bale of pine straw **before going without it, or switching to an alternative product**, if you knew that it was harvested locally. *(Specify bale type:* round or square – *circle one)*

☐ $4.00
☐ $4.50
☐ $5.00
☐ $5.50
☐ $6.00
☐ $6.50
☐ $7.00
☐ $7.50
☐ $8.00
☐ Other ➔ *Please specify* $_____

Appendix F

AUBURN
UNIVERSITY

SCHOOL OF FORESTRY
AND WILDLIFE SCIENCES

February 14, 2011

«Name»
«Street»
«City»

Dear «Name»,

I am writing to ask for your help with an important study being conducted by Auburn University to understand agroforestry practices and the non-timber forest product (NTFP) market in Alabama. In a few days, you will receive a request to participate in this project by answering questions about your forestland and management practices. This research project will help us better understand landowner awareness of agroforestry practices, perceived costs and benefits, and needs for technical assistance or incentive programs.

I would like to do everything that I can to make it easy and enjoyable for you to participate in the study. I am writing in advance because many people like to know ahead of time that they will be asked to fill out a questionnaire. Further information will come attached to the questionnaire.

I hope you will take 10-15 minutes of your time to help us. I also hope that you enjoy the questionnaire and the opportunity to voice your thoughts and opinions about forestland in Alabama. This research can only be successful with the generous help of people like you.

Sincerely,

Dr. Becky Barlow
Assistant Professor
School of Forestry and Wildlife Sciences
(334) 844-1019
becky.barlow@auburn.edu

Auburn University Institutional Review Board has approved this document from 11-22-10 to 11-21-11. Protocol #10-339 EX 1011

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Appendix G

AUBURN
UNIVERSITY

SCHOOL OF FORESTRY
AND WILDLIFE SCIENCES

February 18, 2011

«Name»
«Street»
«City»

Dear «Name»,

We are asking for your help on agroforestry practices in Alabama. As an owner of forestland in Alabama, your opinion is important to us. We are also interested in your awareness and interest in harvesting non-timber forest products (NTFPs). Please take a few minutes to fill out the enclosed survey, returning it in the postage-paid envelope provided. The questionnaire should only take about 10 to 15 minutes to complete. Your answers are completely confidential. After the survey is returned to us, your name will be removed from our list and never connected to your answers. We ask that you do not write your name or other information associated with you or your business on the questionnaire.

If you do not own any forestland in Alabama, please answer only Question 1 and Parts 5 and 6, and return the survey in the postage-paid envelope.

Your decision about whether or not to participate will not jeopardize your future relations with Auburn University or the School of Forestry and Wildlife Sciences. If you have any questions about this survey, please call Dr. Becky Barlow, by telephone at (334) 844-1019 or by email at becky.barlow@auburn.edu. If you have any questions about your rights as a research participant, you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by telephone at (334) 844-5966 or by email at hsubjec@auburn.edu.

By taking a few minutes to share your experiences and opinions, you will be helping us out a great deal. The information you share with us can be used to help develop alternative forest products markets in Alabama and provide income opportunities for forestland owners. I have included a sticker as a way of saying "thank you." I hope that you enjoy completing the questionnaire and look forward to receiving your responses.

Sincerely,

Dr. Becky Barlow
Assistant Professor
School of Forestry and Wildlife Sciences
(334) 844-1019
becky.barlow@auburn.edu

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE, THE DATA YOU PROVIDE WILL SERVE AS YOUR AGREEMENT TO DO SO. THIS LETTER IS YOURS TO KEEP.

Auburn University Institutional Review Board has approved this document from 11-22-10 to 11-21-11. Protocol #10-339 EX 1011

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Appendix H

Appendix I

February 25, 2011

Dear «Name»,

Several days ago you received a brief survey about agroforestry and non-timber forest products in Alabama.

If you have already completed and returned the questionnaire, thank you! You have helped me and my colleagues to gauge awareness of agroforestry practices and ways landowners can be better served. If you have not yet completed the questionnaire, please do so. We rely on research participation from people like you to help guide outreach programming statewide.

If you did not receive a questionnaire, or if it was misplaced, please contact me at (334) 844-1019 or becky.barlow@auburn.edu and I will mail another one to you. Thank you again for your participation.

Sincerely,

Dr. Becky Barlow
Assistant Professor
School of Forestry and Wildlife Sciences

Appendix J

AUBURN
UNIVERSITY

SCHOOL OF FORESTRY
AND WILDLIFE SCIENCES

March 22, 2011

«Name»
«Street»
«City»

Dear «Name»,

About three weeks ago I sent a questionnaire to you that asked about your forestland and interest in agroforestry and production of non-timber forest products. To the best of my knowledge, it's not yet been returned.

I am writing again because of the importance that your responses have for helping to get accurate results. Although the survey was sent to owners of forestland in six counties in Alabama, it's only by hearing from nearly everyone in the sample that I can be sure the results are representative of the individual counties.

A few people have told me that they should not have received the survey because they do not own forestland in Alabama. If this applies to you, please answer only Question 1 and Parts 5 and 6 of the survey and return it in the postage-paid envelope.

A questionnaire identification number is printed in the upper-right corner on the first page of the survey so that I can remove your name from the mailing list when it is returned. The list of names is then destroyed so that individual names can never be connected to the results in any way. Protecting the confidentiality of your answers is very important to me and to Auburn University.

I hope that you will fill out and return the questionnaire soon, but if for any reason you prefer not to answer it, please let me know by returning a note or blank survey in the enclosed stamped envelope.

Sincerely,

Dr. Becky Barlow
Assistant Professor
School of Forestry and Wildlife Sciences
(334) 844-1019
becky.barlow@auburn.edu

P.S. If you have any questions about this survey, please feel free to contact me by telephone at (334) 844-1019 or by email at becky.barlow@auburn.edu.

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE, THE DATA YOU PROVIDE WILL SERVE AS YOUR AGREEMENT TO DO SO. THIS LETTER IS YOURS TO KEEP.

Auburn University Institutional Review Board has approved this document from 11-22-10 to 11-21-11. Protocol #10-339 EX 1011

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