POLICY AND PROGRAM INCENTIVES AND THE ADOPTION OF AGROFORESTRY IN MISSOURI

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ABSTRACT

More landowners in the USA are concerned about management of their lands and natural resources in light of the negative effects of many agricultural practices on the environment. Land conservation program incentives, which include agroforestry, were designed by government agencies to ameliorate the problem. The study identifies the characteristics of adoption of agroforestry practices, and participation in state and federal government incentive programs that include trees and those that do not. The data from this study is drawn from a 2006 survey of 360 landowners conducted in four counties in two regions of Missouri, USA, selected because of their proximity to agroforestry research centers, their rural or urban character, and a land holding greater than ten acres. Logistic regression is used to evaluate the effect of the independent variables on adoption. The results show that age, advice from landowners/farm operators, conservation magazines they subscribe to, familiarity with the practices and personal knowledge of the practices are significant determinants of adoption. Participation in programs was not significant. Lessons are drawn on how sources of information can increase knowledge and encourage stewardship practices that incorporate trees in the context of very diverse groups of landowners.

Chapter I

Introduction

The Problem

Farmland accounts for about half of the land area within the United States of America (Lambert et al., 2006). Farming practices employed by America's two million farm operators have a major impact on health, ecosystem, sedimentation levels in streams and rivers, nutrient and pesticide runoff, groundwater contamination and air quality (Lambert et al., 2006). Landowners and farmers face a number of new challenges as they seek to make their farms and forest lands productive and environmentally sustainable. The challenges include agricultural intensification, changes in water quality and availability, changes in agricultural land use, urbanization of rural lands, climate change, food security, and competition from foreign markets (Workman and Allen, 2004). The above have caused concerns to farmers in the United States and in other parts of the world on how to manage their lands and natural resources. These increasing environmental concerns have caused some farmers to start searching for conservation practices (Jose et al., 2004), which opens a door for alternative uses of farm land such as agroforestry.

The search for highly productive, yet sustainable and environmentally responsible agricultural systems, has led to a renewed interest in agroforestry practices in the temperate regions of the world (Jose et al., 2004 cited Matson et al., 1997). Improved conservation practices using agroforestry can help yield both environmental and

economic benefits. Agroforestry is defined as, "intensive land use management that optimizes the benefits (physical, biological, ecological, economic, and social) from biophysical interactions created when trees and /or shrubs are deliberately combined with crops and/or livestock" (p.66, Gold et al., 2000). This is the growing of trees and shrubs together with livestock, forages and crops in a design on the land that is beneficial to all.

Research has shown that agroforestry, in all its varied forms, is an accepted land management practice in most tropical countries. However, adoption of agroforestry practices in temperate countries such as the United States has been slow (Cutter et al., 1999) despite their multiple environmental, economic and social advantages (Lehrer, 2005). The risk-averse producers are reluctant to establish agroforestry practices because of the absence of readily available market information, access to distribution channels and lack of marketing institutions (Gold et al., 2004). Difficulties for new landowners to enter the niche marketplace include the reluctance of other producers to share their sources of information and methods of production and knowledge of the value chain in order to maintain their competitive advantage (Gold et al., 2004 cited Vollmers and Vollmers, 1999).

Government intervention through various types of public programs is one way of enabling landowners, by sharing in the risks associated with agroforestry. In the United States, both federal and state governments administer a variety of programs designed to encourage forestry – related activities by private landowners. Despite such advancements, however, research has shown that adoption rates by landowners compared to the agricultural related programs are low and many challenges still exist to the development and adoption of agroforestry as a viable land management strategy in the United States.

There have been some concerns and issues about the costs, benefits and implementation of incentive programs. Lichtenberg and Smith-Ramirez (2004) using Maryland Conservation Reserve program (CRP) data, argued that the effectiveness of such programs may be compromised by adverse selection arising from the voluntary nature of the programs, transaction costs associated with participation and the impact of political influence on the funding process. Lichtenberg (2000) pointed out that cost sharing could actually worsen environmental problems by making it profitable for farmers to expand production onto lands that would otherwise be unprofitable to cultivate.

Lack of information for landowners and agricultural professionals is another factor constraining agroforestry adoption (Workman et al., 2003). Building strong partnerships and networks among landowners to help increase their knowledge can be an alternative approach to motivate landowners to invest in agroforestry. Information delivery that is used to overcome lack of knowledge may be a factor that could encourage adoption. Passing information through conservation magazines might be a way to overcome lack of knowledge. Many farmers may be willing to adopt conservation practices without the incentive programs. Malik and Shoemaker (1993) modeled incentives for the adoption of a single conservation practice, showing that many of the farmers applying for cost share were those for whom adoption of a conservation technology would be profitable even without incentive programs.

Agroforestry Practices

There are five temperate agroforestry practices: alley cropping, silvopasture, windbreaks, forested riparian buffers and forest farming (Gold et al., 2000). Alley

cropping is defined as growing crops between wide spacing of trees planted in rows. Windbreaks are single or multiple rows of trees planted to reduce wind effects on crops or livestock. Riparian buffers are strips of permanent vegetation, consisting of trees, shrubs, and grasses planted or managed between agricultural land (usually cropland or pastureland) and water bodies (rivers, streams, creeks, lakes, wetlands).

Silvopasture is defined as trees, forages, and livestock that are intentionally combined and managed as a single integrated practice. Forest farming combines high-value specialty crops grown under the canopy of a forested area. These practices enable landowners to diversify their income from production and to achieve conservation benefits simultaneously (University of Missouri, 2006 and Gold et al., 2004).

Agroforestry is completely different and more complex than land use management practices like commodity agriculture and livestock production. It requires more intensive technical management systems that include specialized equipment for the long-term tree management to maintain their protective values and broad knowledge of both trees and plants to improve growing environments for both. In terms of income returns, they can provide short-term cash flow from annual crops while also providing medium to long-term products from the trees while the well-managed timber can provide a long-term investment. According to Kurtz (2000) the time frame from establishment of an agroforestry practice to the time of realizing system benefits from trees is long, involving multiple years when compared to commodity agriculture.

Specific Research Problem

The vast majority of land in Missouri is under direct ownership and control of private landowners, who own more than 93% of all land and 85% of forest land (MDC, 2005). In the 2002 census, 57% of the 110,000 Missouri farmers reported their principal occupation as farming (OSEDA, 2005). To help care for land resources, the federal, state, and private agencies have offered a wide range of incentive programs to farmers and landowners including agroforestry. Godsey (2005) listed the various state agencies that promote agroforestry practices which include the Missouri Department of Agriculture (MDA), Missouri Department of Conservation (MDC), and the Missouri Department of Natural resources (MDNR). At the federal level these agencies and programs include Farm Service Agency (FSA), the Natural Resources Conservation Service (NRCS), Sustainable Agricultural Research and Educational program (SARE), USDA Forest Service (USDA/FS) and United States Fish and Wildlife Service (USFWS).

At present, policy makers have limited knowledge of farmers' participation in agroforestry incentive programs. Furthermore, there is a very diverse population of potential participants and adopters with different attitudes, characteristics and agricultural opportunity cost (Falconer, 2000). Despite the incentive programs, adoption of agroforestry is not widespread in Missouri. A review of available literature on adoption lists several limitations to adoption of agroforestry technologies which include risks and uncertainties, transaction costs, lack of knowledge of its benefits, lack of information and technical assistance, lack of institutional support, lack of social networks and lack of

established market information (Workman et al., 2003; Strong, 2004; Long, 2003; Gold et al., 2004; Adewale and Martin, 1995; Korsching et al., 1983). This research will develop a model from the literature review to test the relationship between the characteristics limiting or favoring adoption and agroforestry adoption.

The factors leading to the decision to adopt agroforestry and participate in the various incentive programs are diverse and vary for different landowners and farmers. By identifying the characteristics of farm households who adopt agroforestry practices and participate in conservation programs, we can begin to understand how potential landowners might respond to agroforestry technologies and participate in market and program incentives (Lambert et al., 2006). The characteristics of landowners are important determinants of the extent of participation in voluntary agro-environmental programs (Falconer, 2000).

This research will examines and documents the characteristics of landowners who have adopted agroforestry technology with and without funding incentives from the government. For the landowners who have adopted agroforestry without the government programs, the study identifies what other factors might have motivated them to adopt. This will enable policy makers, researchers and extension outreach professionals to understand how landowners might respond to the funding programs, if at all, and to understand the various types of landowners and their motivating principles.

Research Objectives

The primary objective of this research is to identify the characteristics of landowners that adopt agroforestry practices with and without government incentive

programs compared to non-adopters, and their motivating factors. The primary objective will be achieved through completion of the following specific objectives:

1. To understand the environmental incentive facing landowners in Missouri by reviewing existing government agroforestry incentive policies and programs.
2. To review the literature on adoption of agricultural and agroforestry technologies, identifying factors influencing the adoption of agroforestry with particular attention devoted to comparing adopters and non-adopters.
3. To hypothesize what roles do sources of information, perceptions of trees, benefits of the technology, program participation, individual characteristics, production costs and transaction costs play in influencing a landowner's adoption of agroforestry.
4. To empirically investigate the relationship between the hypothesized factors and landowners adoption of agroforestry technology.

Overview of the Thesis

The following chapters will provide in detail descriptions of characteristics of landowners in the two research regions (central Missouri and Ozarks) in Missouri. Chapter II provides a review of literature related to characteristics and factors in adoption of agricultural and agroforestry technology, adverse effects of modern agriculture on the environment and the incentive environment facing landowners in Missouri. Chapter III includes a description of the data source, the conceptual model and hypotheses. The description of variables and their measurement, the empirical models, and the analysis technique are also included. Chapter IV describes the two research regions, Howard and

Boone counties where HARC (the horticulture and agroforestry research center of the University of Missouri) is located; and Crawford and Phelps counties for the Ozarks in Missouri. It also describes the landowners surveyed for this research, their socioeconomic conditions in each area, to provide an understanding of the environment surrounding landowners in Missouri in making decisions about new agricultural technologies. Chapter V focuses on the results and discussion of the empirical models. Finally, Chapter VI concludes with an analysis of the limitations of this study, and recommendations for future research.

Chapter II

Literature Review

The literature on adoption of agricultural and agroforestry technologies is reviewed to inform the development of a conceptual model. The topics explored in this chapter include adverse effects of modern agriculture on the environment, incentive environment facing landowners, adoption of agricultural and agroforestry technologies and expected contribution.

Adverse Effects of Modern Agriculture on the Environment

The effect of agriculture on the environment has caused changes in the policies of agriculture in the United States and in other parts of the world. The principal goal of agriculture policies worldwide some years back was increasing agricultural output, but today protecting the environment and the resource base of agricultural production is becoming a concern of equal importance in much of the world (Lichtenberg, 2000). The intensification of agriculture through mechanization and use of chemicals has created new problems of environmental degradation and health problems which have caused reorientation of policies (Lichtenberg, 2000). Despite the adverse effect of agriculture on farmland and the environment, ensuring an adequate and reliable food supply and a continuous flow of income is still the concern of many countries and farmers.

The adverse problem of agriculture has been linked to corporate industrial-scale agriculture. The intensification of agriculture has created, and continues to create, serious

problems for agriculture, rural communities, and the environment (McCann et al., 1997). Attempts to counteract this large-scale industrial farming system have led some countries to adopt policies to ameliorate adverse environmental effects of the farm sector, and for farmers to organize organic farm movements.

Agriculture before the industrial revolution was by definition mostly organic because agricultural chemicals were not available (Jordan, 2004). Modern organic farming was founded as a reaction against agricultural practices that had the potential to harm nature and human health (Jordan, 2004 cited Hardwood 1990). The organic farm movement has provided consumers the option to purchase healthier foods produced in a sustainable, environmentally friendly way, thereby giving them an opportunity to contribute to sustainable agriculture (McCann et al., 1997).

Incentive Environment Facing Landowners

While there has been a long history of agro-environmental programs in the United States and the EU (European Community), such programs began to play a large role in federal farm policies during the 1980s partly because of the concern about the environmental damage resulting from agriculture production (Bernstein and Claassen, 2004). Buck (1995) points out that it was not until the mid 80's that policies affecting agroforestry in a positive way were implemented. Both the federal and state governments in the US have administered a variety of incentive programs designed to encourage and help landowners with the cost of setting up and maintaining agroforestry practices.

Institutional arrangements are critical for effective implementation of any incentive programs. Governments must be careful to understand household decisions when attempting

to create incentives for the adoption of agroforestry practices. This is because the decisions regarding adoption are ultimately household decisions and if the incentives are not well coordinated with their decisions, then policies may be ineffective.

Economic gain has been identified as the primary motivating factor in the adoption of agroforestry in the US (AFTA, 2006). Agroforestry practices must offer at least as much income potential without increasing risk, compared to current farming practices, and better scenarios for solving conservation problems than the current farming practice for adoption to take place (AFTA, 2006). Incentives for agroforestry can be implemented to provide economic or ecological benefits to the landowner and entice them to adopt practices that may have been too risky or foreign to them prior to the incentives.

Godsey (2005) and the National Agroforestry Center (2003) investigated the funding incentives available through the federal, state and non-governmental organizations (NGO) for the five agroforestry practices. Cost sharing was found to be the most commonly used incentive. Other incentives such as producer grants, land rental payments, financial incentive payments and technical assistance were also identified. Most federal funding available for agroforestry practices are distributed through the United States Department of Agriculture (USDA), while the state of Missouri funding is available through the Missouri Department of Agriculture (MDA).

Research has shown that firms and individuals rarely practice sustainable agroforestry activities, and that the rate of participation in the incentives programs is low. The following have been identified as constraints of government programs: inadequate funding, the lack of problem targeting, lack of tailoring to specific circumstances, the complexity of the programs, and the reduced capacity of agencies to deliver such programs. These have been

the criticisms of farmers and ranchers on existing farm bill conservation programs (Batie, 2001). Lichtenberg and Smith-Ramirez (2004) using Maryland Conservation Reserve Program (CRP) data, argued that the ineffectiveness of most of the incentive programs might be as a result of transaction cost landowners bear in participating in the programs and political influence on the funding process.

Lynch and Brown (2000) researched the decision making process in regards to riparian buffers in Maryland in order to understand how landowners will respond to the Conservation Reserve Enhancement Program (CREP) which requires a 10-15 year commitment to keep lands out of agricultural production. A decision approach was used to evaluate whether individual landowners will participate in the program or sell their land for development, taking account of the location of farms close to areas with heavy urbanization. It was found that landowners may not want to have long term constraints on their land, which is required by CREP, when an opportunity to sell arises. Non agricultural opportunity costs are important parts of the decision process in this situation. Isik and Yang (2004) surveyed one hundred counties in Illinois to determine the reasons for participation in CRP. Land benefits and farmer characteristics have significant impact on participation in the program.

The lessons learned from the decades of experience with federal programs that can guide state programs include: set clear measurable objectives, measure and monitor, target and tailor, lower transaction costs of participation, devolve responsibility, require accountability and invest in science, technology, and people (Batie, 2001). This may be changing as the 2002 Farm Bill has been documented as the single most significant commitment of resources toward conservation on private lands in the Nation's history by the NRCS (2002). The 2002 Farm Bill has loosened eligibility requirements and provided greater access to incentives

leading to participation by more landowners (Dorr, 2006) and eventually adoption of agroforestry by a higher number of landowners.

Despite the advancement of government programs to encourage landowners to adopt conservation practices like agroforestry, research has shown that adoption rates by landowners compared to the agricultural related programs are still low and many challenges remain to develop and adopt of agroforestry as a viable land management strategy in the United States. Rietveld and Francis (2000) stated that the competition of innovative agroforesty practices with conventional agriculture is one of the major challenges because farmers are reluctant to change or try new ideas.

Participation in conservation efforts depends on a lot of factors like land values, rental rates and crop prices at any given time. For example in the US where currently the prices of corn have risen sharply in response to its demand as feedstock for fuel ethanol, the significant increase in income from production of corn is a disincentive for complying with the requirements by government incentive programs which includes putting land under trees. The effect of high corn prices on non-participation in incentive programs is supposed to have a greater impact on farm operators compared to non-operators who have other sources of income.

Adoption of Agricultural and Agroforestry Technology

The characteristics of adoption of agriculture and agroforestry technologies have been studied for decades. Landowners face many and different challenges in adopting new and complex technologies. Studies addressing characteristics of adoption are discussed in this section to conceptualize a framework of adoption from previous studies. Understanding and

identifying the characteristics of farm households that adopt conservation-friendly farming practices and participate in conservation programs, can lead to an understanding of how potential participants might respond (Lambert et al., 2006).

The fundamental challenge is the development of new farming systems that have to be adopted and maintained by farmers (Pannell, 1999). By far the most difficult part of achieving widespread adoption is the complex and completely different system that agroforestry represents compared to current farming practices. The complexity of agroforestry technology such as intensive technical management systems and broad knowledge of both trees and plants to improve growing environments for both may be a cause of the slow adoption of agroforestry. This might be partly related to the fact that when farmers are uncertain about a new technology and its profitability, they often decide to continue using existing farming system known to them even though it might not be cost-effective.

Pannell (1999) identified four conditions under which farmers will consider adopting an agricultural innovation: awareness of the innovation, a perception that it is feasible to implement, that the innovation is worth trying, and that the innovation promotes the farmer's objectives. Pattanayak et al. (2003) listed five categories of determinants of technology adoption: economic incentives, biophysical conditions, risk and uncertainty, household preferences, and resource endowments. Workman et al. (2003) also showed that lack of familiarity with the practice and lack of demonstration by professionals are seen as major obstacles to the use of agroforestry.

Coase (1937) on the "nature of the firm" explains that the factors affecting adoption depend not on the technology itself but also on the costs of transacting business. He states

that the market mechanism entails certain costs: discovering the relevant prices, negotiating and enforcing contracts. Huyienbroeck et al. (2004) list the transaction costs as administrative, monitoring, information, negotiation, and control costs. McCann et al. (2005) define transaction costs more broadly as the resources used to define, establish, maintain, and transfer property rights. McCann et al. (2005) argue that there have been difficulties in transaction cost measurement because of inconsistent definitions. Transaction costs are seen in this research from the viewpoint of the farmer or landowner and can be defined as the costs of making decisions, searching for and obtaining information about agroforestry practices, and finding a trading partner to sell agroforestry specialty products.

One of the issues for the adoption of agroforestry technology is finding markets for the specialty products produced as well as understanding the markets. Researchers point out that widespread adoption of agroforestry is lagging in North America because of the absence of readily available market information when compared to commodity markets where market information is readily available (Gold et al., 2004). The marketing of specialty products is much more complicated than commodity goods like corn which have well defined markets and more readily available market information such as pricing. Workman et al. (2003) conducted a survey of extension professionals and landowners in the Southeastern USA to understand their perceptions, perceived benefits, and concerns about agroforestry as a land use option. Lack of markets and market information ranked second in importance as a major obstacle to the use of agroforestry.

The lack of market information can be seen as the transaction cost, when considering the time a landowner has to invest in searching for market information for their agroforestry products. The only information that may be known about the agroforestry market is that

someone is growing the product and consumers are buying. Landowners need to have access to information on and linkages with market and related institutions. Transaction costs are the cost of searching for the information, in this case about a potential outlet for the production.

Swanson et al. (1986 cited in Kurtz 2000) saw lack of sources of information as a barrier to adoption of soil conservation practices. Long (2003) used the America Farmland Trust Survey of 1,617 landowners in five states with logistic regression to identify how information about conservation practices can motivate landowners to adopt the practices. Of the total interviewed, twenty two landowners used practices based on information they received through contact with relatives, friends, government agencies, cooperatives and university extensions. Four landowners were interested in a practice, and then sought information about it. The study points to local sources as being effective because they are trusted by the landowners. Inability to access information regarding practices that provide solutions to problems is felt to inhibit adoption (Kurtz, 2000). One of the barriers is access to distribution channels and this can be achieved and promoted through advertising (Gold et al., 2004). Strong (2004) used a social marketing framework in surveying 223 Pennsylvania farmers to understand perceptions about agroforestry as well as obstacles for adoption of agroforestry. Strong found that awareness of agroforestry was generally low and that farmers felt access to information was difficult to obtain. The lack of information left farmers unsure about the feasibility of the application of agroforestry as well as the profitability.

Rikoon and Heffernan (1989) found that different information sources appealed to different groups of adopters. Those who adopted conservation practices early were more likely to use means like the mass media while the middle and later adopters depend more on neighbors, family and friends. Glendining et al. (2001) said the most commonly used

channels of communication were the extension agent, neighboring farmers and group meetings used to promote new technology.

Adewale and Martin (1995) did a study to determine the perceptions of selected farmers on issues related to sustainable agricultural practices. It was found that most farmers appeared to be at an information generating stage. They saw the sources of education used at this point in decision –making about new practices as central to the level of adoption.

According to Sood and Mitchell (2004) there are many studies on the impact of farmers' social-psychological variables towards the adoption of new agricultural technologies and soil conservation technologies to enhance agricultural yield, but there is still a gap in the understanding of how these factors influence the motivation of farmers to grow trees in agroforestry systems. A valuable approach in developing agroforestry is to utilize the perceptions of landowners with regard to trees and forests. Adewale and Martin (1995) concluded that it is likely that the successful adoption of conservation practices will be influenced more by a farmer's attitude and perceptions than by any other factors. This might not be the case for different countries and regions since economic gain has been found to be the primary motivating factor in the adoption of agroforestry in the US (AFTA, 2006).

While studying factors affecting farm operators' interest in riparian buffers and forest farming in Missouri, Valdivia and Poulos (2005) saw attitudes, in this case those interested in the scenic beauty of planting trees, and those who believed that trees were important for future generations were more likely to be interested in the agroforestry practices. In a study of Missouri farm operators on interest in riparian buffers and forest farming, Flower (2004) concluded that those with the conservative attitude are more likely to be interested in riparian buffers, while the accumulator attitude are more likely to be interested in forest farming. The

lifestyle attitude was found to be more likely interested in both riparian buffers and forest farming. Dorr (2006) found a lifestyle attitude that is represented as "loss of trees as a problem" to be interested in the agroforestry practices except for windbreaks where it was found not significant. These result shows that attitudes are not the most important factor influencing conservation practices but play an important role in whether there is interest in new practices.

In a survey of farmers in traditional agroforestry systems of western Himalaya, Sood and Mitchell (2004) find that perceptional and attitudinal aspects, such as their perceptions of restrictions of trees on their own land, were the most important socio-psychological factors influencing tree growing. Mangaoang (2002) showed how tree farming depends largely on how people perceive the value and usefulness of the undertaking in their day-to-day living, finding that those who perceive cultivation of trees as economically beneficial, are more likely to engage in tree farming. Beliefs about the potential benefit from trees, whether related to natural resources or economic issues, can have an impact on whether farm operators will adopt agroforesty (Valdivia et al., 2001).

Ervin and Ervin (1982) conducted a study of 92 Missouri farmers and applied a model that included educational level as a personal factor. The three dependent variables chosen were the farmers' perception of the degree of erosion problem, decision to use practices and soil conservation effort. The researchers found that the three dependent variables were affected by the education level. Korsching et al. (1983) also showed that education relates directly to innovation. The higher the level of education the more likely landowners are to be interested in adopting new practices like agroforestry. Flower et al. (2005) found that educational level was positively related with the adoption of agroforestry practices in their

study of habitus and interest in agroforestry practices in Missouri, while Dorr (2006) found education level significant in silvopasture and not significant in windbreaks, alley cropping, riparian buffers and forest farming.

There is inconsistent evidence about the relationship of age and adoption (Rogers, 2003). This may be due to the use of age as a variable for the adoption of conservation practices as a whole instead of the adoption of individual conservation practices (Clearfield and Osgood, 1986). About half of the many diffusion studies on adoption show no relationship, a few found that early adopters are younger and some indicate they are older (Rogers, 2003). Diffusion in this context refers to the stage in which the technology spreads to general use and application while adoption refers to the stage in where a technology is selected for use by an individual or an organization. Age is thought to be detrimental to the adoption of agroforestry as the older people are, the less likely they are to be interested in implementing new practices. Arbuckle (2005) in his study of non-operator landowner and agroforestry found age variable as not significant, while Dorr (2006) found age to be significant and negative for alley cropping, windbreaks, and forest farming, and not significant and negative for riparian buffers and silvopasture. Ayuk (1997) concluded that it can be due to the fact that the profitability of adoption may be an increasing function of time, which would imply that technologies requiring several years to maturity would be of concern to older decision makers.

Studies on farm size and the use of practices show either a significant and positive relation (Korsching et al, 1983; and Ervin and Ervin, 1982) or non-significant effects (Mattews et al., 1993). Most studies indicate the larger the farm size the greater the use of conservation practices. In a study on adopters and their relationship to innovativeness,

Korsching et al. (1983) found adopters to have larger farms with greater income and own more land. Larger farms are able to absorb most of the production costs in establishing agroforestry due to economies of scale, but at the same time they might see the trees as an obstacle for farm equipment to operate effectively which may prevent them from adopting.

Landowners may derive benefits from agroforestry through a great number of different sources, including consumption of goods and services, and improvement of the environment. Adesina and Baidu-Forson (1995) state that it is necessary to expand the range of variables used in adoption studies away from broad socio-economic, demographic and institutional factors to include profitability/benefits of the technology when modeling adoption processes for a better understanding of the process of adoption. One of the key factors in determining agroforestry adoption is the benefits of the practice in comparison with other land-use practices.

Agroforestry practices provide a mix of market goods and non-market goods and services. According to Alavalapati et al. (2004), if non-market goods and services can be internalized to the benefit of landowners, the adoption of agroforestry systems will increase. The benefits of agroforestry are usually measured through economic gains and /or improved environmental conservation.

In developed countries, the most important challenge is to develop a farming system that is more profitable than the current practice (Pannell, 1999). Agroforestry will have different benefit potential for the landowner depending on their individual financial circumstances and how the agroforestry practices fit into the overall farming operation. Workman et al. (2003) researched the perceptions of landowners and extension workers in the southeastern United States in regards to agroforestry. The study found that landowners and professionals had

different ideas of the benefits of agroforestry. Professionals thought that water quality and wildlife habitat were the most important benefits while landowners believed that aesthetics, wildlife habitat, shade and soil conservation were the most important.

Benefits of Agroforestry

The past ten years have witnessed the potential usefulness of agroforestry practices in addressing today's concerns over the economic and environmental sustainability of farm land uses (Lassoie and Buck, 2000). Agroforestry practices meet the overall management objectives of many landowners by providing a consistent, periodic flow of income through products and farm income diversification, with conservation benefits as an added bonus.

Economic Benefits

Farm productivity and product quality can be increased when agroforestry windbreak practices are fully utilized. Brandle et al. (2004) listed the following economic benefits of agroforestry:

1. When various species are included in the design, they can contribute directly to the production of nuts, fruits, timber and other wood products. This helps to diversify and increase farming income while also providing a stock of capital in valuable timber.
2. When used in livestock production systems, they improve animal health, improve feed efficiency and contribute to the economic returns of producers.
3. The practices can also help to reduce energy consumption by the farm and improved working conditions within the farm area, which helps to save cost and increases productivity.

4. Agroforestry technology can reduce costs of production, increase productivity and provide multiple outputs.

Environmental Benefits

The five practices of agroforestry have various environmental benefits. These can help protect water quality, stabilize eroding banks, improve aesthetics, improve microclimate for grazing, protect soil from wind erosion, protect structures, filter and reduce dust, help control odors and provide noise abatement.

Windbreaks protect crops from wind erosion and enhance wildlife habitat. This practice improves air quality through wind speed reductions and the physical capture of airborne particulates including dust, smoke and odors; provide aesthetic diversify by adding trees in an agricultural landscape. Riparian buffers help to reduce runoff and non-point source pollution, stabilize stream banks, improve aquatic and terrestrial habitats. Alley cropping can reduce soil erosion from wind and water (University of Missouri Center for Agroforestry Training Manual, 2006).

In summary, adoption of a technology can be viewed first at the farm-level, as a decision to either adopt or not to adopt. This is concerned with the factors influencing the adoption decision. And secondly at the macro-level determining how adoption occurs across a region or population (Mercer, 2004). The current literature shows that perception and attitudes toward trees, transaction cost incurred in searching for market information, production costs in establishing and maintaining the technology, benefits of the technology, sources of information and demographic information play a large role in the adoption of agroforestry.

Sources of information and difficulties in accessing information about agroforestry practices have been shown to affect adoption. The most commonly used channels of communication found from the literature were the extension agent, neighboring farmers and group meetings. Access to information can help to inform farmers about the feasibility of the application of agroforestry as well as the profitability, contributing to reduce the transaction cost involved in searching for information. The level of knowledge can also help decrease some of the risk and uncertainty associated with agroforestry practices. The relative benefit of the practice in comparison with other land-use practices also plays a role in adoption. Like any other technology, the returns from agroforestry must appear practical and beneficial in both human and economic terms, and be greater than what the landowner is already doing for adoption to occur.

Age has been shown to be significant in previous studies. Age is thought to be detrimental to the adoption of agroforestry. As people become older, the less likely they are to be interested in adopting new practices. Level of education has been shown to be important in many studies. The higher the level of education, the more likely interested in adopting new practices. Studies on farm size and the use of practices have been found to show either a significant effect or a strong positive relationship.

Expected Contribution

This study will identify the characteristics of landowners who think of agroforestry as a good stewardship practice. Farms that have chosen to adopt will be compared with those who have chosen not to adopt in terms of participation in government programs. In Missouri, most studies about agroforestry have been on factors

affecting the interest and knowledge in agroforestry (Valdivia and Poulos, 2005; Flower, 2004) with few if any focused on looking at the characteristics of adopters. An understanding of the characteristics that have led the farmers to adopt even though they are few in number, will be valuable in understanding the process of adoption to supporting new efforts and to promote these practices funded by government agencies (Bannister and Nair, 2003).

The documented findings will add to the existing literature on agroforestry and new technology adoption studies. The purpose is also to enable policy makers, researchers, extension agents and national resource professionals to understand how potential participants might respond to the funding programs and the motivating principles of the different types of farmers, important to the success of future agroforestry programs.

Chapter III

Method and Procedures

This chapter formulates a conceptual model derived from frameworks and findings reviewed in the last chapter, of factors affecting adoption of agricultural and agroforestry technologies, and the incentive environment facing landowners. Data source, procedures used for variable selection, formulation of the empirical model and the analysis techniques are developed in the next sections of this chapter.

Conceptual Model: Adoption of Agroforestry

The conceptual model proposes that adoption of Agroforestry (AoA) is a function of market information (MI); perception of trees (PT); individual characteristics (D & E); social networks (N); production costs (PC); benefits of the technology (BT); participation in incentive programs (P); and transaction costs (TC). The relationship is expressed as:

Adoption of agroforestry = F (Ml, PT, D&E, N, PC, BT, P, TC)

The dependent variable adoption of agroforestry represents a qualitative choice of the landowner about the possibility of adoption of an agroforestry practice. The adoption of agroforestry depends on a combination of different variables that include perception of trees, social network, individual characteristics, production costs, benefits of the technology, participation in incentive programs and transaction costs. Each of these will have an independent effect on the adoption of agroforestry.

Hypothesis

Identifying the characteristics of landowners who have adopted agroforestry practices and participated in incentive programs is very important in understanding how potential landowners might respond to the funding programs and adoption of agroforestry. The factors leading farmers to adopt are diverse and vary for different landowners. The primary hypothesis of the research focuses on the relationship between perception of trees, sources of information, production costs, benefits of agroforestry, policy and incentives, transaction costs and demographic characteristics, and the adoption of agroforestry.

Analysis Procedures

The quantitative data analysis technique used for adoption is a Logit regression. SPSS software version 15.0 was used to analyze the data. A Logit regression, instead of a linear regression, was chosen because of the dichotomous nature of the dependent variable. Logistic regression is most useful when you modeling the event probability for a categorical variable with two outcomes. Since the probability of an event must lie between 0 and 1, it is impractical to model probabilities with linear regression techniques, because the linear regression model allows the dependent variable to be greater than 1 or less than 0 (Wooldridge, 2006).

In Logit analysis, the relations between the dependent measure and the predictors are the focus, and the results are usually expressed as odds. The dependent random variable is assumed to be binary, taking on but two values, 0 and 1. The odds of

something happening are equal to (p/(1-P)) and is expressed as a ratio of probabilities, where p is the probability of the event occurring (SPSS Training Manual, 2000).When the predictor is less than 1, increasing value of the variables corresponds to decreasing odd of the event's occurrence, when it is greater than 1, increasing value of the variable corresponds to increasing odds of the event occurrence. Logit is estimated by a method called maximum likelihood estimation (MLE), which is concerned with picking parameter estimates that imply the highest probability of having obtained the observed samples (Aldrich and Nelson, 1984).

Logistic regression procedures report the Hosmer-Lemeshow goodness of fit statistic that helps to determine whether the model adequately describes the data. Hosmer-Lemeshow statistic indicates a poor fit if the significance value is less than 0.05. R-square statistics cannot be exactly computed for Logit model, so the Nagelkerke R square is computed instead. Large Nagelkerke R-square indicates that more of the variation is explained by the model (SPSS Training Manual, 2000).

ANOVA and chi-square analysis test for significant differences, in means and distributions between regions and among operators and non-operators in the profile of landowners. F-test ($p < .05$) indicates significant group differences.

Survey Population and Sample

This research uses secondary data obtained with a 2006 survey of 360 landowners conducted in four counties (Howard, Boone, Crawford and Phelps) in two regions of Missouri. The counties were chosen for their proximity to University of Missouri outlying research centers that include agroforestry research. Howard county was selected

for its rural character and because the University of Missouri outstation research center is located there. Boone County, where the city of Columbia is located, was chosen for its significant urban population and because is an adjacent county to Howard, where HARC is. The second region is the Ozarks, characterized by livestock production and forests. Two counties were selected, the first is Crawford where the Wurdack research center of the University of Missouri is located, and the second is Phelps, a county with the city of Rolla, adjacent to Crawford.

The target population included all landowners with 10 or more acres of land selected at random from the county's tax assessors' lists of property owners of the selected counties per region. All land owned by the state and development companies was removed from the list. A random sample selection with replacement was used. With this method, each landowner with assigned number has an equal chance of being selected each time. The sample frames included 4000 owners in HARC region (Howard and Boone counties) and 2100 owners in the Wurdack region (Crawford and Phelps counties). Respondents were contacted in the order drawn; 184 face -to -face interviews were completed for HARC, and 176 for Wurdack, a total of 360 interviews.

Person to person interviews were conducted to increase consistency in the response to questions. Past experience with face-to –face vs. mail surveys had a significant difference in terms of completeness and response to economic questions (Valdivia et al., 2000). Research assistants monitored the enumerators weekly by collecting and reviewing surveys, calling enumerators for clarifications and making sure the enumerators were filling out the forms correctly. The household survey included the following characteristics: knowledge of the different types of agroforestry practices,

benefits and obstacles of planting trees and sources of information about planting trees, along with questions about the landowners' activities, resources, practices, attitudes and income sources.

Understanding the Variables

The dependent variable, adoption of agroforestry was constructed from a set of six questions asking how much land a respondent had under various agroforestry practices. The respondents answered the questions by indicating how many acres of land they have in the various practices. The variables were recorded as '1' for adopters, those who have land in any of the practices; and '0' for non-adopters, who do not have land in any of the practices.

Below are descriptions of each independent variable included in the model, how it is defined and measured and how it is predicted to affect the adoption of agroforestry. Questions from the survey were selected to represent the independent variables either directly measuring the variables or through a proxy. A correlation matrix was constructed for each category of variables to asses the degree of correlation. The questions considered in the analysis are included in appendix A.

Attitudinal Variable

Attitudes of landowners play an important role in whether landowners will adopt agroforestry. Attitudes in this research represent the perception of landowners with regards to benefits of planting trees. Those who perceive that cultivation of trees is economically beneficial are more likely to engage in tree farming (Mangaoang, 2002).

The potential benefit of trees is expected to have a positive effect on adoption of agroforestry.

In the survey, questions were asked that would help identify each respondent's perception about trees. The variable chosen to represent this category is the response to the survey questions which asked the respondents to indicate how important are the following factors: wind protection, wildlife, scenic beauty, economic benefits, water quality, erosion control, contributions to future generations, flood protection, tax benefits and carbon sequestration to them when consider planting trees. The variables were scored in a scale from 1 to 4 a response of 1 is not important and 4 is very important. Unimportant and slightly important are regrouped as not important = 0 and moderately important and very important as important = 1.

After the correlation matrix was constructed (Appendix B), all benefits were found significant and positively correlated with each other. Scenic beauty was highly correlated with wildlife at .556; erosion control was highly correlated with protecting water quality at .649; and contributions to future generation was highly correlated with erosion control and protecting water quality at .564 and .539 respectively. Contributions to future generation and scenic beauty were chosen as the variables to represent perception of trees.

Benefits of the Technology

The benefits of planting trees are included as a measure of the profitability of agroforestry. The benefits are derived from the question in the survey that asked the landowners to list their top three reasons for planting trees. These reasons are grouped into on-farm monetary benefits (both direct and indirect), on-farm environmental benefits

(non-market benefits), and off-farm environmental benefits (food production and habitat for wildlife). These are hypothesized to have positive effect on adoption of agroforestry practices. Very few respondents mentioned profitability as their reason for planting trees. This was grouped under on-farm monetary benefits. This question differs from the one on perception of trees because these tested the realized benefits of trees to landowners.

The benefits/profitability of agroforestry practices enhances the probability of adoption (Ayuk, 1997). Landowners may derive benefits from agroforestry through a great number of different sources, including consumption of goods and services and improvement of the environment. The profitability of agroforestry is therefore measured on the basis of economic benefits and/ or improved environmental conservation.

A correlation matrix of the three groups of benefits of planting trees (Appendix B) showed all three variables to be significant correlated. On-farm monetary benefits is used in this analysis to represent the benefits of the technology based on the notion that economic gain is the primary motivating factor in the adoption of agroforestry in the US (AFTA, 2006). The variable is scored as 1=Yes or 0= No.

Sources of Information

Sources of information identifies where landowners obtain their information about agroforestry practices, and its role in enhancing knowledge and opportunities. The ability of landowners to access information regarding agroforestry practices that provide solutions to problems can increase adoption. Government agencies, university extension, fellow farmers/landowners are likely sources to find information about planting and managing trees.

Five variables were identified for this category. The first four were questions that asked the respondent to indicate the groups they would prefer to seek advice from if they were going to plant or manage trees. The variables are university extension, landowners/farm operators who have experience with trees; advice from federal conservation professionals; and advice from non-federal conservation professionals. The fifth variable asked respondents to list any agriculture or conservation magazines they currently subscribe to. The various magazines listed were grouped into conservation and production/lifestyle magazines. A correlation matrix was constructed for the all the variables (Appendix B). University extension was highly correlated with non-federal conservation professionals, and conservation magazines subscribed was highly correlated with production/lifestyle magazines. Variables chosen to capture sources of information are conservation magazines, advice from landowner/farm operators, non–federal conservation professionals (which includes the Missouri Department of Conservation Resources (MDC) and Local Soil and Water Conservation District (SWCD)), and federal conservation professionals which are the Natural Resources Conservation Service (NRCS). They are expected to have a positive relationship with adoption of agroforestry. Contact with fellow landowners/farmers and magazine subscription is seen as an avenue for group meetings, and source of education respectively. This is based Glendining et al. (2001) and Adewale and Martin (1995) who found that the most commonly used channels of communication were the neighboring farmers and group meetings used to promote new technology.

Transaction Cost

Transaction costs are seen in this research from the viewpoint of the farmer or landowner, and are defined as the costs of making decisions, searching for information about agroforestry practices, and finding a trading partner to sell agroforestry specialty products. Lack of market information can be seen as obstacles to adoption. Two variables were identified for this category. The first was to know if respondent is aware of timber markets in their area, with a response of 1= Yes and 0 = No. Knowledge of where to sell their timber products will most certainly reduce the cost of getting information. If landowners are not aware they will have to seek this information, invest in obtaining it. On the other hand, if you are aware of markets, search costs will be low, the risks of finding a market, or going to the market and being able to sell will also be lower.

The second variable chosen asked respondents if they are aware of anyone who has used any of the agroforestry practices; this is a yes/no variable. That means landowners who know of other landowners using agroforestry practices will have some knowledge of the practices. This will reduce the time used for searching for information about the technology before deciding to adopt. They will also be sure of a source for information concerning the market for agroforestry products.

Correlation matrix (Appendix B), analysis finds that both variables are not correlated with each other, and both are included to represent the transaction costs landowners incurred in implementing agroforestry. Both variables are hypothesized to have positive effects on adoption of agroforestry.

Participation in Incentive Programs

Policies and incentive programs have been provided by both the federal and state government to encourage and help landowners with the cost of setting up and maintaining agroforestry practices. Cost sharing was found to be the most commonly used incentive for the practices. Rate of participation in incentive programs is low and the reasons, among many, include complexity of the programs, land benefits, long- term constraints on their land, the nature of production, relations with government, and impact of political influence on the funding process.

The first sets of questions identified from the survey ask respondents to indicate how many acres of land they have in the following programs: Environmental Quality Incentive Program (EQIP), Wildlife Habitat Improvement Program (WHIP), Wetlands Reserve Program (WRP) and Private Conservation Incentive. Those who indicate a number of acres of land in the programs are considered participants, and the variables are coded as yes.

The second question identified asks landowners if they have received any cost share or other assistance for conservation practice establishment with a government agency; this was a yes/no variable.

The third variable asked how many acres respondents have enrolled in the Conservation Reserve Program (CRP).

A correlation matrix from the set of three questions (Appendix B) found all variables to be significantly correlated. They were all chosen because they are critical explanatory variables.

Production Costs

The costs of production of agroforestry can also be a major obstacle to landowners aside from its complexity. Vosti et al. (1997) found that adoption of agroforestry requires a thorough understanding of physical and financial returns, along with the production and maintenance costs in adopting. The question from the survey that asked respondents to indicate how much the cost of establishing and managing trees are seen as obstacle to planting trees was used to measure the production costs. The variable is scored in a likert scale from 1 to 5, with 1 indicating no influence and 5 having a very large influence. The variable is rescored as no influence and little influence = 0 and moderate to very large influence = 1. If respondents answered very large influence, it means the production costs in establishing agroforestry is high and can prohibit them from adopting.

Individual Characteristics

The individual characteristics variables included are education, farm size, age, own knowledge of agroforestry, location of respondent and type of respondent. An analysis of correlation is performed to avoid including variables that can pose problems with multi-collinearity in the model.

Age and farm size are continuous variables. Age has been found to be an important characteristic in the adoption of innovation, with younger people generally being more likely to adopt (Rogers, 2003). The same may be expected in this case since the profitability of agroforestry in terms of tree investment may be an increasing function of time, which would imply that technologies requiring several years to maturity would be of concern to older decision makers. Economics (E) measured as farm size was

expected to. have a positive effect on adoption. Korsching et al. (1983) found adopters to have larger farms with greater income and own more land. However, in this case, those with larger farm size (economic of scale) might see trees as an obstacle for their farm equipment to operate which may prevent them from adopting agroforestry.

Own knowledge of agroforestry practices has been shown to increase adoption and interest of practices (Dorr, 2006 and Flower, 2004). Own knowledge is measured through the way landowners rate their knowledge about the various practices. It was asked with a likert scale from 1 to 5 with 1 being very low and 5 being very high knowledge. The variable is rescored as high and very high = 1 and low, medium and very low = 0. The variable own knowledge is expected to have a positive relationship to adoption.

Education is a continuous variable measured in years. Generally higher levels of education are linked to higher levels of adoption. Education is expected to increase knowledge and help landowners to better understand the complexity of agroforestry. Thus, education is expected to positively influence the adoption of agroforestry.

The location of respondent was classified HARC and Wurdack regions. Wurdack is a region characterized by livestock production and forests while the HARC region is known for its row crop production. According to Arbuckle et al. (2005), those that have a larger percentage of land in row crops were considerably less likely to be interested in agroforestry practices. From the profile of landowner in table 4.6, we can see the mean acres of land under row crops are greater in the HARC region compared to the Wurdack region. For the reasons stated above, it is predicted that the Wurdack regions will be more likely to adopt agroforestry than the HARC regions.

Type of respondent is the farm operators and non-operators. The farm operators are made up of full time and part time farmers while the non-operators are landowners living on or away from the land/farm, not farming the land. The grouping is 1 for operators and 0 for non-operators. In a study on Missouri landowners that are non-operators, Arbuckle et al. (2005) found those who have closer ties to farming and strong financial motivations are less interested in agroforestry, while those who place a high importance on environmental and recreational aspects of their land are more interested in agroforestry as a potential land use application. They also found that those that participate in farming activities and have a larger percentage of land in crops are considerably less likely to be interested in agroforestry practices. From the profile of landowners in table 4.4, we observe that the non-operators places high importance on natural resources benefits than economic benefits, while the average acres of land in row crops is more for operators than non- operators in table 4.6. For the reasons stated above, it is predicted that non-operators will be more likely to adopt agroforestry than operators.

Before performing the logistic regression, a correlation matrix was run for all the selected variables chosen to identify any multicolinearity problem. It was found that education and age, farm size and landowner type, advice from federal conservational professionals and other incentives were all highly correlated. To explore how the correlation affects significance of the variables that are correlated and their sign, the model was run without including one of the correlated variables to assess what happens to the model coefficients, for significance and sign effects. The significance of age changed due to the correlation. Education was removed from the model and assumed magazine subscription and contact with landowners as means of educating respondents

about agroforestry. The logistic result with age and education in the model can be seen in appendix C. One explanation for this positive correlation between age and education is that in the US the older the more educated, because education is mandatory through high school.

Farm size and landowner type was found highly significant and farm size was eliminated because it is essential we understand the different types of landowners and their interest in adopting agroforestry (chapter four). Advice from federal conservation professionals was found highly correlated with other incentives programs, which caused the sign of the coefficient of other incentive programs to change. Advice from federal conservation professionals was eliminated because other incentive program is one of the critical variables tested in explaining the relationship between policy incentives and agroforestry adoption.

Conservation Model of Adoption

The first logistic model included the five practices of agroforestry that yield both conservation and economic benefits. When the regression was run, the policy variables were found not significant. A second logistic regression was run that included two practices, windbreak and riparian buffer. Since most of the incentive programs are oriented towards conservation of the environment, the two practices that yield mostly conservation benefits were run with the independent variables.

All the explanatory variables used in the first model remained the same with the conservation model. The variable “knowing someone using the practices” and “own

knowledge of the practices" includes just windbreak and riparian instead of the five practices as in the first model.

Own knowledge of agroforestry and aware of someone using the practices were found highly correlated when correlation matrix was run. When the logistic regression model was run, "own knowledge of agroforestry" was found in this case not significant but "aware of someone using the practices" was significant. The result can be seen in appendix C. The logistic regression was run without "aware of someone using the practices" and "own knowledge" became significant, which proves that one is affecting the other to the point that is changing significance.

In summary, variables that were selected for the adoption of agroforestry technology empirical model included:

Sources of information: Number of conservation magazines subscribed; advice from non-conservation professionals; and contact with landowners/farm operators with experience with trees.

Transaction cost: Aware of timber market in your area; and aware of someone using agroforestry practices.

Benefits of the technology: On-farm monetary benefits.

Perception of trees: Trees for future generation; and scenic beauty.

Participation in programs: Acres of land in CRP; participation in other incentives programs; and cost share assistance

Individual characteristics: Age, own knowledge about the technology; location; and landowner type.

Production cost: Costs of establishing and managing trees.

Empirical Model

The dependent variable is adoption of agroforestry technology. According to the current literature on the adoption of agroforestry, adoption may be influenced by several factors. The independent variables hypothesized to effect adoption are perception of tress, benefits of the technology, transaction costs, sources of information, individual characteristics, program participation and production costs.

Adoption of agroforestry= $f\{pt_1; pt_2; b_1; tc_1; tc_2; n_1; n_2; n_3; dn_1; dn_2; dn_3; dn_4; pp_1; pp_2; pp_3; pd_1;\}$

Agroforestry Adoption

$$(AOA/(1\text{-}AOA)) = \alpha + \beta_1 mags + \beta_2 cfam + \beta_3 afed + \beta_4 awp + \beta_5 awm + \beta_6 ofmb + \beta_7 cmt + \beta_8 tfg + \beta_9 scnic + \beta_{10} loc + \beta_{11} age + \beta_{12} trep + \beta_{13} oknow + \beta_{14} crp + \beta_{15} oinc + \beta_{16} csasst$$

Where:

AOA	= Adoption of agroforestry (expressed as the probability of adoption of Agroforestry)
Mags	= # 0f conservation magazines subscriptions (continuous)
Cfam	= contact with landowners/farm operators (yes=1; no=0)
Afed	= advice from non-federal conservation professionals (yes=1; no=0)
Awp	= aware of someone using the technology (yes=1; no=0)
Awm	= aware of timber market (yes=1; no=0)
Ofmb	= on -farm monetary benefits of planting trees (yes=1; no=0)
Cmt	= cost of establishing and managing tress (moderate to very large Influence=1; no influence and little influence=0)
Tfg	= trees for future generation (moderately important and very important=1; Unimportant and slightly important=0)
Scnic	= scenic beauty (moderately important and very important=1; Unimportant and slightly important=0)
Loc	= location (HARC=1; Wurdack=0)

Age = age of respondents (number of years)
Trep = type of respondents (operators=1; non-operators=0)
Oknow = own knowledge of the practices (high and very high=1; low, medium and very low=0)
Crp = acres in CRP (number of acres=yes)
Oinc = participants in other incentive programs (participants in incentive Programs=yes)
Csasst = cost share and other assistance (yes=1; no=0)

The hypothesis for the AOA Logit model is the following:

H_o: The perception of trees, transaction costs, sources of information, benefits of the technology individual characteristics, production costs and program participation will have no effect on the probability that landowners will adopt agroforestry.

H_a: The perception of trees, transaction costs, sources of information, benefits of the technology individual characteristics, production cost and program participation will affect the probability that landowners will adopt agroforestry

The following results are expected:

mags	cfan	afed	awp	awm	ofmb	cmt	tfg	scnic	loc	age	trep	oknow	crp	oinc	csasst
+	+	+	+	+	+	-	+	+	+	-	+	+	+	+	+

Landowner's perception of trees (PT) will have a positive effect on adoption.

Sources of information (N) measured as contact with other farmers, advice from non-conservation professionals and number of magazines subscribe will have a positive relationship with adoption.

Individual characteristic (D&N) like location (being in Wurdack) and landowner type (non-operator) is expected to have a positive relation with adoption of agroforestry, while age is expected to be negative relation. Own knowledge of the technology is assumed to be positively related to the adoption of agroforestry because landowners may

have a better understanding of agroforestry; Benefits of the technology (BT) measured as on-farm monetary benefits will also have a positive relationship with adoption of agroforestry.

Transaction costs (TC) measured as aware of timber market and aware of someone using the technology will have positive and significant effects on adoption; while cost of production (PD) that is measured as cost of establishing and managing trees will have a negative and significant effect on adoption because the higher the cost the less likely for landowners to adopt. The variables for program participation are all expected to have positive relationship with adoption.

CHAPTER IV

Sites, Sampling and Landowner Profiles in Missouri

This chapter presents profiles of landowners in two regions of Missouri. The data was gathered through a household survey of 360 landowners in Missouri. Two distinct agro ecological regions were chosen. The first is in Central Missouri where the horticulture and agroforestry research center of the University of Missouri is located (HARC). Two counties were selected; Howard, a rural county where HARC is located, and Boone county, where the city of Columbia is located, a county with a significant urban population

The second region is in the Ozarks, characterized by livestock production and forests. Two counties were selected, Crawford County, which hosts the Wurdack research center of the University of Missouri, and Phelps County where the city of Rolla is located. The logic for site selection included the following criteria: proximity to a university research center where agroforestry practices were studied; a county that was mostly rural to capture household that relied on agricultural production; a county with a city or town to capture the effect of a changing rural landscapes.

Respondents were contacted in the order drawn; 184 face- to -face interviews were completed for HARC and 176 for Wurdack. Questions asked included attitudes towards agroforestry as well as social, economic and production characteristics of the two regions. Also asked were landowner characteristics, activities, income sources, participation in government programs (local, state and federal), knowledge of different

agroforestry practices, benefits and obstacles of planting trees, and sources of information about planting trees.

Demographic Characteristics for Operators and Non-operators

Demographic characteristics of adoption of agroforestry practices are analyzed by comparing two groups of people, farm operators and non-operators. The farm operators are those who are either full-time or part-time farmers while the non-operators are those living on or away from the land, not farming the land. Both groups are compared by regions.

According to the survey results (Table 1), in 2005 farm operators in Wurdack and HARC regions are different in both age and education. Farm operators in HARC belong to an older group, average age 70.41 years with an average number of schooling years of 14.41 compared to those operators in Wurdack region that have a mean age of 55.27years and average education of 13.10 school years. Both regions have approximately similar means in number of farming experience and percentage marital status. There were a similar male number of operators in both regions but there are more female farm operators in Wurdack (23.4%) compared to HARC (15.3%). In terms of the differences of farm operators by region, only age and education were found to be significantly different.

For the non-operators, the age and education levels differ in both regions. Wurdack has a mean age of 78.8 years compared to 57.5 years in HARC, while the amount of education in HARC is greater, a mean of 15.20 years as compared to 14.2 years in Wurdack. There are more married non-operators in HARC region (80.8%) than

Wurdack (78.4%). Each region has similar means in gender and farming experience since their18th birthday. As in farm operator, age and education were found to be significantly different in both regions.

Table 4.1. Household Characteristics of Farm Operators and Non-farm Operators in Wurdack and HARC Regions in Missouri, 2006.

	Farm Operator		**Non-Operator**	
	Wurdack	HARC	Wurdack	HARC
Age (years)-Mean(SE)	55.27 (1.6) *	70.41 (12.3)	78.80 (11.4) *	57.54 (1.15)
Education(years)-Mean(SE)	13.10 (0.4) ***	14.41 (0.32)	14.03 (0.62) ***	15.20 (0.27)
Farming Experience since 18th Birthday(years) - Mean (SE)	28(2.0) N	29.5 (1.8)	13.9 (1.9) N	14.2 (1.94)
Gender-numbers (%)	N		N	
Male	48 (75.0)	48(81.4)	79 (71.2)	85 (68.0)
Female	15 (23.4)	9 (15.3)	32 (28.8)	35 (28.0)
Marital Status - numbers (%)	N		N	
Married	54 (84.4)	53 (89.8)	87 (78.4)	101 (80.8)
Never Married	2 (3.1)	1 (1.7)	3 (2.7)	1 (.8)
devoice/separated	4 (6.3)	3(5.1)	11 (9.9)	11 (8.8)
Widow/Widower	4(6.3)	2(3.4)	10 (9.0)	9 (7.2)

Source: landowner survey, 2006.
ANOVA to determine significant differences (means) among operators between regions and non-operators between regions and chi-square to determine significant differences (number and percentage by regions) among operators between regions and non-operators between regions.
***significant at 0.01
** Significant at 0.05
* Significant at 0.10
N not significant

Land Tenure and Employment Characteristics for Operators and Non-operators

In 2005, the mean number of acres owned by farm operators in the HARC was 284 compared to 209 acres for Wurdack regions (Table 4.2). In addition to owned land, farm operators in HARC regions have more numbers renting out their land, mostly using cash lease, and rent more land than those in Wurdack regions. In Wurdack, landowners

own their land longer, a mean of 73 years compared to 54 years in HARC regions. When asked the likelihood that someone in the family will be farming the land when they stop farming, about 15.6% from Wurdack and 10.2% from HARC were unsure; 48.4% from Wurdack and 55.9% from HARC were sure that someone would continuing while 32.9% from Wurdack and 30.5 from HARC were sure that no one would.

Off farm employment is very common among farm operators and their spouses in both regions. A total of 67.2% of farm operators in Wurdack regions indicated that they have off farm employment while in the HARC region 61% indicated they have off farm employment. Those farm operators that are married in Wurdack regions indicated that 46.2% of their spouses have off farm employment, while those in HARC had 34% of their spouses working off the farm. Despite the fact that they are farm-operators, the majority of them have an off farm job. This means that majority of the farm operators might be part-time farmers, even when the self-classify as full time farmer.

For the non-farm operators, the mean number of acres owned in the HARC was 125 compared to 86 acres for Wurdack regions. In addition to land owned, non-farm operators in HARC region have higher numbers of those renting out their land, mostly using cash lease, and rent more land than those in the Wurdack regions. Non-farm operators in Wurdack on average tend to own their land a little longer (44.85 years) compared with those in HARC region (40.61) with a mean difference of 4.24 years. About 13.0% from Wurdack and 12.8% from HARC were unsure if someone in the family will be farming the land in the future. 41.4% from Wurdack and 59.2% from HARC were sure that no one from the family would be farming the land, and 42.3% from

Wurdack and 27.2% from HARC were sure the land would be farmed by a family member.

The only significant difference found in both regions among operators and non-operators is the type of lease used (table 4.2).

Table 4.2 Land Tenure and Employment Characteristics of Farm Operators and Non-farm operators in Wurdack and HARC regions in Missouri, 2006.

	Farm Operators		Non-Operator	
	Wurdack	**HARC**	**Wurdack**	**HARC**
Years the oldest portion of land has been in the family- Mean (SE)	72.66(21.1) N	54.42 (16.7)	44.85 (10.6) N	40.61 (8.4)
Acres of Land Owned in 2005- Mean (SE)	208.59 (32.9) N	284.29 (55.2)	86.30 (17.1) N	124.53 (15.9)
Landowners renting out their land- Number (%)	2(3.2) N	5 (8.5)	8 (7.2) N	35 (28.0)
Acres rented out in 2006 - Mean (SE)	6.34 (5.7) N	18.19 (8.7)	16.5 (9.2) N	55.78 (12.5)
Type of lease				
Cash- number (%)	10 (15.6) ***	21 (35.6)	5 (4.5) ***	23 (18.4)
Share- number (%)	2 (3.1) ***	12 (20.3)	0 ***	16 (12.8)
Off-farm employment				
Farm/non-farm Operator- Number (%)	43 (67.2) N	36 (61.0)	30 (27.0) N	26 (20.8)
Spouse -number (%)	31 (46.2) N	34 (57.7)	28 (25.2) N	17 (14.4)

ANOVA to determine significant differences (means) among operators between regions and non-operators between regions and chi-square to determine significant differences (number and percentage) among operators between regions and non-operators between regions.
***Significant at 0.01
** Significant at 0.05
* Significant at 0.10
N not significant

Debt Levels and Assets for Operators and Non-operators

The majority of farm operators in both regions own a large portion (91-100%) of their assets debt free, with 53.1% from Wurdack and 44.1% from HARC (Table 4.3). A large proportion (20.3%) of those in HARC have more than $1,000,000 in market value

of their farm, home, business, and other investments, while a large proportion (21.9%) in Wurdack fall within the range of $200,001-$300,000. Operators in HARC have more assets in machinery for row crops (49.1%) than operators in the Wurdack region (6.2%) while operators in Wurdack have more machinery for livestock (51.5%) than those in HARC (45.7%). These results are consistent with what both regions are known in terms of their production system. The chi-square results showed significant differences in assets in livestock, machinery for row crops and farm real estate (table 4.3). The data showed that operators in both regions have a mixed production system of crop and livestock.

The most frequent category of the non-farm operators in both regions also owns a large portion (91-100%) of their assets debt free: 42.3% in Wurdack and 38.4% in HARC. We expected more debt-free operators in HARC region but this was not the case (Table 4.3). Both regions had a wide range of market value of their farm, home, business and other investments with a large proportion of them within the range of $100,001-$300,000 (38.7% for Wurdack and 39.2% for HARC). Like the farm operators in Wurdack, non-operators in HARC also have more machinery for row crops (12.8%) than non-operators in the Wurdack region (5.4%) while non-operators in Wurdack have more machinery for livestock (13.5%) than those in HARC (10.4). Machinery for livestock, machinery for row crops and non-farm real estate was found to be significantly different between both regions (table 4.3). The data also showed that non-farm operators in both regions have a mixed production system of crop and livestock on their land rented out.

Table 4.3. Debt Levels and Assets for Farm and Non-farm Operators in Wurdack and HARC Regions in Missouri, 2006

	Farm-Operator		Non-Operator	
	Wurdack	**HARC**	**Wurdack**	**HARC**
Percent of total assets owned debt free- number(%)	**N**		**N**	
Less than 20%	5 (7.8)	4 (6.8)	12(9.6)	12(9.6)
20-30%	5 (7.8)	2 (3.4)	4(3.6)	10(8.0)
31 - 40%	1 (1.6)	5 (8.5)	2(1.8)	5(4.0)
41 - 50%	3 (4.7)	4 (6.8)	2(1.8)	6(4.8)
51 - 60%	4 (6.3)	1 (1.7)	8(7.2)	7(5.6)
61 - 70%	6 (9.4)	6 (10.2)	7(6.3)	6(4.8)
71 - 80%	2 (3.1)	5 (8.5)	12(10.8)	11(8.8)
81 - 90%	2 (3.1)	3 (5.1)	7(6.3)	8(6.4)
91 - 100%	34 (53.1)	26 (44.1)	47(42.3)	48(38.4)
Market value of farm, home, business, and other investments - number(%)	N		N	
Under $100,000	0	0	10 (9.0)	5 (4.0)
$100,001 - $200,000	5 (7.8)	2 (3.4)	24 (21.6)	24 (19.2)
$200,001 - $300,000	14 (21.9)	9 (15.3)	19 (17.1)	25 (20.0)
$300,001 - $400,000	8 (12.5)	3 (5.1)	13 (11.7)	8 (6.4)
$400,001 - $500,000	5 (7.8)	5 (8.5)	4 (3.6)	8 (6.4)
$500,001 - $600,000	2 (3.1)	2 (3.4)	2 (1.8)	6 (4.8)
$600,001 - $700,000	1 (1.6)	6 (10.2)	2 (1.8)	1 (.8)
$700,001 - $800,000	2 (3.1)	5 (8.5)	1 (.9)	2 (1.6)
$800,001 - $900,000	3 (4.7)	2 (3.4)	3 (2.7)	5 (4.0)
$900,001 - $1,000,000	4 (6.3)	3 (5.1)	1 (.9)	2 (1.6)
More than $1,000,000	6 (9.4)	12 (20.3)	8 (7.2)	14 (11.2)
Asset Distribution in Following Categories number(%)				
Livestock	36(56.2) *	38(64.4)	6(5.4) N	12(9.6)
Machinery for Livestock	33(51.5) N	27(45.7)	15(13.5)*	13(10.4)
Machinery for Row crops	4(6.2) ***	29(49.1)	6(5.4)*	16(12.8)
Farm Buildings	28(56.3)N	37(62.7)	33(29.7)N	41(32.8)
Farm Real Estate	37(57.8)**	48(81.3)	66(59.5)N	82(65.6)
Non-Farm Assets	31(48.4)N	35(59.3)	45(51.4)*	70(56)

Source: landowner survey, 2006. Number and percentage is by regions.

ANOVA to determine significant differences (means) among operators between regions and non-operators between regions and chi-square to determine significant differences (number and percentage) among operators between regions and non-operators between regions.

*significant at 0.10

***significant at 0.01

** Significant at 0.05

N not significant

Perceptions of Trees for Operators and Non-operators

A valuable approach on understanding adoption of agroforestry by landowners is to utilize their perceptions of trees and forests. An understanding of the way landowners perceive trees can assist in designing policies that can be effective in motivating adoption. To assess the value they place on the benefits of agroforestry practices, respondents were asked to rate the importance of potential benefits of planting trees. To gain an understanding as to what might influence their decision to adopt agroforestry practices, they were also asked to respond to a list of benefits and obstacles to planting trees and to indicate how these factors increase or reduce their interest in investing in trees.

The Benefits of Trees

Landowners were asked to indicate how important a number of benefits would be to them in a decision to plant trees. The variables were scored in a scale from 1 to 4 a response of 1 is not important and 4 is very important. Moderately important and very important are regrouped as important. The benefits are grouped into economic benefits and natural resource benefits. Table 4.4 presents the number of landowners who are operators and non-operators and percentage by regions who responded with “importance” with regards to economic and natural resource benefits.

Based on the number of operators that responded with “importance” to benefits of planting trees, a majority in both regions listed wildlife, scenic beauty; protect water quality and erosion control. On the other hand, future generations ranked highest in both regions, followed by tax benefits in Wurdack region, and economic benefit in HARC region.

Table 4.4. Farm Operators and Non-farm Operators in Wurdack and HARC Regions in Missouri, 2006 that Believe in the Importance of Planting Trees.

	Farm Operator			Non-Operator		
	Wurdack		HARC	Wurdack		HARC
Indicate how important the following benefits would be to you in planting trees						
Natural Resources Benefits						
Wind Protection	25 (39.1)	N	26 (44.1)	46 (41.4)	N	49 (40.5)
Wildlife	33 (51.6)	*	39 (66.1)	79 (71.2)	*	97 (79.5)
Scenic beauty	32 (50.0)	N	33 (55.9)	72 (64.9)	N	88 (72.1)
Carbon Sequestration	22 (34.4)	N	19 (32.2)	52 (50.0)	N	55 (47.8)
Protect Water Quality	37 (57.8)	N	39 (66.1)	68(61.8)	N	84 (68.9)
Erosion control	37 (57.8)	*	43(72.9)	70 (63.1)	N	86 (70.5)
Flood Protection	24 (37.5)	N	17 (28.8)	41 (38.0)	N	47 (39.5)
Economic and Future generations						
Economic Benefits	25 (39.1)	**	35 (59.3)	39 (35.1)	N	50 (41.3)
Tax benefits	26 (40.6)	N	29 (49.2)	41 (38.0)	N	49 (40.8)
For Future Generations	38 (59.4)	***	47 (79.9)	84 (75.7)	***	47 (39.5)

Source: landowner survey, 2006. Number and percentage is by regions.
Chi-square to determine significant differences (number and percentage by regions) among operators between regions and non-operators between regions.
***significant at 0.01
** Significant at 0.05
* Significant at 0.10
N not significant

The same result was found for non-operators in both regions, more landowners in both regions listed wildlife, scenic beauty, erosion control and protection of water quality and carbon sequestration. Preserving the natural resource base for future generations ranked the highest in both regions followed by economic benefits for HARC and tax benefits for Wurdack.

We can infer from the result that apart from economic benefits, other factors can also play a role in decisions to invest in trees. Incentives for agroforestry can be more than just economic. We can also observe from the table that non-operators ranked natural resource benefits higher than operators.

From the chi-square results, the significant difference found among operators in both regions are wildlife, erosion control, economic benefits and future generations. For non-operators, wildlife and for future generations was found to be significantly different in both regions (table 4.4).

Obstacles to Planting Trees

Landowners were asked to indicate how much influence the factors listed in Table 4.5 would reduce their interest in planting trees. The variables were scored in a scale from 1 to 5 a response of 1 is no influence and 5 is very large influence. Very large influence and large influence are regrouped as" some influence". The obstacles are grouped into tree specific obstacles and economic and information obstacles. Table 4.5 presents the number of landowners who are operators and non-operators, and percentage by regions who responded with "some influence" with regards to tree specific and economic and information obstacles.

Based on the number of landowners that responded with "some influence" of obstacles of planting trees, a large proportion of operators in both regions listed the following factors: cost of establishing and managing trees, time required to manage trees, trees as obstacles for farm equipment, lack of tree management experience and takes too long to make profit. Takes too long to make a profit ranked the highest obstacles in both HARC and Wurdack.

Non-operators in both regions listed cost of establishing and managing trees, lack of tree management experience, takes too long to make a profit, time required to manage trees and lack of

technical information as their major obstacles when considering investing in trees. The cost of establishing and managing trees ranked the highest among non-operators in both regions.

Table 4.5. Farm and Non-Farm Operators in Wurdack and HARC Regions in Missouri, 2006 that Believe Obstacles in Planting Trees will Reduce their Interest in Tree Investment

	Farm Operator		Non-Operator	
	Wurdack	**HARC**	**Wurdack**	**HARC**
How Much Influence the following factors would have in reducing your interest in planting trees.				
Tree Specific Obstacles				
Negative effects on crops	27 (42.9) *	36 (61.0)	23 (21.3) *	38 (32.2)
Trees are an obstacles for farm Equipment	35 (55.6) N	37 (62.7)	25 (22.7) *	37 (31.4)
Lack of tree management experience	36 (57.1) N	32 (54.2)	54 (50.0) **	76 (63.3)
Too much Invested clearing trees	38 (60.3) N	28 (47.5)	38 (35.2) N	52 (42.6)
Economic and information obstacles				
Inadequate market prices for timber	28 (45.2) N	28 (47.5)	32 (31.1) N	44 (36.4)
Lack of technical information	27 (43.5) N	21 (35.6)	40 (37.0) *	58 (47.5)
Cost of establishing and managing trees	36 (57.1) N	37 (63.8)	58 (53.7) ***	84 (69.4)
Takes too long to make a profit	37 (59.7) *	42 (72.4)	42 (39.3) N	50 (41.7)
Time required to manage trees	36 (57.1) *	42 (72.4)	50 (45.9) ***	79 (64.8)

Source: landowner survey, 2006. Number and percentage is by regions.
Chi-square to determine significant differences (number and percentage by regions) among operators between regions and non-operators between regions. N not significant
***significant at 0.01
** Significant at 0.05, *Significant at 0.10

From the response rate, most of the obstacles listed among operators and non-operators are reasons that have to do with the cost, information and profitability. This calls

for government agencies to focus on delivery of relevant information as a means of overcoming lack of knowledge that may be a factor preventing landowner adoption of agroforestry. Making practices more profitable that will cover the cost of production can be another factor to be considered.

From the chi-square results, time required to manage trees, takes too long to make a profit and negative effects on crops was found to be significantly different among operators in both regions. Most of the obstacles in tree specific and economic and information obstacles were found to be significantly different among non-operators in both regions (table 4.5).

Land Characteristics and Use for Operators and Non-operators

(Table 4.6) Farm operators in Wurdack have more land in managed and unmanaged timber and have harvested more trees for sale and less in row crops compared to operators in HARC. This is consistent with the production systems in both regions, the Wurdack known for its livestock production and forestry and the HARC for crop production. There are differences by region in the acres of managed and unmanaged timber and amount of land in row crops (table 4.6). A similar result was found among non-operators, those in Wurdack have more land in managed and unmanaged timber and less land in row crop compared to those in HARC. Acres in unmanaged timber, amount of land in row crops and harvested tress for sale was found to be different in both regions (table 4.6). This means despite the fact that they are non-operators; the same result with operators in terms of land use characteristics by region can be made.

In terms of land in the five agroforestry practices, there were very few operator and non-operator landowners in both regions who have implemented agroforestry practices on their land. The more traditional agroforestry practices like windbreaks and

riparian buffers had the largest proportion of respondents among operators and non-operators in both regions though this number was more in HARC regions. This might be because of the presence of the University of Missouri outstation research center and the benefits of the practices on row crops. For silvopasture, more of the respondents were from Wurdack regions and this might be because the Ozarks, a region characterized by livestock production and forests. The chi-square results showed significant difference in both silvopasture and forest farming among operators in both regions. For non-operators, significant differences in both regions were found in alley cropping, windbreaks and riparian buffers (table 4.6).

To see how effectively the incentives have encouraged landowners to adopt agroforestry practices, landowners in the survey were asked to state how many acres of land they have enrolled in various incentives programs and if they have received any cost share or other assistance for the establishment of conservation practices. Landowners are considered participants in the incentive programs if they indicate that they have a number of acres of land in the programs and receive cost share or other assistance from government agencies.

Based on the responses, a greater number of operators and non-operators in HARC regions participated in the incentive programs compared to Wurdack regions. This might be due to differences in farming activities in both regions. From the response rate, participation in incentive programs is not the experience of the majority of landowners.

Table 4.6. Land Characteristics and use for Operators and Non-operators in Wurdack and HARC Regions in Missouri, 2006.

	Farm Operator		Non-Operator	
	Wurdack	**HARC**	**Wurdack**	**HARC**
Land in following Categories (acres)- Mean (SE)				
Hay land and pasture (non-wooded)	160.81 (33.4) N	163.6(28.1)	34.921(10.2) N	33.834(5.1)
Cropland	14.617 (11.0) ***	224.5(86.0)	5.351(2.1) ***	32.391(7.6)
Managed Timber Stands	28.734 (11.1) **	16.762(6.4)	24.485(6.4) N	18.360(5.17)
Unmanaged Timber Stands	92.886 (23.5) **	71.239(12.8)	49.776(10.2) **	30.943 (47.5)
Harvested Trees for sale number (%) by region	29 (45.3) N	26 (44.1)	35 (31.5) **	24(19.2)
Implemented Practice on farm number(%)by region				
Alley Cropping	0	0	0 *	3 (2.5)
Windbreaks	13 (20.6) N	14 (24.1)	10 (9.0) **	25 (20.3)
Riparian Buffers	13 (20.6) N	17(29.3)	9 (8.8) *	20 (16.7)
Silvopasture	9 (14.1) ***	1 (1.7)	5 (4.5) N	3 (2.5)
Forest farming	0 *	2 (3.4)	1 (.9) N	2 (1.6)
Land Enrolled in Incentive programs. Number (%) by region				
CCRP	0 *	2(3.6)	0 *	3(2.5)
CRP	0 ***	11(20.0)	0 * **	8(6.8)
EQIP	1(7.1) N	4 (26.7)	0	0
WHIP	0 *	2 (3.6)	0 N	2(1.7)
WRP	0	0	0 N	2(1.7)
private programs	0 ***	8 (13.8)	1(1.4) N	4(3.3)
Land in conservation practices established with: number by region				
NRCS	5	15	0	14
SWCD	5	15	1	9
MDC	0	5	2	4

Source: landowner survey, 2006. Number and percentage is by regions.

ANOVA to determine significant differences (means) between regions and Chi-square to determine significant differences (number and percentage) between regions. N not significant

***significant at 0.01

** Significant at 0.05

*Significant at 0.10

Sources of Information for Non-Operators and Operators

Table 4.7 shows that majority of operators and non-operators in both regions listed University Extension, Missouri Department of Conservation (MDC), landowners, or farmers who have experiences with trees, as their sources of advice about planting and managing trees. The operators in both regions listed University Extension first followed by MDC and landowners or farmers, while the non-operators listed MDC followed by University Extension and landowners or farmers.

Table 4.7. Sources of information for Operators and Non-operators in Wurdack and HARC Regions in Missouri, 2006.

	Farm Operator		Non-Operator	
	WURDACK	**HARC**	**WURDACK**	**HARC**
Number of magazine Subscriptions. Number (%)	38 (59.4) **	47 (79.9)	72 (64.9)	93 (74.4)
First choice of group you would seek advice from about planting or managing trees. Number (%)	**		N	
University Extension	24 (38.7)	17 (29.8)	33 (30.8)	35 (29.4)
Landowners/farmers who have tree experience	11 (17.7)	9 (15.8)	11 (10.3)	14 (11.8)
Local Soil and Water Conservation District	3 (4.8)	5 (8.8)	5 (4.7)	8 (6.7)
Natural Resources Conservation Service	1 (1.6)	1 (1.8)	9 (8.4)	6 (5.0)
Missouri Department of Conservation	16 (25.8)	15 (26.3)	36 (33.6)	46 (38.7)
Consulting Forester	2 (3.2)	4 (7.0)	5 (4.7)	6 (5.0)
Commercial Logger	2 (3.2)	2 (3.5)	1 (1.9)	0
Timber Buyers	1 (1.6)	1 (1.8)	1 (1.9)	0

Source: landowner survey, 2006. Number and percentage is by regions.

The response rate for the number of magazines subscribed to as a source of education about managing trees was also large among operators and non-operators in both regions. The survey result shows that University Extension, MDC and subscribing to

magazines are the sources where farm operators and non-operators would go to find information about planting and managing trees, while they are also comfortable with other landowners or farmers who have experience with trees.

Chapter V

Empirical Results and Analysis of Adoption models

This chapter provides empirical results from the statistical models. Logistic regression is used to predict the likelihood of the outcome based on the independent variables. Two hypotheses were evaluated for the two adoption models. Frequencies of respondents by variables of the logistic regression model are provided in Table 5.1.

Table 5.1. Frequencies of Respondents by Variables of the Logistic Regression Model of Landowners in Wurdack and HARC Regions in Missouri, 2006 .

Category	# of Respondents	% of Respondents
Location		
HARC	184	51.3
WURDACK	175	48.8
Adoption of agroforestry		
Adopted	112	31.2
Non-adopted	247	68.8
Landowner type		
Operators	123	34.3
Non-operators	236	65.7
Age	350	97.5
Own knowledge of agroforestry		
Some High	235	65.5
Low	122	34.0
Aware of timber market in your area	170	47.8
Know any One using agroforestry		
Yes	163	53.5
No	192	45.4
Conservation magazine subscriptions	192	53.3
On-farm monetary benefits	84	23.4
Received advice from landowner/farm operators with experience with trees	59	16.4
Received advice from non-federal conservation professionals	134	37.3
Cost of establishing and managing trees		
Some Influence	215	59.9
No Influence	135	37.6
Trees for future generation		
Some Importance	264	73.5
Trees for scenic beauty		
Some importance	225	62.7
Acres in CRP	19	5.3
Participation in other incentive programs	21	5.8
Costs share and other assistance	53	14.8

Source: Landowner survey, 2006. Center for Agroforestry, University of Missouri

The parameter results for the adoption of agroforestry technology Logit model are presented in table 5.2. The model analysis showed that with only the intercept in the model, it could predict correctly 68.7% of the time with 100% accuracy for those that have not adopted agroforestry technology and 0% of the time for those that have adopted agroforestry technology. With the independent variables included in the model, the model could predict correctly 77.1% of the time with 90.1% accuracy for those that have not adopted agroforestry technology and 48.5% accuracy for those that have adopted the technology (Table 5.3). The model is very good at predicting those that have not adopted agroforestry, but has much less success with those that have adopted agroforestry. The reason is because of the low (31.2%) percentage of adopters that makes it difficult for the model to capture the characteristics of those who have adopted agroforestry.

Three hundred and twenty five observations were included in the analysis and the chi-square value was highly significant, 89.46. The Nagelkerke R squared value for the model was .340, showing that more of the variation is explained by the model (Table 5.4). The Hosmer-Lemeshow statistic indicates a poor fit if the significance value is less than 0.05 (SPSS Training Manual, 2000). The model adequately fits the data because the model has a significance of .833 (Table 5.5). The estimation result indicates that landowners who subscribed to conservation magazines and are comfortable receiving advice from landowners/farm operators who are knowledgeable about planting and managing trees, have a significantly higher probability of adopting agroforestry. The Logit results provide statistical evidence for rejecting the null hypothesis (table 5.2).

The parameter estimates also support previous research indicating that there is a significant relationship between the probability that a landowner will adopt agroforestry

and their knowledge level. This is indicated by the significant and positive relationship of adoption of agroforestry and personal knowledge of the practices. Landowners that have knowledge are 2.5 times more likely to adopt than those who do not have knowledge. The costs of establishing and managing trees that represents the production costs borne in establishing the technology, and age, were found to have a negative and significant relationship with adoption of agroforestry. Those that are concerned with the costs of establishing trees are 50 percent less likely to adopt. Those who are older are 15 percent less likely to adopt. Knowing someone using the practices, (reduced transaction costs) and landowner that are non-operators were also significant. Knowing someone, meaning lower transaction cost in accessing information increased the probability of adoption by 3.5 times.

Some of the variables did not support previous research on the adoption of agroforestry. Policy programs and incentives had no effect on the likelihood of adoption (Acres in CRP, participation in other incentive programs, cost share and other assistance). Trees for future generation and for scenic beauty which were significant in analysis of interest in specific agroforestry practices were not significant. Advice from non-federal conservation professionals was also not significant. The location (HARC and Wurdack) and awareness of timber market were also found not significant. It is important to note that economic matters. In this case on-farm monetary benefits of planting trees which are the direct and indirect economic gain landowners have in planting trees were found positive and highly significant.

Table 5.2. Parameter Estimates for Adoption of Agroforestry Logistic Regression Model of Landowners in Wurdack and HARC Regions in Missouri, 2006 .

Variables	Regression Coefficient	Standard Error	P-Value (Sig.)	Change in Probability
Age	-.015	.012	.036**	.985
Advice from Landowner/farm operators	.305	.377	.019*	1.356
Advice from non-federal conservation professionals	-.004	.292	.989	.996
Conservation magazine subscribed	.339	.309	.033**	1.617
Location	.110	.313	.725	1.116
Landowner type	.415	.320	.096*	1.514
Acres in CRP	-003	.012	.816	.997
Cost share and other assistance	.225	.462	.627	1.299
Participants in other incentive programs	.271	.635	.670	1.311
On-Farm Monetary benefits of planting trees	1.672	.325	.000***	5.323
Own knowledge of agroforestry	.926	.351	.008***	2.524
Knowing someone using agroforestry	1.258	.308	.000***	3.519
Aware of timber market	.019	.310	.950	1.019
Trees for future generation	-. 155	.372	.677	.856
Trees for scenic beauty	-.438	.358	.221	.645
Cost of establishing and managing trees	-.534	.316	.091*	.586

*significant at α =.10, **significant at α =.05, ***significant at α =.01

Table 5.3. Empirical Model Predictive Power for the Dependent Variable Adoption of Agroforestry.

		Predicted			
		Non-Adopted	Adopted	% Correct	% Overall Correct
Observed	Non-adopted	200	22	90.1	
	Adopted	52	49	48.5	77.1

Table 5.4. Empirical Model Summary for Agroforestry Adoption.

Chi-Square (p-value)	# of Observations	Nagelkerke R square
89.466(.000)	323	.340

Table 5.5. Hosmer and Lemeshow Test

Chi-Square	df	sig
4.264	8	.833

Conservation Model for Adoption

This model only includes adoption of traditionally considered conservation agroforestry practices (windbreak and riparian buffer). Frequencies of respondents by variables of the conservation model are provided in table 5.6

Table 5.6. Frequencies of Respondents by Variables in Logistic Regression with Conservation Model of Landowners in Wurdack and HARC Regions in Missouri, 2006 .

Category	# of Respondents	% of Respondents
Location		
HARC	184	51.3
WURDACK	175	48.8
Adoption of Agroforestry		
Adopted	98	27.3
Non-adopted	261	72.7
Landowner type		
Operators	123	34.3
Non-operators	236	65.7
Age	350	97.5
Own knowledge of Agroforestry (with two practices)		
Some High	105	29.2
Low	252	70.2
Know any one Using Agroforestry		
Yes	133	37.0
No	223	62.1
Number of Conservation Magazines Subscription	192	53.3
On-Farm Monetary Benefits of planting trees	84	23.4
Received Advice from Landowner with experience with trees	59	16.4
Received Advice from Non-federal Conservation Professionals	134	37.3
Cost of Establishing and Managing Trees		
Some Influence	215	59.9
No Influence	135	37.6
Aware of timber market in your area	170	47.8
Trees for future generation		
Some Important	264	73.5
Trees for scenic beauty	225	62.7
Some importance		
Acres in CRP	19	5.3
Costs share and other assistance	53	14.8
Participation in other incentive programs	21	5.8

Source: Landowner survey, 2006. Center for Agroforestry, University of Missouri.

The parameter results for the adoption of agroforestry technology Logit model are presented in table 5.7. The model analysis showed that with only the intercept in the model, it could predict correctly 73.2% of the time with 100% accuracy for those that have not adopted agroforestry technology and 0% of the time for those that have adopted agroforestry technology. With the independent variables included in the model, the model could predict correctly 76.9% of the time with 90.3% accuracy for those that have not adopted agroforestry technology and 40.2% accuracy for those that have adopted the technology (Table 5.8). The model has the same difficulty as the model with the five practices in terms of predictive power. The model is very good at predicting those who have not adopted agroforestry, but has much less success at predicting those that have adopted agroforestry. With the small percentage (27.3%) of adopters, it makes it difficult for the model to capture the characteristics of those who have adopted the technology.

Three hundred and twenty five observations were included in the analysis and the Chi-Square value was significant (68.96). The Nagelkerke R squared for the model was .278, showing that more of the variation is explained by the model (Table 5.9). The Hosmer and Lemeshow goodness of fit test has a significance of .924 which shows that the model adequately describes the data (Table 5.10). Similar to the adoption model results with the five practices, the number of conservation magazine subscribed was found significant. The estimation result indicates that if someone subscribes to conservation magazines, it is approximately 2 times more likely to adopt agroforestry. Advice from landowners/farm operators who are knowledgeable about planting and managing trees was found not significant. Advice from non-federal conservation

professionals is expected to be significant with this model because both of these practices have been promoted for years by the federal government.

The parameter estimates also support previous research and the model with the five practices that indicates that there is a significant relationship between the probabilities with those landowners who have adopted agroforestry and their knowledge level. This is indicated by the significant and positive relationship of adoption of agroforestry and personal knowledge of the technology that indicates that those with knowledge are 2.5 times more likely to adopt. The cost of establishing and managing trees, the production cost borne in establishing the technology, and age, were found to have a negative and significant effect on adoption of agroforestry. If the costs were perceived high, or the landowner was older, the likelihood of adoption decreases by almost fifty percent.

Some of the variables did not support previous research of the adoption of agroforestry. Policy incentives for example, acres in CRP, and participation in other incentive programs did not increase the likelihood of adoption. Trees for future generation and trees for scenic beauty had no effect on the likelihood of adoption. Advice from non-federal conservation professionals also did not have an effect on adoption. The location and aware of timber market were also found not significant. On the other hand on-farm monetary benefit of planting trees was found positive and highly significant indicating that those who see economic gain as an important reason for investing in trees are 6.4 times more likely to adopt agroforestry. Landowners that are non-operators was also found to be significantly related to agroforestry.

Table 5.7. Parameter Estimates for Conservation Model in Logistic Regression of Landowners in Wurdack and HARC Regions in Missouri, 2006.

Variables	Regression Coefficient	Standard Error	P-Value (Sig.)	Change in Probability
Age	-.009	.012	.055*	.991
Advice from Landowner/farm operators	.151	.388	.196	1.218
Advice from non-federal conservation professionals	.120	.295	.684	1.128
Conservation magazine subscribed	.584	.316	.065*	1.993
Location	.197	.321	.538	1.218
Landowner type	.621	.316	.050*	1.861
Acres in CRP	.004	.012	.757	1.004
Participation in other incentive programs	-.179	.673	.790	.836
Cost share and other assistance	-.103	.464	.823	.902
Aware of timber market	.012	.311	.970	1.012
On-Farm Monetary benefits	1.856	.321	.000***	6.401
Own knowledge of agroforestry	.920	.311	.003***	2.508
Trees for future generation	-. 071	-.386	.854	.931
Trees for scenic beauty	-.114	.358	.751	.893
Cost of establishing and managing trees	-.532	.321	.098*	.588

*significant at α =.10, **significant at α =.05, ***significant at α =.01

Table 5.8. Empirical Model Predictive Power for the Dependent Variable in Conservation Model of Adoption.

		Predicted			
		Non-Adopted	Adopted	% Correct	% Overall Correct
Observed	Non-Adopter	215	23	90.3	
	Adopter	52	35	40.2	76.9

Table 5.9. Empirical Model Summary for Conservation Model of Adoption.

Chi-Square (p-value)	# of Observations	Nagelkerke R square
68.96(.000)	325	.278

Table 5.10. Hosmer and Lemeshow Test

Chi-Square	df	sig
3.155	8	.924

Discussion

This research focuses on identifying the characteristics that affect adoption of agroforestry practices with more attention paid to the incentive programs. It strives to provide information to policy makers, researchers and extension outreach professionals to help them understand how landowners might respond to funding programs and to understand the motivation of various types of landowners.

The explanatory variables identified in the study include the attitude and perception of trees, sources of information, incentive programs, benefits of agroforestry, transaction costs, production costs and demographic characteristics. The results of the Logit regressions showed that the variables chosen are useful predictors of adoption of agroforestry.

Differences in agricultural settings of the Wurdack and HARC regions allowed for broader application of the results to landowners through out the state of Missouri who are involved in commodity crops or livestock production. Results of the study also provided insight to the differences in perception and interest of agroforestry by landowners. This chapter provides an analysis of the study results and discussion.

Analysis of the Adoption Model

The variables chosen to represent sources of information on agroforestry available to landowners were the number of conservation magazines subscribed, advice from landowners/farm operators with experience with trees, and advice from non-federal conservation professionals. Both number of conservation magazine subscriptions and advice from landowners/farm operators with experience with trees had a significant and positive effects on adoption. Advice from non-federal conservation professions was found not to be significantly associated with adoption of agroforestry. The results showed that subscription to conservation magazine doubles the likelihood to adopt agroforestry. Furthermore, there was a slightly better than fifty-fifty chance of adoption of agroforestry practices by those receiving advice from landowners/farm operators who are knowledgeable about planting and managing trees. This means conservation magazine subscriptions and landowners/farm operators with experience with trees are the sources respondents go to in search of information about trees.

Own knowledge of agroforestry was found, as expected, to be positive and significant. The result supports previous research that states that own level of knowledge of the practices has a positive effect on the adoption of agroforestry practices. If someone

has high knowledge of agroforestry, they are two and a half times more likely to adopt agroforestry.

Age, as expected, had a negative impact on adoption as the older the respondents, the odds of their interest in adopting agroforestry decreases, though the rate of change of probability is less than one. This means that since the profitability of adoption may be a function of time, technologies requiring several years to maturity, like tree investment, were less likely to be adopted by older landowners.

The cost of establishing and managing trees was found, as expected, to have a significant and negative effect on adoption of agroforestry. Those respondents that considered production costs a constraint in establishing and maintaining trees were less likely to adopt agroforestry. The change in probability is approximately one, which means that the likelihood of adoption is less than a fifty-fifty chance. Awareness of someone using practices which represented transaction costs, was also found, as expected, to be positive and significant. Those landowners who know of other landowners using any of the practices are three and half times more likely to adopt agroforestry technology. This could be due to increased knowledge of the practices that can reduce the time used in searching for information about the technology before deciding to adopt; and also they are sure of a source to look for information concerning the market for agroforestry products.

Trees for future generations and for scenic beauty, used to represent the attitudinal factors of respondents, were found to not be significantly associated with adoption, while on-farm monetary benefit of the technology was found to be positively and highly significant. The result shows that attitudes expressed in values about future generations

and scenic beauty, of respondents in this research do not play a role in whether there will be interested in or adopt agroforestry while economic benefits does. Respondents that have achieved on-farm monetary benefits of agroforestry are five times more likely to adopt agroforestry. This result supports earlier findings by AFTA (2006), pointing to that economic benefits as the primary motivating factor in the adoption of agroforestry in the US.

Acres of land in CRP, participation in other incentive programs and cost share and other assistance were found to not be significant. These are policy variables used to assess how incentive programs affect adoption. From the survey result, the number of landowners with acreage enrolled in the various incentive programs was very small. One of the reasons for low participation and not significant relationship might be the current prices of corn that have risen sharply in response to its demand as feedstock for fuel ethanol. The significant increase in income from production of corn can be a disincentive for complying with the requirements by government incentive programs which includes putting land under trees. There is also a historical low participation in the Ozarks that may be affecting the result.

Another reason might be because the adoption model used in this study includes five practices that yield both conservation and economic benefits while the incentive programs focuses mainly on conservation benefits, this might have led to the small percentage of participants. The lack of variation in the data set hides the effect that these variables could have on landowners that have adopted agroforestry. The conservation model of adoption that includes only practices that yields conservation benefits is used as

an alternative model to test for significant relation of the policy variables with adoption of windbreak and riparian buffers (results below).

Location, chosen to allow for differences in terms of production system, was found not to be significantly related to adoption while landowner type was found to be significant. Non-operators are one and half times more likely to adopt agroforestry than operators due to the fact that they place a high importance on environmental and recreational aspects of their land and have a smaller percentage of land under crops. The reasons above are consistent with Arbuckle et al. (2005) study of Missouri landowners who are non-operators. Those landowners who have closer ties to farming and strong financial motivations are less interested in agroforestry, while those that place a high importance on environmental and recreational aspects of their land are more interested in agroforestry as a potential land use application. They also found that those who participate in farming activities and have a larger percentage of land under crops were considerably less likely to be interested in agroforestry practices. From the survey, 17.8% of non-operators indicated they have land under row crops, while 30.1% of operators indicated they have land planted to row crops. From the profile of landowners in table 4.4, more of non-operators listed natural resources benefits for their land compared to operators. Out of the 112 adopters, 50 were operators and 62 were non-operators.

Analysis of the Conservation Adoption Model

The variables chosen to represent sources of information were the same variables used for the adoption model. In this model, only the number of conservation magazine subscriptions was found significant with adoption while advice from landowners/farm

operators with experience with trees and receiving advice from non-federal conservation professionals was found not to be significant. The results showed that if someone subscribed to conservation magazine, they are two times more likely to adopt agroforestry practices with conservation benefits. This means conservation magazines are the source they are more comfortable with and most likely to use to get information about trees.

Own knowledge of agroforestry was found, as expected, to be positive and significant. These results support previous research, that knowledge of the practice has a positive effect on the adoption of agroforestry practices. Own knowledge of the practice was found correlated with awareness of someone using the practices. When both were run together in the Logistic model, own knowledge was found to be not significant (Appendix C). When awareness was removed from the model, own knowledge became significant which proves that one is affecting the other, pointing to multicolinearity.

Age, also as expected, had a negative impact on adoption of the two traditionally considered conservation agroforestry practices, windbreak and riparian buffers. That means the older the respondents, the odds of their interest in adopting agroforestry decreases with a change of probability less than one. This means seeing agroforestry in terms of tree investment were less likely to be adopted by older landowners because of the time frame involved in production.

Location, chosen to allow for differences in terms of production systems, was found not to be significantly related to adoption of windbreak and riparian buffers while landowners who are non-operators was found to be significant. Non-operators are 1.9 times more likely to adopt windbreak and riparian buffers than operators due to the fact that they place a high importance on environmental and recreational aspects of their land and have a smaller

percentage of land under crops. The reasons above are consistent with Arbuckle et al. (2005) study of Missouri landowners who are non-operators. Those landowners who have closer ties to farming and strong financial motivations are less interested in agroforestry, while those that place a high importance on environmental and recreational aspects of their land are more interested in agroforestry as a potential land use application. They also found that those who participate in farming activities and have a larger percentage of land under crops were considerably less likely to be interested in agroforestry practices.

The cost of establishing and maintaining trees was also found, as expected, to have a significant effect on the two conservation agroforestry practices, windbreak and riparian buffers. Those respondents that considered production costs a constraint in establishing and maintaining trees were less likely to adopt these practices. The change in probability is approximately one, which means that the likelihood of adoption is less than a fifty-fifty chance.

Trees for future generations and for scenic beauty, used to represent the attitudinal factors of respondents, were found to not be significantly associated with adoption of windbreak and riparian buffers, while on-farm monetary benefit of the technology was found to be positively and highly significant. The result shows that attitudes expressed in values about future generations and scenic beauty, of respondents in this research do not play a role in whether there will be interested in or adopt these practices while economic benefits does. Respondents that have achieved on-farm monetary benefits of agroforestry are 6.4 times more likely to adopt these practices. This result supports earlier findings by AFTA (2006), pointing to that economic benefits as the primary motivating factor in the adoption of agroforestry.

The three policy variables, acres of land in CRP, participation in other incentive programs and cost share and other assistance were found not significant as with the model with the five practices. The reasons for not significant effect might also be the current prices of corn that have risen sharply in response to its demand as feedstock for fuel ethanol.

Chapter VI

Conclusion, Limitations and Recommendations

Conclusion

The objective of the study was to identify and evaluate those factors influencing the adoption of agroforestry. The results of this research have shown that landowners in Missouri have adopted agroforestry practices that provide both conservation and economic benefits with and without government incentives.

Own knowledge of agroforestry practices was positively and significantly associated with agroforestry adoption. This supports previous research that prior knowledge of technology has been shown to increase interest and adoption of agroforestry. Since knowledge has been shown to be so important, it is necessary to provide access to information to landowners in an attempt to increase their knowledge of agroforestry practices. Almost 90% of landowners will subscribe to magazines in seeking information about tree management. Furthermore, 30.4% of respondents would go to university extension while about 15% would go to landowners or fellow farmers who have experience with trees. MDC is next after university extension in terms of where landowners would like to seek advice about planting and managing trees with about 32%. The NRCS was low with a score of 5%. Magazine subscription and contact with landowners/ farm operators were found to be significant. These highlight the role of building strong partnerships and networks among landowners and passing information through conservation magazines as mechanisms to share

information that enhances knowledge about agroforestry, and should be explored as an avenue for extension.

The policy variable in the research, used to determine the effects of the incentive programs on adoption, was not significant. Out of the 112 adopters, 78.6 percent have not participated in any incentive programs, while 21.4 percent have. We can conclude that participation in incentive programs is not the experience of the majority of landowners at least in these two regions, and were not instrumental in promoting agroforestry.

On-farm monetary benefits of planting trees were found positive and highly significant among all other factors. From the profile of landowners, economic benefits ranked the second highest when asked the landowners to indicate how important various benefits would be to them if considered planting trees while most of the obstacles landowners listed that can influence their interest in investing in trees are reasons that have to do with the cost and profitability. This support findings by AFTA (2006), pointing to economic gain as the primary motivating factor in the adoption of agroforestry in the US.

Limitations and Recommendations

The variables that were selected to represent transaction costs are awareness of someone using the practices and awareness of timber market in your area. One of the limitations of the research was that there were insufficient variables that adequately describe the transaction costs because when the survey questions were being prepared, questions on transaction costs were not considered. More research is needed to address the issue of transaction costs. In the future, it will be important to create survey questions that capture transaction costs to see

how it affects adoption of agroforestry. Another line of research is to investigate the transaction costs borne by farmers and landowners to comply with program guidelines or regulations that are necessary to fully evaluate conservation programs. This will allow the government to determine if these programs conflict with the characteristics of today's divers landowners.

Another limitation of the research was that the variable used to represent the production cost of agroforestry was designed in the survey as a perception question and not actual costs, and thus it is limited in its representation of production costs. Further research is needed to compare landowner's perceptions to reality, which could make the practical application of the finding more relevant for extension of agroforestry adoption.

The variable participation in other incentive programs was selected to represent the policy variable. From the Logit regression result, the predictive power was very low. It is possible that more of the effect can be captured if it is incorporated as a continuous variable instead of a yes or no variable, for example, number of acres in other incentive programs.

From the survey results, we observed that the rate of participation in the government programs was very low and the variables were found not significant. Complexity of the programs and reduced capacity of agencies to deliver such programs has been a complaint. It will be worth while for government to loosen eligibility requirements to allow more landowners to participate in the program and increase adoption. Another reason of low participation in the incentive programs might be the significant increase in income from production of corn that can be a disincentive for complying with the requirements by government incentive programs which includes

putting land under trees. The government can look for ways, for example increased subsidies, to make practices more profitable that can encourage landowners to adopt despite the high price of corn.

Most variables representing sources of information and personal knowledge of agroforestry were found to be significant. Since one of the aims of agroforestry research is to increase adoption of agroforestry, it is recommended that the federal and state government should invest in research that provides the underlying science and should strengthen and support the work of those who deliver agroforestry information and those who apply agroforestry practices on-the- ground. One of the ways can be educating landowners by on-site demonstration to increase their knowledge of the practices that could be beneficial to them as an initial stage in the adoption process.

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Appendix A: Survey Questions

Attitude and Perception of trees:

1) If you were to consider planting trees on your property, please indicate how important each of the following potential benefits would be to you? (4 = very important, 3 = moderately important, 2 = slightly important, 1= unimportant)

a. Wind protection
b. Wildlife
c. Scenic beauty
d. Economic benefits
e. Protect water quality
f. Erosion control
g. For future generations
h. Flood protection
i. Tax benefits
j. Carbon Sequestration

Benefits of the technology:

1) What were your top 3 reasons for planting these trees?

Transaction Costs:

1) Are you aware of timber markets in your area? 1 = yes 0 = no

2) Do you know anyone who has used any of the following practices?
1=yes 0 = no

Production Costs:

1) The following is a list of potential obstacles to planting trees. Please indicate how much influence each of the factors would have in reducing your interest in planting trees. (5 = very large influence, 4 = large influence, 3 = moderate influence, 2 = little influence, 1 = no influence)

a. Costs of establishing and managing trees

Participation in Incentive Programs:

1) How many acres of land do you have enrolled in the Conservation Reserve Program (CRP)?

2) How many acres of land do you have enrolled in the Environmental Quality Incentives Program (EQIP)?

3) How many acres of land do you have enrolled in the Wildlife Habitat Improvement Program (WHIP)?

4) How many acres of land do you have enrolled in the Wetlands Reserve Program (WRP)?

5) Have you received any Natural Resources Conservation Service (NRCS) cost share or assistance for conservation practice establishment? 1 = yes 0 = no

6) Have you received any Soil and Water Conservation District (SWCD) cost share or other assistance for conservation practice establishment? 1 = yes 0 = no

7) In the last five years, have you received any MDC cost share or other assistance for conservation practice establishment? 1 = yes 0 = no

Demographic Characteristics:

1) In 2005, how many acres of land did you own?

2) How old were you on your last birthday?

3) How many years of education have you completed?

For example:
12 years = High school graduate or G.E.
16 years = College graduate
20 years = PhD

4) How would you rate your level of knowledge about the following, with 5 equaling very high and 1 equaling very low? (5 = very high, 4 = high, 3 = medium, 2 = low, 1 = very low)

a. Alley cropping
b. Windbreak(s)
c. Riparian/stream bank plantings
d. Silvopasture
e. Forest farming

Sources of Information:

1) Please list any agriculture, forestry or conservation magazines you currently subscribe to? (Include online subscriptions) List in order of importance of usefulness for informing your decisions about farming.

2) Please indicate, in order of importance, the top three groups you would prefer to seek advice from if you were going to plant or manage trees. (Use 1, 2, and 3 with 1 being the highest).

1 = University Extension
2 = Landowners/farm operators who have experience with trees
3 = Local Soil and Water Conservation District (SWCD)
4 = Natural Resources Conservation Service (NRCS)
5 = Missouri Department of Conservation Resource Forester/Private Land Conservationist.

Appendix B: Correlation Matrices

Perception of trees

	Wind protection	wildlife	Scenic beauty	Economic benefits	Protect water quality	Erosion control	For future generation	Flood protection	Tax benefits	Carbon sequestration
Wind protection	1	.307**	.310**	.152**	.287**	.237**	.262**	.245**	.287**	.231**
Wildlife		1	.556**	I97**	.464**	.440**	.454**	.183**	.262**	.330**
Scenic beauty			1	.155**	.390**	.423**	.348**	.311**	.280**	.402**
Economic benefits				1	.335**	.265**	.355**	.235**	.401**	.242**
Protect water quality					1	.649**	.539**	.448**	.380**	.417**
Erosion control						1	564**	442**	335**	424**
For future generation							1	307**	334**	388**
Flood protection								1	355**	377**
Tax benefits									1	372**
Carbon sequuestration										1

Benefits of the technology

	On-farm monetary benefits	On-farm environmental benefits	Off-farm environmental benefits
On-farm monetary benefits	1	.376**	.230**
On-farm environmental benefits		1	.202**
Off-farm environmental benefits			1

Sources of information

	Advice from University Extension	Advice from landowner/farm operators	Advice from non-federal conservation professionals	Advice from federal conservation professionals	Conservation magazines subscribe	Production/lifestyle magazine subscribe
Advice from University Extension	1	.165**	-.510**	.042	.009	.099
Advice from landowner/farm operators		1	.077	.161**.	.067	006
Advice from non-federal conservation professionals			1	.185**	073	-.078
Advice from federal conservation professionals				1	-.008	.049
Conservation magazines subscribe					1	-476**
Production/lifestyle magazine subscribe						1

Transaction costs

	Aware of Timber market	Knowing someone using agroforestry practices
Aware of timber markets	1	.091
Knowing someone using agroforestry practices		1

Participation in incentive programs

	Acres of land in CRP	Participation in other incentive programs	Cost share and other incentives received from government agencies
Acres of land in CRP	1	.292**	.224**
Participation in other incentive programs		1	.432**
Cost share and other incentives received from government agencies			1

Individual characteristics

	Farm size	Age	Education	Own knowledge of agroforestry	Location of respondent	Type of respondent
Farm size	1	-.007	-.054	.057	.086	253**
Age		1	.322**	-.037	-.055	-.031
Education			1	.031	.143**	-.099
Own knowledge of agroforestry				1	.132*	.009
Location of respondent					1	.047
Type of respondent						1

Appendix C

Table C.1. Parameter Estimates for Adoption of Agroforestry Logistic Regression Model (with five practices).

Variables	Regression Coefficient	Standard Error	P-Value (Sig.)	Change in Probability
Age	-.015	.012	.232	.985
Education	016	.058	.787	1.016
Advice from Landowner/farm operators	.315	.379	.109	1.371
Advice from non-federal conservation professionals	-.004	.293	.990	.996
Conservation magazine subscribed	.342	.309	.023**	1.617
Location	.085	.326	.795	1.088
Landowner type	.419	.321	.095*	1.521
Acres in CRP	-003	.012	.790	.997
Participants in other incentive programs	.270	.635	.670	1.311
Cost share and other assistance	-.236	.464	.610	.789
On-Farm Monetary benefits	1.678	.326	.000***	5.353
Own knowledge of agroforestry	.920	.352	.009***	2.510
Knowing someone using agroforestry	1.261	.309	.000***	3.528
Aware of timber market	.023	.310	.940	1.024
Benefits of Trees for future generation	.017	.388	.966	1.017
Trees for scenic beauty	-.462	.369	.211	.630
Costs of establishing and managing trees	-.535	.316	.091*	.586

*significant at α =.10, **significant at α =.05, ***significant at α =.01. Source: Landowner survey, 2006

Table C.2. Parameter Estimates for Adoption of Agroforestry Logistic Regression Model (with windbreak and riparian buffers).

Variables	Regression Coefficient	Standard Error	P-Value (Sig.)	Change in Probability
Age	-.005	.008	.053*	.995
Advice from Landowner/farm operators	.246	.402	.147	1.273
Advice from non-federal conservation professionals	.104	.305	.732	1.110
Conservation magazine subscribed	.573	.326	.069*	1.911
Location	.091	.331	.784	1.095
Landowner type	.453	.326	.060*	1.573
Acres in CRP	.002	.012	.880	1.002
Participation in other incentive programs	-.401	.697	.555	.070
Cost share and other assistance	.086	.473	.855	1.090
Aware of timber market	.-030	.321	.925	.970
On-Farm Monetary benefits	1.975	.337	.000***	7.209
Own knowledge of agroforestry	.519	.332	.118	1.680
Know anyone using practices	1.310	.331	.000***	3.707
Trees for future generation	-. 103	.396	.795	.902
Trees for scenic beauty	-.472	.377	.210	.624
Cost of establishing and managing trees	-.573	.335	.087*	.564

*significant at α =.10, **significant at α =.05, ***significant at α =.01. Source: Landowner survey, 2006.