2013

Assessment Of The Adoption Of Agroforestry Technologies By Limited-Resource Farmers In North Carolina

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by

Limited-Resource Farmers in North Carolina

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A thesis submitted to the graduate faculty

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Department: Agribusiness, Applied Economics, and Agriscience Education

Major: Agricultural Education

Major Professor: Dr. Paula E. Faulkner

Greensboro, North Carolina

2013

School of Graduate Studies
North Carolina Agricultural and Technical State University
This is to certify that the Master's Thesis of

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has met the thesis requirements of
North Carolina Agricultural and Technical State University

Greensboro, North Carolina
2013

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Biographical Sketch

Bismark K. T. Owooh is the son of the late Mr. Robert Ansah Owooh and Madam Ama Tsiwa, all of blessed memory, may their souls rest in perfect peace. He was born February 16, 1962 in Gomoa Mankesim in the central region of Ghana. He received his Bachelor of Science degree in Agricultural Education at The University of Education Winneba in 2006. He worked as a teacher at Hwidiem High School in the Brong Ahafo Region of Ghana from 2006 to 2009. He is a candidate for the Masters of Science degree in Agricultural Education.

Dedication

I dedicate this thesis to Mr. Kweku Atta and Ms. Karla Loa Lyles for the confidence and encouragement they provided me during my course of study. I really appreciate their support.

Acknowledgements

I would like to thank God for providing me with the knowledge, strength, and determination for completing this study. I would like to extend my deepest gratitude to North Carolina Agricultural State University Cooperative Extension for the financial support for completing this study. I am grateful to my academic adviser, Dr. Paula E. Faulkner who has been my constant source of wisdom, helpful criticism and advice, encouragement and support throughout the period of my research. I have learned a great deal working with her and it has been an honor. My sincere gratitude also goes to my committee members, Dr. Joshua Idassi of the North Carolina Agricultural and Technical State University Cooperative Extension Program, Dr. Terrence Thomas and Dr. Chastity Warren-English of the Department of Agribusiness, Applied Economics and Agriscience Education for their guidance in producing this piece of work. Special thanks go to Dr. Antoine J. Alston, program coordinator, for the Agricultural Education Program for his counseling. I will like to acknowledge my brother J. M. K. Owooh and Ms. Karla Loa Lyres for their love care and support, without them my dreams would not have materialized. I would like to thank my fellow research students in C.H. Moore and all the students who worked with me on the agroforestry demonstration field; I really appreciate your help. My sincere thanks go to my family members, my dear wife Cecilia, and my children Obed Owooh, Ewurama Owooh, and Shadrack Owooh for their prayers. To my friend Eric Ofori Akuamoah, I say a big thank you for the support you provided to make my dream come true. Many thanks also go to the limited-resources farmers in North Carolina, without them this thesis would not have been possible.

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Abstract

The study was conducted to assess the awareness regarding the adoption of agroforestry technologies of limited-resource farmers in North Carolina. Agroforestry technologies are part of the solutions to challenges that limited-resource farmers are faced with. The adoption of these technologies is critical if an impact on the livelihood of limited resource farmers will occur. A survey was used to collect data from the farmers. The study found that farmers lacked ample information on the benefits of agroforestry technologies. In regard to the barriers for adopting the technologies, most farmers reported there were no markets for products, expenses for additional resources, lack of technical assistance, lack of demonstration sites, insufficient land, and lack of seedlings.

The respondents reported a need for obtaining information on agroforestry technologies. Based on the findings, it was concluded that while farmers exhibited limited knowledge about agroforestry technologies, more education should be provided to fully explain the benefits of agroforestry technologies. It is recommended that limited resource farmers be provided with equipment and other agricultural inputs to remove the barriers for agroforestry adoption. More importantly, agricultural policies should be enacted to address their needs and ensure agroforestry is a part of the agriculture agenda for improving their financial well-being.

CHAPTER 1

Introduction

1.1 Background

No matter how elegant, efficient, productive, or ecologically sustainable agroforestry systems can contribute to sustainable land use only if they are adopted and maintained over a long period of time (Raintree, 1983; Scherr, 1992). Although there are examples of significant cases of adoption practices over the past two decades (Barrett, Place, & Abdud, 2002; Current, Lutz, & Scherr, 1995; Franzel & Scherr, 2002), many have lamented the fact that adoption and diffusion have lagged behind the scientific and technological advances in agroforestry research, reducing the potential impacts of agroforestry-based development projects (Alavalapati, Luckert & Gill, 1995; Andesina & Chianu, 2002; Bannister & Nair, 2003). As a result, research studies conducted related to the adoption of agroforestry innovations by farmers have attracted much attention and generated a relatively amount of literature on this subject in the past decade.

The approaches used to analyze agroforestry adoption technologies tend to follow the vast literature on adoption of agricultural production technologies, most of which focus on new or improved production inputs (e.g. Green Revolution inputs) for conventional agricultural crops (Feder & Umali, 1993). The adoption of agroforestry is considerably more complex than traditional agriculture because it usually requires establishing a new input-output mix of annuals, perennials, green manure, fodder, and other components combined with new conservation techniques such as contour hedgerows, alley cropping, and enriched fallows (Amarcher, Ersado, Hyde, & Haynes, 2004). Unlike standard agriculture, there are few packaged agroforestry or farm-based, natural resource management (NRM) practices to deliver to farmers (Barrett, Place, & Abdud, 2002). As a result, agroforestry and other NRM practices are typically more

knowledge-intensive than modern agricultural development packages based on improved seed, chemical, and/or mechanical inputs. Therefore, farmer education, experimentation, and modification are more important for agroforestry and NRM development than for conventional agriculture (Barrett et al., 2002). Most research related to adoption practices supports the notion that decisions to adopt resource-conserving practices like agroforestry are largely driven by expected contributions to increased productivity, output stability through risk reduction, and enhanced economic viability compared to the alternatives (Salam, Noguchi, & Koike, 2000). Pattanayak, Mercer, Sills, Yang, and Cassingham (2002) conducted a meta-analysis of multiple regression based agroforestry studies that examined the broader adoption literature that assessed the current state of knowledge small farm owners possess on agroforestry adoption. They found that farmers should be provided with more information and training on agroforestry relative to other agricultural activities, which limits the utilization of some practices.

1.2 History of Innovation and Adoption of Agroforestry

From a sociological viewpoint, an innovation is an idea, practice, or object that an individual perceives as new. Since the focus is on the perception of the idea, the innovation needs only be 'new' to the potential adopter. This premise suggests that adoption is the mental process from the individual first hearing about an idea to deciding to make full use of the new idea. However, Evans (1988), Feder & Zilberman (1985) and Rogers (1995), argued that sociological definitions of adoption are usually inadequate for 'rigorous theoretical and empirical analysis' due to its imprecision and failure to distinguish individual or farm-level adoption from aggregate adoption. From an economic standpoint, an innovation is a technological factor of production with perceived and/or objective uncertainties about its impact on production. Farmers reduce uncertainty over time by acquiring experience, modifying the innovation, and

becoming more efficient in its application. Therefore, economists have defined the final adoption at the farm level as 'the degree of use of a new technology in the long-run equilibrium when the farmer has full information about the new technology and its potential' (Feder & Zilberman, 1985). The adoption of agroforestry technologies has typically been viewed from two perspectives. For instance, at the individual farm level, technologies involve each household deciding whether or not to adopt and at what intensity. Farm-level adoption research studies are concerned with determining the factors that influence adoption decisions by incorporating the learning and experience of an individual for the adoption. An agroforestry technology, which has emerged in recent years for the containment of animals, is the live hedge. A live hedge (distinct from live fence) refers to one or more rows of trees closely planted (1 foot or 2 feet apart) to form a continuous barrier around the desired area. The rows may contain one or several types of species, and the entire hedge is usually cut at an appropriate barrier height (Budowski, 1993).

1.3 Policy on Agroforestry

The Farm Bill on Food, Conservation, and Energy Act was passed on June 18, 2008. The legislation provides opportunities for landowners to receive financial support to use forestry and agroforestry through the efforts of USDA programs. The 2007 Farm Bill outlines a number of policies for Agroforestry adoption. These policies are implemented to support the benefits of Agroforestry in the United States. The policies include: 1- Risk Mitigation: Involves making loan protection and crop insurance available for agroforestry and other alternative cropping systems this means that it will not have any result on farmers incurring additional risk to plant non-traditional commodity crops and maintaining crop histories for implementing agroforestry options that could further mitigate risk; 2- Producer Investment Costs: The cost of agroforestry

technologies requires different equipment than used with conventional cropping systems. Financial assistance is necessary to offset initial capital investment for long-term crops that can then be harvested throughout the years; 3-Research Funding: Involves sustained funding that is needed for research to be conducted on new crop production systems and its management. It provides seed funding for research for high potential crops and its processing and marketing that will facilitate the development of new markets, research and development by the private sector; 4-Technology Development: Government support is imperative for initiating and sustaining research that can provide important future, economic, and environmental benefits. Soybeans, for example, were considered an alternative crop for more than a century until government support launched them into the spotlight and encouraged adoption by private industry; 5-Market Research: Involves research on production and processing that is accompanied by market research to match production to the demand that will drive adoption and provide development opportunities for natural communities; 6- Payments for Environmental Services: Involves targeted payments that can help offset start-up crops and contribute to environmental quality. Agroforestry must be explicitly incorporated into US policy on greenhouse gases, climate change, and air quality; and 7- Recognition: For these benefits to be realized, agroforestry technologies must also become recognized more widely as an important land management option. This can be accomplished by incorporating agroforestry practices into relevant legislation, promoting and distributing information on such practices, and encouraging the implementation of agroforestry provisions at a local and regional level (Jolliff, 1999).

1.4 Policy solutions

According to Jolliff (1999) groups of farmers committed to socially, economically, and environmentally sustainable development must work together to meet the aforementioned needs

by promoting the following policy changes for agroforestry: 1-Incorporate Agroforestry into existing programs by expanding the Conservation Security Program (CSP) and Environmentally Quality Incentives Programs (EQIP) that pay farmers for conservation practices such as erosion control and watershed protection on working lands; 2-Fully fund and expand Forest Land Enhancement Programs (FLEP) to reward a broader range of agroforestry practices; 3-Incorporate agroforestry options into payment-for-environmental-service programs and; 4-Create new programs and promote the active implementation of agroforestry practices on a local or regional level (e.g. Natural Resource Conservation Services (NRSC), Soil and Water Conservation Districts (SWCD), and Resource Conservation and Development (RC&D).

Limited-resource farmers as the name implies are farmers who operate at a disadvantage in terms of their ability to compete in modern agricultural system. They are characterized as having lower net farm incomes and farm smaller acreage than other farmers. They also tend to have poor access to information, technology and capital and have labour-intensive operations that rely on family labour. Despite the challenges faced by limited-resource farmers, they constitute quite a substantial part of the US agricultural community (Kingslow, 1990).

1.5 Problem statement

Limited-resource farmers are faced with the difficult challenge of making their farm business economically viable. Recently, it has been suggested that agroforestry may offer an investment opportunity for limited-resource farmers to improve their economic position. If agroforestry offers a real opportunity, as suggested, efforts should be made to encourage limited-resource farmers to invest in agroforestry. Before launching any program to encourage limited-resource farmer investment in agroforestry, it is advisable to first determine how farmers feel

about investing in agroforestry, establish their level of knowledge of agroforestry and determine their willingness to invest.

1.6 Significance of the Study

The continual awareness of limited-resource farmers to the growing industry of agroforestry technology and how the industry impacts the community is vital to the future of North Carolina's agroforestry growth and the improved viability of poor resource small farmers. The positive view of agroforestry technology will not only be beneficial in improving the livelihood of limited-resource farmers, but it is also essential in enhancing environmental conservation. This uniqueness of agroforestry is likely to influence adoption in a different way and hence the need for further investigation.

1.7 Objectives

The general objective of this study was to assess if limited-resources farmers in North Carolina understand and perceive agroforestry as a business opportunity with the potential to increase their farm income and enhance environmental conservation, and to identify the factors that influence limited-resources farmers and woodland owners' decisions to adopt technologies. The following are the research questions that were intended to be addressed in this study:

1. What do limited-resource farmers know about agroforestry technologies?

2. What are the benefits limited-resource farmers perceive they will receive from adopting agroforestry technologies?

3. What are the barriers limited-resource farmers report for adopting of agroforestry technologies?

4. What is the degree of willingness of limited-resource farmers for investing in agroforestry as an investment opportunity?

CHAPTER 2

Literature Review

Agroforestry is a dynamic, ecologically based, natural resource management system that through the integration of trees on farms and the agricultural landscape diversifies and sustains production for increased social, economic, and environmental benefits for land users at all levels. Agroforestry entails planting trees on farms. Compared to single output systems (monoculture), agroforestry systems have a number of advantages, as reported by landowners in certain areas (Cairnes & Garrity, 1999; Dakora & Kenya, 1997). Additionally, agroforestry can be simplified to be a practice of growing trees with agricultural crops and/or livestock on the same piece of land (Anderson, Bidwell, & Roman, 1991).

Several studies have been conducted on the benefits of adopting agroforestry technologies and have found that there are significant benefits attributed to landowners adopting agroforestry.

According to Cairnes & Garrity (1999) and Dakora & Keya (1997), landowners have reported both financial and non-financial benefits from adopting agroforestry technologies. Financial benefits include: 1-an increase in the use of the available land; 2- the reduction in time between cash flows, and 3-shared resources, such as fertilizers and herbicides between multiple outputs. In addition to these financial benefits (Cairnes & Garrity, 1999; Caviglia & Kahn, 2001; Dakora & Keya, 1997) it has been indicated that agroforestry is considered to be more compatible with society's ecological and environmental goals than monoculture agriculture. Agroforestry in this respect may contribute to: 1-increasing species diversity; 2-reforestation; 3-reducing the use of chemical agents on the farm and 4-improving soil fertility.

2.1 Agroforestry technologies

According to Beetz (2011), agroforestry technologies in the US include alley cropping, silvopasture, windbreaks and shelterbelts, riparian buffer strips and forest farming (special forest products).

2.1.1 Alley cropping. The Center for Agroforestry at the University of Missouri (2009) describes alley cropping as planting rows of trees at wide spacing while a companion crop grows in the alleyways between the rows. Alley cropping can diversify farm income, improve crop production, and provide protection and conservation benefits to crops. Examples of alley cropping plantings include wheat, corn, soybeans or hay planted in between rows of black walnut or pecan trees. Crops or forages grown in the alleys and nuts from walnut, pecan and chestnut trees provide an annual income from the land while the longer-term wood crop matures. Specialty crops (e.g. herbs, fruits, vegetables, nursery stock, and flowers) can be grown in alleys, utilizing the microclimate created by trees to boost economic production from each acre (Workman & Allen, 2003).

2.1.2 Silvopasture. Anderson, Bidwell, and Roman (1991) found that silvopasture involves the grazing of livestock and growing of trees on the same piece of land. It can be developed by establishing trees in existing pastures or by establishing pastures with trees under existing tree stands. The system can be arranged in unlimited combinations of livestock and tree components, enabling farmers to use all types of areas not easily farmed by more structured or mechanical methods.

Silvopasture can be established by adding trees to existing pasture or by thinning an existing forest stand and adding or improving a forage component. Trees are managed for high-value timber or saw logs and at the same time they provide shelter for livestock, reduce heat

stress and improve food and water consumption. In the winter, the protection of trees reduces cold stress; therefore, animals do not lose as much energy keeping warm and are able to gain more weight. Forage and livestock provide short-term income at the same time a crop of high-value sawlogs is being grown, providing a greater overall economic return from the land (Workman & Allen, 2003).

2.1.3 Riparian forest and upland buffer. Riparian forest and upland buffers are living filters comprising of trees, shrubs, and grasses, including native plants. Riparian forest and upland buffers protect the water quality of streams and lakes and are effective tools for controlling erosion and providing food and cover for wildlife (Garrett & McGraw, 2009).

At times riparian forest buffers are described as strips of permanent vegetation, consisting of trees, shrubs, and grasses, planted or managed between agricultural land usually cropland or pastureland and water bodies (e.g. rivers, streams, creeks, lakes, wetlands) to reduce run-off and non-point source pollution. Forest buffers are usually planted in three distinct zones near an agricultural stream for stabilizing stream banks, improving aquatic and terrestrial habitats, and providing harvestable products (Workman & Allen, 2003).

2.1.4 Windbreaks. Long, Jordan, and Clingerman (2005) define windbreaks as the system of growing trees or woody species in a line formation (often as a fence) to provide protection to crops, animals and people from wind, snow, soil erosion, and the sun.

The landowner receives benefits from trees, such as economic savings from reducing energy costs from heating, and cooling buildings, improving crop yields, and the protection of roads and highways from drifting snow.

Windbreak practices (e.g. shelterbelts, timber-belts, hedgerows, and living snow-fences) are planted and managed as part of a crop or livestock operation to enhance crop production,

protect crops and livestock, manage snow distribution, and/or control soil erosion. In general, field windbreaks are used to protect a variety of wind-sensitive row crops, forage, tree, and vine crops to control soil erosion, and provide other benefits such as improved insect pollination of crops and enhanced wildlife habitat (Workman & Allen, 2003).

2.1.5 Forest farming. When a natural forested area is managed both for wood products and as an additional enterprise, it becomes a forest farming system. Woodlands can generate income from many products other than timber and pulpwood. Established forests offer many non-timber special forest products that can contribute to cash flow without requiring the one-time harvest of old trees. For example, landowners can manage established woods to encourage naturally occurring patches of berries and bittersweet or they could plant understory crops such as ginseng or goldenseal that are adapted to the forest type and climate.

Growing mushrooms on logs is another more labor-intensive, or possibility a canopy of either hardwoods or pine which could provide shade needed to maintain moisture for fruiting. Harvesting berries and vines for crafts or basketry are examples of products that can be marketed without costs of establishment. On the production end, it may require only that the canopy be managed for optimal light conditions. Examples of non-timber forest products include: fruits, nuts, and berries; maple syrup; honey and other hive products; aromatics; mushrooms; fence posts, firewood, and smoke wood; herbs and medicinal plants.

2.2 Benefits of adopting agroforestry technologies

Agroforestry plays an important role in revitalizing rural America. Both the need and opportunities provided by agroforestry are overwhelming (Garrett, 2002). Agroforestry provides a different land use option, compared with traditional arable and forestry systems. Agroforestry can meet the specific needs of the landowner and society while preserving the integrity, stability

and beauty of the family farm. It is a practice that respects the environment and has an obvious landscape benefit. For instance, landscaping can be a good source of exercise that is not vigorous or physically straining. This is an additional aspect that becomes more important as individuals become older. It may not be the case if lifting heavy landscaping items, but there are many activities to keep one busy which is easy and manageable by all ages (Garrett, 2002). Agroforestry allows for the diversification of farm activity and makes better use of environmental resources.

2.2.1 Economic value. As a new product diversification, tree products such as wood, pulp or oils provide new income streams to buffer against the cyclical downturns in the profitability of farm enterprises. In this case, trees are planted for their direct cash value. Supplementary Income: One unique characteristic of integrated farming system in general and agroforestry in particular, is the promotion of a traditional subsidiary occupation. This is due to the availability of raw materials for these activities. As a result, farmers initiated many subsidiary ventures like basket making, mat weaving, and bamboo crafts. These subsidiary occupations added to the total family income generated from the farmers (Gangadharappa, Shivamurthy, & Ganesamoorthi, 2003). Employment: North America, Western Europe, and developed Asia-Pacific account for about 30 percent of global employment and the majority of global value-added and forest products exports (e.g. 85 percent of value-added and 76 percent of exports).

As would be expected, for almost all measures of productivity (e.g. production, value-added or exports per Cubic meter/ Metric ton (CUM/MT), per hectare of forest or per employee), the forestry sector in these three regions performs at a level that is well above the global average (FAO, 2004).

2.2.2 Environmental benefits. In agroforestry, the incorporation of multiple species into production systems intrinsically results in a high biodiversity compared to monocultures. In monocropping, ecosystems are extremely simplified by human manipulation to favor the production of single plant species. For intensive timber plantations often the same applies. Agroforestry systems, through multi-species and structural diversity add complexity to agro-ecosystems, bringing them closer to nature. Such systems can be seen as an interface between nature and agriculture, providing new niches and opportunities for wildlife that do not exist in monocultures. Various studies have found that natural fence lines, windbreaks, and intercropping systems act as important refugia and corridors for wildlife and show increased numbers of animals such as birds and insects and small mammals (Williams, Gordon, Garrett, & Buck, 1997).

According to the Workman, Bannister, and Nair (2003), agroforestry protects resources and conserves beauty. The resource base (quality of soil and water resources) of the farm must be protected and enhanced so that traditional farming enterprises can survive in long-term. Trees may be planted to address wind and water erosion and salinity. The primary purpose of planting trees is to ensure the long-term viability of enterprises. Trees add horizontal and vertical structure to the landscape and provide new niches for other plants and animals. Trees can be planted to buffer remnant vegetation, provide wildlife corridors, and make the landscape more aesthetically pleasing for human habitation.

Several studies have been conducted to assess the perception of agroforestry by south-eastern small and wood landowners. During spring 2001, The Center for Subtropical Agroforestry (CSTAF) extension staff documented the adoption of agroforestry practices throughout the south-eastern region. The information was gathered by conducting field

observations, interviews with extension personnel foresters, and with university faculty and with producers during farm visits.

In 2001, natural resource professionals, extension and forestry personnel were presented with a list of potential benefits and asked to rank the importance of use of agroforestry from lowest to highest. Workman and Allen (2003) found that wildlife habitat and water quantity were ranked as the most important benefits, with influence on water quality, and long term investment following close behind. The only significant differences between the rankings were that professionals in Florida perceived soil conservation as less of a beneficial than their counterparts in Alabama and Georgia.

In a study conducted by Zinkhan and Mercer (1997) that examined Florida landowners' perception of agroforestry found that they valued aesthetics and that shade for livestock was the most important benefits of agroforestry. In a study conducted by Schuren (2005) the existence of marketing factors posed a great constraint to successful tree adoption by small holders. Farmers found it difficult to reach markets with their products, and most often they received low prices in comparison to middlemen wholesalers and retailers.

2.3 Diffusion theory of adoption process

When examining the factors that cause an individual to choose to or not to adopt practices, it is important to understand when they choose to adopt, the reasons that cause such to occur. To examine these reasons, the diffusion theory of adoption was examined and found that according to Rogers (1995), the diffusion of an innovation occurs via a five–step decision-making process.

The process occurs through a series of communication channels over a period of time among the members of a similar social system. Rogers categorizes the five stages as: knowledge,

persuasion, decision, implementation, and confirmation. It is noted that an individual may reject an innovation at any time during or after the adoption process is initiated.

2.3.1 Stages of the adoption process. Knowledge involves an individual being exposed to an innovation for which there is no prior knowledge about the innovation. During this stage, the individual has not been inspired to find or learn more information about the persuasion. During this stage, the individual is interested in learning about the innovation. The next stage is Decision, when the individual weighs the advantages and disadvantages of the innovation and makes the decision whether to adopt or not adopt the innovation. Due to the individualistic nature of this stage, Rogers noted that it was the most difficult stage to acquire empirical evidence (Rogers, 1995). Implementation involves the individual employing the innovation at varying degrees depending on the situation. During this stage the individual determines the usefulness of the innovation and may search for information to become more familiar about the innovation. The final stage is the Confirmation stage which involves the individual confirming their innovation decision.

In addition, Rogers identified five attributes upon which individuals adopt an innovation. He points out that individuals determine whether the innovation is more advantageous than other innovations or the present circumstance (relative advantages), that it is not overly complex to learn or use (complexity), that it fits in or is compatible with circumstances into which it will be adopted (compatibility), that it can be tried out (adaptability), and that results can be observed (observe ability).

2.3.2 Relative advantage. In addition to financial profitability, relative advantage accounts for subsistence profitability (Swinkels & Franzel, 1997). The assessment of the opportunity costs of the innovation, and its contribution to subsistence needs occur. The

opportunity cost includes the value of resources lost or forgone to develop agroforestry, and the time invested that could have been spent elsewhere. Relative advantage assesses the profitability of an innovation in relation to current practice and other alternatives, such as natural forest resources. It also accounts for temporal aspects of profitability as farmers assess the timing and magnitude of costs and benefits at each stage of an innovation stage. For example, the relative advantage of adopting the use of an agroforestry technology is influenced by the timing and size of initial investments, maintenance costs, sustainability, food and income security and the immediacy of rewards associated with the system. Pannell (1999) identified the ability to assess the profitability of agroforestry innovations in relation to current practice and other alternatives as a major challenge.

The relative advantage of agroforestry technologies vary based on individuals' needs and objectives for adopting current practice, capital assets at their disposal and viable alternatives; however, some illustrative generalizations can be made. For instance, due to the slow growth of most tree species, the time-scale over which rewards are delivered through agroforestry systems is considerable, reducing their relative advantage (Snapp, Mafongoya, & Waddington, 1998). In common with forestry enterprises, it means that profitability needs to be determined in relation to discount rates, which are typically high. However, without training or assistance, such calculations are beyond the reach of most small limited-resource farmers.

The cost of ending the use of an agroforestry system can be high. For example, it can be higher than the cost of clearing primary forest (Vosti, Witcover, Oliveira, & Faminow, 1997). The primary maintenance cost of agroforestry systems is labor, which can be higher than other land use systems such as pasture maintenance. Agroforestry systems may have to compete with non-cultivated supplies from natural forests where extraction costs can be lower than cultivation

costs (Guimaraes & Di Addario, 1998). In addition, the opportunity cost of land for other uses is particularly significant for smallholders (Dove, 1991), who are often perceived to benefit most from agroforestry technologies, and should be taken into account in location decisions (Hoekstra, 1983). The benefits of preventative technologies are often long-term and in the absence of long term trials, it is often difficult for farmers to predict the cost of not adopting. These factors reduce observability and trial ability and make it difficult to assess relative advantage. As a consequence, the adoption of preventative technologies is characteristically slow (Rogers, 1995). This may explain the low adoption rates of many agroforestry interventions with conservation objectives, such as erosion or deforestation control, unless the fulfillments will bring immediate rewards.

Additionally, some agroforestry interventions have attempted to meet unperceived or low priority problems by packaging them as by-products of solutions to high priority problems (Evans, 1988; Raintree, 1983). Providing incentives for individuals (financial or material) can increase the relative advantage for adopting innovations. Although more individuals may adopt an innovation if incentives are provided, the quality of adoption may be poor, leading to partial implementation and discontinuation (Rogers, 1995). For example, the financial incentives given to farmers who participated in the Malawian Tree Planting Bonus Scheme resulted in poor silvicultural practices and high tree mortality due to farmers planting trees at extremely high densities to claim the maximum payment (Dewees, 1995).

2.4 Compatibility of technology

According to Swinkels and Franzel (1997) the concept of feasibility, compatibility assesses the extent to which a technology is compatible with environmental and socio-cultural factors, and farmers' needs. For a technology to be adoptable, it must be compatible with the

physical environment of the target area. For agroforestry technologies, species must be selected with reference to climatic and edaphic factors. Technologies must also be compatible with existing land use systems, and previously introduced innovations.

For example, intercropping may not be compatible with mechanized ploughing and harvesting systems. Agroforestry technologies that build on and incrementally improve existing land-use systems are likely to be more compatible than technologies that replace systems. Sociological studies about innovation have shown that innovations which are consistent with socio-cultural values are adopted more rapidly than innovations which conflict with these values (Hassinger, 1959).

2.5 Adaptability of innovativeness

The extent to which an innovation can be adapted to meet dynamic user demands and specifications can influence its adoption potential. In addition to characteristics of the agroforestry technology itself, adaptability depends on the adaptive capacity of farmers (influenced by factors such as marketing knowledge, access to credit and risk aversion). Vosti et al., (1997) described two components of adaptation as agronomic and socioeconomic "agility." Understanding an innovation is a prerequisite to its effective adaptation, as adaptation without the appropriate knowledge can result in technologies that are ineffective, inefficient and sometimes counter-productive (Larsen & Agarwala-Rogers, 1977).

The inter-relatedness of components in agroforestry technologies can limit the extent to which they can be adapted, as the adaptation of one component may influence other related components. Nevertheless, the multiproduct, multi-component nature of agroforestry technologies tends to make them more adaptable than single component agronomic innovations (Vosti et al., 1997). It is possible to alter the crop, product and input mix or any combination of

these in response to changing needs, objectives or capital assets. This obviates the need to adopt different innovations under changing circumstances. Consequently, adaptable innovations have lower discontinuation rates (Rogers, 1995).

2.5.1 Observability of innovations. In the circumstance that an innovation is highly visible, it may be adopted more readily (Rogers, 1995). The slow growth rates of trees make their effects and the rewards of adopting difficult to observe by farmers (Snapp, Mafongoya, & Waddington, 1998). Indeed, it is a fact that some conservation benefits are indirect and intangible. One of the mechanisms through which trials can increase adoption rates is by tangibly demonstrating the benefits of an innovation. As such, demonstration plots can improve the observability of agroforestry systems and have been shown to have a direct impact on agroforestry adoption rates (Evans, 1988).

2.5.2 Complexity of innovations. Innovations which are unfamiliar and/or difficult for individuals to understand and implement are less likely to be adopted than technically simple innovations (Rogers, 1995; Strong & Jacobson, 2006). The complexity of an agroforestry innovation depends on the characteristics of the innovation and the farmer. For example, younger and more educated farmers are more likely to adopt new technologies before other sectors of society (D'Souza, Cyphers, & Phipps, 1993). Additionally, younger farmers may favor agroforestry innovations simply because they have longer planning horizons than older farmers, and cost-benefit calculations for agroforestry systems tend to favor long planning horizons.

2.6 Adopter categories

Rogers (1995) defines an adopter category as a classification of individuals within a social system on the basis of innovativeness. Rogers continues by discussing a total of five categories of adopters to standardize the usage of adopter categories in diffusion research.

The categories of adopters include: innovators, early adopters, early majority, late majority, and laggards.

2.6.1 Definition of adopter categories. Innovators are those individuals who are the first to adopt an innovation. Innovators are willing to take risks, are normally younger, have the highest social class, have great financial lucidity, are very social and have the closest contact to scientific sources and interaction with other innovators. Risk tolerance has them adopting technologies which may ultimately fail. Early Adopters are the second fastest category of individuals who adopt an innovation. These individuals have the highest degree of opinion leadership among the other adopter categories. Early adaptors are typically younger in age, have a higher social status, have more financial lucidity, advanced education, and are more socially forward than late adopters. Early Majority individuals adopt an innovation after a varying degree of time. The time of adoption is significantly longer than the innovators and early adopters (Rogers, 1995).

The Early Majority tends to be slower in the adoption process, have above average social status, contact with early adopters, and seldom hold positions of opinion leadership in a system. Late Majority Adopters will adopt an innovation after the average member of the society. These individuals approach an innovation with a high degree of skepticism and after the majority of society have adopted the innovation. The Late Majority are typically skeptical about an innovation, have below average social status, very little financial lucidity, in contact with others in late majority and early majority, and very little opinion leadership. Laggards are individuals that are last to adopt an innovation. Unlike some of the previous categories, individuals in this category show little to no opinion leadership. These individuals typically have an aversion to change and tend to be advanced in age.

Rogers (1995) Laggards typically focus on “traditions,” are likely to have the lowest social status, financial lucidity, and be the oldest of other adopters, with contact with only family and close friends and have very little to no opinion leadership.

2.6.2 Constraints of agroforestry adoption. The constraints of farmers for adopting agroforestry technologies have been noted in the literature as having a lack of management skills and technical knowledge, incompatibility between multiple outputs, high establishment or annual management costs, negative impacts of livestock on tree seedlings and soil productivity (Cannon, 1998; Kettler, 1995) and the potential for weedy species and pest interactions (Dix, Bishaw, Workman, Barnhart, Klopfenstein, & Dix, (1999) economic planning for intensity and timing of inputs and outputs; meager institutional and policy support including finances and incentives (Kettler 1995) and market development, landowner information and public education (Kettler,1995; Mercer, 2000). The valuation of non-market benefits or non-economic values is evident to many practitioners and motivates an individual to implement practices; however, it is often a constraint at higher levels of institutional and social policy (Merwin, 1997).

Neupane, Sharma, and Thapa (2002) found that in Nepal, females in households that had young children spent more time in childcare and other household production activities and therefore had less time for farming activities. Such families were therefore less likely to get involved with agroforestry technologies. Agroforestry can be a complex task to determine what opportunities, limitations, and trade-offs exist in each situation to design an agroforestry practice that achieves the best balance among them (Dosskey & Wells, 2000).

Notwithstanding the promising opportunities of agroforestry, there are some formidable constraints that prevent the realization of the potential benefits, which institutional is a major constraint. Agroforestry is not recognized as an official land use class.

National laws oblige farmers to harvest trees before age 40 to prevent agroforestry plots from shifting to a forest status and considerably decrease in value. Local regulations may impede the planting and falling of trees or force farmers to replant trees after falling (FAO, 2004).

2.7 Agroforestry resources

The willingness for farmers to spend more time on farm management and learning new skills are limited (Israel & Ingram, 1990). Since many farmers also have off-farm employment, unless it is compelling and preferably convenient, most will not attend special functions. The same is true for their devotion to additional time for collecting information about land management options. Though the majority of landowners welcome information to help them improve their enterprises, most fail to take advantage of resources. Due to the number of landowners being reliant on a single or few production options (e.g., cattle, timber) on their agricultural land, using northern Florida as an example (Israel, 1990; Israel & Ingram, 1990) diversification through the use of agroforestry technologies could provide greater income stability.

The landowners that express concerns about their time and capital available for investment need information and assistance in learning how to evaluate which alternatives suit their needs. Many individuals look to the Cooperative Extension Program and State Forestry agencies or other trusted sources for information to guide their decision.

Extension educators are interested in developing their skills to serve their clientele's needs. They tend to concentrate their efforts on topics of highest demand.

To promote agroforestry technologies, one must first recognize them as relevant and applicable, since they are only one set of tools in a suite of several that can be called upon to offer land managers Professionals are continually faced with integrating knowledge from various

disciplines with their personal experiences and observations. Training in agroforestry, therefore, must offer professionals background knowledge on how tree-animal and tree-crop combinations can be advantageous for local circumstances.

Professional training must be advertised through effective networks and be offered at convenient times for participants. Since in-service training programs for extension and forestry professionals are coordinated through state agencies and institutions, one-to two-day workshops could be delivered at several district locations throughout each state.

Additional “agroforestry modules" could be included in mini-conferences and field days held by various state programs (e.g. small farms, sustainable agriculture, pest management, silviculture) or included in programs with federal agencies (e.g. Natural Resources Conservation service (NRCS) Agricultural Research Service (ARS) private industries (e.g. Heifer Project, The Nature Conservancy, Audubon), or professional partner groups (e.g. Society of American Foresters). Each of these potential training sponsors could also utilize demonstration sites, delivered by university experiment stations or farmers and extension agents.

2.8 Management of agroforestry enterprises

Some well-established agroforestry systems, such as pecans and cattle, are managed by families from generation to generation. Others; however, are currently being developed and serve as outdoor agricultural laboratories where management plans are based on observation, continual change and improvement based on past successes. Agroforestry can be successful when production is obtained on the same piece of land with only a single cropping system. As it relates to agriculture, costs, inputs, and adverse environmental effects must be minimized for the enterprise to remain healthy and productive (Snell, 2000).

The reasons landowners are motivated to adopt agroforestry technologies in the United States specifically in the southern states includes, improved on-farm economics and economic gain, multiple land use management and income diversification, site suitability and erosion control; shortened waste and increased regularity of income; increased diversification and enhanced timing of cash flow; and support of conservation and environmental concerns (Merwin, 1997; Zinkhan & Mercer, 1997).

According to Rusch (2010) many farmers restrict themselves to adopting management techniques passed from their parents or family. The adoption of these techniques is caused by general lack of local organization, low scholastic levels, the lack of new lands being available and relatively few years of experience working with livestock.

Valdivia, Hodge, and Raedeke (2000) conducted research on farmers' attitudes regarding agroforestry technology use in a Fox-Wauconda watershed in Missouri to improve the quality of life and to diversify income sources after the Farm Bill of 1996 revealed that small farms are very diverse, both in type of production activities that farmers engage in, and in time dedicated to farming as opposed to off-farm activities.

Small limited-resource farmers derive an important source of their income from non-farming activities, and their farm cropping enterprises exhibit different degrees of diversification. High levels of income from farming in the southeast US compete with the potential for agroforestry as a commercial activity, though interest is still high when it comes to future generations and environment.

Many of the concerns individuals have expressed with adopting agroforestry relates to costs. Under these conditions, government programs decided that by improving the environment they could find farmers as willing partners. Conventional wisdom suggests that farmers should

readily adopt agroforestry systems, capable of providing substantial net economic and ecological benefits to households and communities (Current, Lutz, & Scherr, 1995).

2.9 Perceived attributes of innovation

To understand the farmers' perceptions of a technology, a number of attributes of technology should be analyzed (Drechsel & Gyiele, n.d.). These attributes include: 1-comparative advantage (not only higher yields, but also better soils test; 2-compatibility with previous and current farming method; 3-complexity (how simple or difficult is the technology?); 4-triability (can the technology be tested?); 5-visibility (is the impact obvious and convincing?); and 6-trouble-free (are there a cultural, gender, technical, difficulties?).

According to Baum, Gyiele, Drecshsel and Nurah (1999), if a certain technology is new to farmers it requires that they must learn new skills to utilize it. For example, a minimum rate of return near to 100% is a reasonable estimate to assume adoption.

As it can be seen from the above studies, it can be emphasized that the reasons landowners are motivated to adopt agroforestry practices in the US and specifically in Southern States is because they want to improve their on-farm economics and support conservational stewardship. In this study, the main objective was to assess if limited-resource farmers in North Carolina were aware of and perceived agroforestry as an investment business opportunity with the potential to increase farm income and enhance environmental conservation.

CHAPTER 3

Methodology

In this chapter the purpose of the study and research design are discussed. Also included is a description of the accessible target population, instrument development and a summary of the data analysis procedures.

3.1 Purpose of the study

The purpose of this descriptive study was to assess the awareness regarding the adoption of agroforestry technologies by limited-resource farmers in North Carolina. In this study, the researcher collected data using a purposive sample to answer following research questions:

1. What do limited-resource farmers know about the agroforestry technologies?
2. What are the benefits that limited-resource farmers perceive they will receive from adopting agroforestry technologies?
3. What are the barriers that limited-resource farmers' report for adopting agroforestry technologies?
4. What is the degree of willingness of limited-resource farmers for investing in agroforestry as an investment opportunity?

3.1.1 Population. The population frame was comprised of 150 limited-resource farmers listed in the North Carolina Agricultural and Technical State University Cooperative Extension Program Directory of Small Farmers. Of this number it was discovered that 13 farmers relocated to another state, and five farmers reported they sold their land and were no longer farming. After removing the 18 farmers from the frame, the target population was 132 farmers. Due to the frame containing only 132 possible participants, the researcher decided it was feasible to gather pertinent information from all 132 (target accessible population) small limited-resource farmers.

3.1.2 Instrumentation. A mail survey consisting primarily of items/questions with a Likert-type scale was used to measure the responses of the limited-resource farmers. Section one of the survey instrument used close ended questions to collect demographic data and to assess the farmers' awareness of agroforestry technologies. Section two of the survey instrument used items with a 5 point Likert-type scale to assess the benefits limited-resource farmers perceived they will receive from adopting agroforestry technologies and the barriers that limited-resource farmers' reported for adopting agroforestry technologies.

The questionnaire was reviewed by a panel of experts consisting of faculty members from the department of Agribusiness, Applied Economics, and Agriscience Education and a natural resources specialist of a Cooperative Extension Program in a School of Agriculture and Environmental Sciences to establish the survey instrument's content validity. The questionnaire was revised based upon the comments and suggestions received from the panel. The study's protocol, IRB #11-0200, was reviewed and approved by North Carolina Agricultural and Technical State University's Institutional Review Board.

3.1.3 Data collection. Data collection was conducted in three stages that lasted six weeks. Cover letters, questionnaires, and prepaid return addressed envelopes were mailed on June 8, 2012 to the limited-resource farmers. The cover letter requested the questionnaires be completed and returned by June 22, 2012. The cover letter stressed that the strictest confidentiality would be upheld during the study. Two weeks after the first mailing, 7 or 5.3% of the 132 farmers responded. On June 25, 2012, a second mailing was sent to all non-responding farmers stressing the importance of their participation in the study. On June 25, 2012, all non-responders were contacted by phone, stressing the importance of their participation in the study. As a result, 51 or 38.6% additional surveys were received. On July 6, 2012, the third mailing was sent to all non-

responding farmers. As a result, 34 or 25.0% additional surveys were returned. The survey ended on July 20, 2012. Ninety-two surveys were returned from a possible target sample of 132 participants representing a final return rate of 70 % (See Table 1).

Table 1

Number and Percent of Returns from Limited-Resource Farmers (N=132)

Mailing	Date	*N*	% of Target Population
First Mailing	June 8, 2012- June 22, 2012	7	5.3
Second Mailing	June 22, 2012 - July 6, 2012	51	39.0
Third Mailing	July 6, 2012- July 20, 2012	34	25.7
Total Returns		92	70.0

3.1.4 Data analysis. The data were coded and analyzed using the Statistical Package for the Social Sciences (SPSS, v 20) to address the study's research questions. Descriptive statistics were calculated, which included frequency distributions, percentages, means, and standard deviations. Babbie (1990) indicates if a study aims to gain more information about a subject and use the information to generate theories or hypotheses, then a descriptive study approach may be used. According to Babbie, the results from a descriptive study can be used to create or further develop knowledge about a given situation, thus paving the way for future studies to be conducted. In this study, descriptive statistics were generated concerning agroforestry adoption, and the willingness of limited-resource farmers to invest in the agroforestry industry.

Such information would be helpful to Cooperative Extension educators and policy makers to determine the need for implementing pragmatic steps and programs to encourage farmers to participate in educational programs and make informed decisions regarding the adoption of agroforestry technologies.

CHAPTER 4

Results

The purpose of this study was to assess the awareness regarding the adoption of agroforestry technologies by limited-resource farmers in North Carolina. The data gathered were analyzed using means, standard deviations, and frequencies. This chapter provides a detailed compilation of the data collected during this study.

4.1 Profile of Limited-Resource Farmers

The participants for this study were asked a series of questions to identify demographic characteristics of the respondents (See Table 2).

There were more males (64%) than females in the study. More farmers reported being between the ages of 40-49 (61%), with farming (86%) reported as their primary occupation. More farmers reported having incomes between $30,000 -$49,999 (46%), with fewer reporting incomes of $75,000 - more than $110,000 (6.6%).

Educationally, almost one half (45%) of farmers reported earning a college degree, while twenty-two (25%) reported some college and thirteen (15%) earned a high school degree.

Table 2

Profile of Limited-Resource Farmers

Variables	*f*	%
Gender:		
Male	64	72.7
Female	24	27.3
	84	100.0

Table 2 cont.

Variables	*f*	%
Age:		
30-39	11	12.9
40-49	52	61.2
50-59	8	9.4
60 and over	14	16.7
	85	100.0
Primary Occupation:		
Farmer	73	85.9
Retired	12	14.1
	92	100.0
Household Income:		
Less than $10,000	6	6.6
Between $10,001-$29,999	13	14.6
Between $30,000-$49,999	42	46.2
Between $50,000-$74,999	24	26.4
Between $75,000-$110,000	3	3.3
More than $110,000	3	3.3
	91	100.0
Education:		
Some high school	6	6.7
Completed high school	13	14.6
Technical certification	5	5.6
Some college	22	24.7
College graduate	40	44.9
A graduate degree	4	3.4
	90	100.0

4.2 Awareness of Agroforestry Technologies

Limited-resource farmers were asked to report on their awareness of agroforestry technologies.

Table 3 contains the results of the limited-resource farmers' awareness regarding adoption of agroforestry technologies.

Respondents reported that they had little awareness of agroforestry technologies in regard to each of the technologies: alley cropping, windbreaks/ shelterbelts, forest riparian buffer, forest farming, non-timber forest farming and crop tree management, the limited-resource farmers reported they were not aware of adopting this agroforestry technology.

Table 3

Awareness of Adopting Agroforestry Technologies Reported by Limited-Resource Farmers (N=91)

Technology	*M*	*SD*
Windbreaks/Shelterbelts	2.66	.81
Alley cropping	2.65	.89
Forest Riparian buffer	2.47	.82
Forest farming	2.30	.85
Non-timber forest farming	2.26	.75
Crop tree management	1.97	.82

Note: Scale: 1=not aware, 2=minimum level of awareness, 3=moderate level of awareness, 4= maximum level of awareness.

4.3 Benefits of Agroforestry

The limited-resource farmers were also asked to report on the perceived benefits of adopting agroforestry technologies. Table 4 contains the result of the farmers' responses.

Overall, the farmers were in agreement that benefits of agroforestry technologies such as improves water quality, protects soils, improves wildlife habitat, increases biodiversity, provides shelter for livestock, and increases income were important. Farmers also noted that the benefit of diversity production was a moderately important benefit of agroforestry technology.

Table 4

Benefits of Agroforestry Technologies Reported by Limited-Resource Farmers (N=91)

Benefits	*M*	*SD*
Improves water quality	4.30	.80
Protects soil	4.29	.80
Improves wildlife habitat	4.23	.92
Increases biodiversity	4.22	.77
Provides shade for livestock	4.14	.85
Increase financial security	4.11	.85
Diversifies production	3.95	1.01

Note: Scale: 1=least important, 2=slightly important, 3=moderately important, 4=important, 5= very important.

4.4 Barriers to the Adoption of Agroforestry

Limited-resource farmers were asked to rate the perceived importance of several barriers of agroforestry, which potentially limits or inhibits the adoption of agroforestry technologies. Table 5 displays the farmers' responses. Respondents reported the following barriers such as does not seem profitable, lack of information on agroforestry, not being familiar with technology, no market for agroforestry products, lack of seedlings, lack of technical assistance, lack of demonstration sites, trees use too much water, and insufficient land, for adopting agroforestry technologies.

Table 5

Barriers to Adoption of Agroforestry Technologies Reported by Limited-Resource Farmers (N=91)

Barriers	*M*	*SD*
Does not seem profitable	2.46	1.50
Lack of information on agroforestry	2.44	1.44
Not familiar with technology	2.30	1.56
No market for agroforestry products	2.29	1.51
Lack of seedlings	2.29	1.47

Table 5 cont.

Barriers	*M*	*SD*
Lack of technical assistance	2.28	1.48
Lack of demonstration sites	2.25	1.52
Trees use too much water	2.22	1.41
Insufficient land	2.04	1.32

Note: Scale: 1=very important barrier, 2=important barrier, 3=least important barrier, 4 =less important barrier, 5=not a barrier.

4.5 Willingness of Limited-Resource Farmers to Establish Agroforestry

The respondents were asked to report how likely they were to establish agroforestry technologies. Table 6 contains the results for the farmers' likelihood to establish agroforestry technologies.

The farmers were not willing to pay out of pocket and rely on family members for labor and capital. However, the farmers were willing to enroll in a cost-sharing program and take out a loan to establish agroforestry technologies on their respective farms.

Table 6

Willingness to Establish Agroforestry Technologies Reported by Limited-Resource Farmers (N=91)

Action	*M*	*SD*
Enrolling in a cost-sharing program	2.68	1.48
Taking out a loan	2.51	1.42
Paying out of pocket	1.85	1.41
Relying on family members for labor/capital	1.88	1.40

Note: Scale: 1=very unlikely, 2=unlikely, 3= neither likely nor unlikely, 4=very unlikely.

CHAPTER 5

Conclusions, Implications, and Recommendations

The purpose of this study was to assess the awareness of adoption of agroforestry technologies by limited-resource farmers in North Carolina. In this concluding chapter, conclusions and the implications of the findings for adoption of agroforestry technologies are presented. Finally, the limitations of the research and recommendations for possible ways to extend the research are provided. There were more males and older adults in the study which suggest more needs to be done to attract more females and younger individuals to agroforestry. These findings support Women in Development's (WID) report that females are less likely to be involved in projects that involve tree planting (Due & Gladwin, 1991). However, more needs to be done to attract women since the number of women farm operators has steadily increased in the United States, comprising of 30% of all farm operators (2007 Census of Agriculture).

This increase in women farmers provides the potential for Extension educators to provide educational programs to this population of farmers about the benefits of adopting agroforestry technologies. For instance, in 2007, there were 306,209 female principal operators (14% of all operations) as compared to 237,819 in 2002. This constitutes an increase of almost 30% in 5 years (USDA, 2007). Braiser, Barbercheck, Kiernan, Sachs, Schwartzberg, and Trauger (2009) stated, "the increasing diversity of farm operators presents a new audience that Extension personnel and administration need to recognize and for whom programs should be developed according to their unique educational needs and opportunities (p.1).

It is also concluded that as more farmers age and fewer individuals farm, the agroforestry industry is threatened since individuals are less likely to adopt new technological innovations (Keil, Beranek, & Konsynski, 2005). Another conclusion could be that there is a lack of

motivation by farmers for investing in agroforestry as a business opportunity due to environmental concerns such as water quality. Additionally, farmers could be educated during on-farm demonstrations about agroforestry technologies as well as encouraged to apply for soft loans. This study's finding concerning finances as a barrier for farmers to adopt agroforestry supports the findings of Sullivan, Huke, & Fox (1992) who conducted a similar study related to financial and economic analyses of agroforestry systems. They found that many of the participants' concerns with adopting agroforestry technologies were related to costs. The premise is also supported by Miner and Harris (2001) who conducted a study that examined factors that influenced individuals' adoption of technology developed by Extension educators. They found that 'cost' of software was a major influence on respondents' decision to adopt.

The findings in this study revealed that overall the respondents felt that agroforestry has the potential to benefit their operation. Garrett and Buck (1975) conducted a study concerning the benefits of adopting agroforestry. They found that the incorporation of multiple species into agroforestry production system intrinsically results in a high biodiversity as compared to mono culture. They also found that farmers valued workshops and extension agents as providing useful sources of information. The adoption of new technology is said to be influenced by the farmer's contact with Cooperative Extension Services staff. In a study conducted by Merwin (1997) that examined farmers' motivation for adopting agroforestry practices in their management schemes in the U.S. and specifically in the southern states was due to their interactions with extension agents.

If Cooperative Extension programs and workshops are provided to farmers concerning investing in agroforestry it may encourage them to take advantage of the opportunity to invest in agroforestry as a business.

Finally, this finding supports that of the FAO (2004) which conducted a study concerning the economic impact of extension services on farmers which found that many farmers had contact with extension services which had an economic impact on their livelihood.

Additionally, policymakers are encouraged to provide appropriate incentives such as subsidized loans, farm inputs for farmers. If provided, each of these incentives is likely to facilitate farmers' investment in agroforestry technologies.

5.1 Implications of the study

Overall, the study revealed a low level of awareness of the adoption of agroforestry technologies by limited-resource farmers. Policymakers and Cooperative Extension educators are encouraged to implement pragmatic steps and programs to encourage more farmers to participate with the agroforestry technology and invest in agroforestry production.

The key implication of this study is the necessity to educate farmers on agroforestry adoption so they are able to implement and later experience the benefits of agroforestry. This premise is supported by Workman, Bannister, and Nair (2003) who found that diversified and integrated production systems using agroforestry on small farms can help farmers on agroforestry adoption, remain competitive, endure land use and cultural transitions, as well as provide environmental amelioration and thus societal benefits.

5.2.1 Limitation of the study. The limitation of the study included the population of the study being limited to North Carolina limited-resource farmers.

5.2 Recommendations for future research

This study has produced information about the awareness of the adoption of agroforestry technologies by limited-resource farmers, and revealed prospects for conducting future research.

Based on the study's findings and conclusions, the following recommendations are made:

1. Limited-resource farmers should be provided with education about the importance of investing in agroforestry. Training programs should focus on the needed skills and knowledge to manage agroforestry technology.
2. Information centers that are readily accessible for farmers with up-to-date information should be provided to in various counties in the region to cater to the farmers as a whole.
3. Incentives such as funding gained from grant writing and subsidized loans for younger adults who are willing to consider agroforestry as an income generating venture should be provided.
4. Agricultural policies should be enacted to address farmers' needs and ensure agroforestry is a part of the agriculture agenda for improving their financial well-being.
5. Cost sharing programs such as Environmental Quality Incentives Program (EQIP) should be designed to promote agroforestry technologies to encourage farmers who want to invest in agroforestry as a business opportunity.

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Appendix A

Informed Consent

Dear Sir/Madam,

I am a graduate student from North Carolina Agricultural and Technical State University, working with Dr. Paula E. Faulkner, my academic advisor on a study titled the Assessment of the Adoption Practice of Agro forestry Practices by Limited-Resource Small Farmers in North Carolina. This study seeks to address the Limited-resource Small farmer's perceptions on the adoption of Agro forestry Practices. Your name and address was obtained from the North Carolina Cooperative Extension Service cliental listing.

Enclosed is a questionnaire that will take approximately 30 minutes to complete. You must be an adult (18 years or older) to participate. Your participation is strictly voluntary; however, your involvement is very important to the success of the study. You may decline to answer any item(s) on the questionnaire; yet completion and return of the study will be considered your implied informed consent. Your responses will be held in strict confidence. The survey has a code number for mailing purposes only. The code number will be used only to follow up with individuals who fail to return the questionnaire.

Please complete the enclosed questionnaire as accurately as possible and return it in the self-addressed postage paid envelope by (specified date). All results will be analyzed and reported for groups not individuals. Please keep this letter in your records in case you have further questions regarding this study. You may also call the office of Research Protections if you need further information about your rights as a research participant.

If you have any questions about your rights as a research study participant, you may contact the chair of the IRB through Compliance Office at (336) 334-7995 or rescomp@ncat.edu.

Thank you in advance for your participation.

Sincerely yours,

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Section 1. For analytical purposes, we need to know more about you. Your responses are strictly confidential. If you choose not to answer any one question, please proceed to the next.

1. _____ Male _____ Female
2. **What is your age?** _____ 18-29 _____ 30-39 _____ 40-49 _____ 50-59 _____ 60+
3. **What is your primary occupation? (Check all that apply)**
   - ____ Farmer
   - ____ Retired
   - ____ Other (Please Specify) _____
4. **Do you have help available for implementing Agroforestry practices on your land?**
   - ____ No
   - ____ Yes, if yes,

   How many people? _____

   Are they hired or partners? _____ Hired _____ Partners
5. **Which category best represents your total household income, from all sources, before taxes? (Please check one)**
   - _____ Less than $10,000
   - _____ Between $10,001-$29,999
   - _____ Between $30,000-$49,999
   - _____ Between $50,000-$74,999
   - _____ Between $75,000-$110,000
   - _____ More than $110,000
6. **What is the highest level of education you have completed? (Please check one)**
   - _____ Some high school
   - _____ Completed high school
   - _____ Technical certification
   - _____ Some college
   - _____ College graduate
   - _____ A graduate degree
   - _____ Other (Please Specify) _____
7. **Would you consider participating in community programs to share knowledge of farming and Agroforestry?**
   - _____ No
   - _____ Yes

15. Please rate the following sources of information relative to your needs for obtaining information on land management practices. (Please circle one response for each possible benefit, with 1 being not useful and 5 being very useful)

Sources of Information	Usefulness				
A. Extension agents	1	2	3	4	5
B. Newsletters	1	2	3	4	5
C. Magazine articles	1	2	3	4	5
D. Workshops	1	2	3	4	5
E. University specialists	1	2	3	4	5
F. Radio programs	1	2	3	4	5
G. Neighbors	1	2	3	4	5
H. Internet	1	2	3	4	5
I. On-farm demonstrations	1	2	3	4	5
J. Family members	1	2	3	4	5
K. Other (Please Describe) _____	1	2	3	4	5
A. Cost sharing	1	2	3	4	5
B. Less regulations	1	2	3	4	5
C. Reduced taxes	1	2	3	4	5
D. Free seedlings	1	2	3	4	5
E. Technical visits	1	2	3	4	5
F. Other (Please Describe) _____	1	2	3	4	5

Section 3. What is the extent of your needs for information on the following practices?

Practices	Interest				
A. Windbreak or Shelterbelt	1	2	3	4	5
B. Alley Cropping or Intercropping	1	2	3	4	5
C. Silvopasture	1	2	3	4	5
D. Riparian Buffers	1	2	3	4	5
E. Forest farming	1	2	3	4	5

11. Which of the practices are you currently using on your farm? (Please enter letter) _____

12. Why did you choose the practice in 11b?

13. How much do you earn from Agroforestry? (Please check one choice)

_____ Minimal
_____ Moderate
_____ Supplemental
_____ Other (Please Describe) _____

14. Indicate your degree of willingness to take action to establish Agroforestry Practice. (Please circle one response, with 1 being not likely and 5 being very likely)

Actions	Willingness				
A. Paying out of pocket	1	2	3	4	5
B. Relying on family members for labor and capital	1	2	3	4	5
C. Taking out a loan	1	2	3	4	5
D. Enrolling in a cost-sharing program	1	2	3	4	5
E. Other (Please Describe) _____					

Section 2. This set of questions relate to your awareness of Agroforestry practices.

8. How much did you know about the following practices? (Please check one box for each term)

	None	Little	Much	Currently Practicing
Agroforestry – Intensive, intentional management of land using woody and herbaceous species together with crops or livestock.				
Windbreak or Shelterbelt – Lines or bands of trees that reduce wind in adjacent fields.				
Alley Cropping – Cultivation of food, forage, or specialty crops between rows of trees or shrubs.				
Silvopasture – Intentional management of trees and livestock together.				
Forest Riparian Buffer – A strip of woody and herbaceous vegetation next to surface water to stabilize banks, reduce erosion, and maintain water quality.				
Forest Farming – Intensively managing forest for timber and understory crops.				
Non-timber Forest Products – Fruits, medicinal plants (such as ginseng or black cohosh), nuts and other edibles, as well as decorative plants in forests and other wooded areas.				
Crop Tree Management – Managing the forest to ensure profitable timber over several generations.				

Exempted 05-30-2002

9. Please use the following 5 points scale to indicate how important are these benefits of Agroforestry to you. (Please circle one response for each possible benefit, with one being the least important practice and 5 being the most important practice.)

Potential Benefits	Importance				
A. Diversifies production	1	2	3	4	5
B. Increases income	1	2	3	4	5
C. Improves wildlife habitat	1	2	3	4	5
D. Increases financial security	1	2	3	4	5
E. Protects soil	1	2	3	4	5
F. Improves crop production	1	2	3	4	5
G. Provides healthy foods for family	1	2	3	4	5
H. Improves water quality	1	2	3	4	5
I. Increases biodiversity	1	2	3	4	5
J. Improves water quantity	1	2	3	4	5
K. Provides long term investment	1	2	3	4	5
L. Provides shade for livestock	1	2	3	4	5
M. Improves surroundings	1	2	3	4	5
N. Allows more family involvement on farm/land	1	2	3	4	5
O. Supplemental income to pay taxes	1	2	3	4	5
P. Produces natural foods	1	2	3	4	5
Q. Provides mulch for other crops	1	2	3	4	5
R. Makes farm/land more interesting	1	2	3	4	5
S. Other: _____	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5

10. On a scale of 1-5 indicate the extent to which the following is a barrier to adoption of Agroforestry practices. (Please circle one response for each obstacle, with 1 being a barrier and 5 not a barrier.)

Potential Benefits	Importance				
A. Competition between trees, crops, and animals	1	2	3	4	5
B. No markets for products	1	2	3	4	5
C. Expense of additional management	1	2	3	4	5
D. Does not seem profitable	1	2	3	4	5
E. Unfamiliar with technologies	1	2	3	4	5
F. Lack of technical assistance	1	2	3	4	5
G. Information about Agroforestry unavailable	1	2	3	4	5
H. Lack of demonstration sites	1	2	3	4	5
I. Cannot afford to experiment	1	2	3	4	5
J. Do not have infrastructure (building, tools)	1	2	3	4	5
K. Do not know where to market products	1	2	3	4	5
L. Insufficient land	1	2	3	4	5
M. Lack of seed / seedling sources	1	2	3	4	5
N. Trees will use too much water for crops	1	2	3	4	5
O. Have not seen Agroforestry successfully used	1	2	3	4	5
P. My soils are inappropriate for Agroforestry	1	2	3	4	5
Q. My neighbors do not do it	1	2	3	4	5
R. It will be too time consuming	1	2	3	4	5
S. It is inconvenient	1	2	3	4	5
T. I don't have the right equipment	1	2	3	4	5
U. Other: _____	1	2	3	4	5
	1	2	3	4	5

Thank you for taking the time to complete this survey. Your assistance in providing this information is very much appreciated. If there is anything else you would like to tell me, please do so in the space below.

Would you like to receive the results of this survey? _____

Code # _____

Assessment of the Adoption Practice of Agro forestry Pr
Limited Resource Small Farmers in North Carol

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