

## Assessment of the Adoption of Agroforestry Technologies by Limited-Resource Farmers in North Carolina

### Abstract

Agroforestry is a natural resource management system that integrates trees, forages, and livestock. The study reported here was conducted to determine farmers' knowledge about and willingness to adopt agroforestry technologies in North Carolina. The study reported participants were primarily older, male farmers, suggesting the need to attract more females and younger individuals to adopt agroforestry technologies. The increasing number of diversified farm operators presents a new audience for Extension educators to offer programs to improve limited-resource farmers' livelihood. The study recommends Extension training programs and information centers for farmers who need skills and knowledge to manage agroforestry technologies.

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### Introduction

Agroforestry is a dynamic, ecologically based natural resource management system that integrates trees, forages, and livestock. Compared to single output systems (monoculture), agroforestry systems have a number of advantages (Cairnes & Garrity, 1999; Dakora & Kenya, 1997). 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 (wind breaks), alley cropping, and enriched fallows (Amarcher, Ersado, Hyde, & Haynes, 2004). Unlike standard agriculture, other natural resource management (NRM) practices typically are more knowledge-intensive than modern agricultural development packages based on the need for improved seeds, chemicals, and/or mechanical inputs. Therefore, farmer education, experimentation, and modification are important for agroforestry and natural resources development versus conventional agriculture (Barrett, Place, & Abdud, 2002).

Few studies have been conducted that examine the benefits of adopting agroforestry technologies; however, of the studies conducted, it has been found that there are significant benefits for landowners adopting agroforestry. This premise is supported by Jacobson and Kar, who conducted a similar study and reported, "A review of the literature on agroforestry Extension adoption in the United States finds

only a few examples" (2013, p.1). It has been found that limited-resource farmers are faced with the challenge of making their farm business economically viable. If agroforestry technologies can offer financial gains, efforts should be made to encourage limited-resource farmers to make an investment. Before implementing any educational program to encourage limited-resource farmers to invest in agroforestry, it is advisable to first determine farmers' knowledge about agroforestry.

## Purpose and Objectives

The continual awareness of limited-resource farmers to the growing industry of agroforestry technology and how the industry affects the community is vital to the future of North Carolina's agroforestry growth and the improved viability of limited-resource small farmers. The positive view of agroforestry technology will not only benefit the livelihood of limited-resource farmers, but also enhance environmental conservation. Because few studies have been conducted on the awareness of limited-resource farmers to the growing industry of agroforestry technology and how the industry impacts the community, the objectives were to:

1. Assess if limited-resource farmers in North Carolina understand and believe agroforestry is a business opportunity with the potential to increase their farm income and enhance environmental conservation; and
2. Identify factors that influence limited-resource farmer's decisions to adopt agroforestry technologies.

The following research questions guided the study reported here.

1. What knowledge do limited-resource farmers possess about agroforestry technologies?
2. What benefits do limited-resource farmers perceive as beneficial for adopting agroforestry technologies?
3. What barriers do limited-resource farmers report for adopting agroforestry technologies?
4. What willingness do limited-resource farmers report for investing in agroforestry technologies?

The framework of the study supports Rogers' Diffusion Process, which defines diffusion as "the process in which an innovation is communicated through certain channels over time among the members of a social system." There are four key elements that make up this definition. These interacting factors include innovation, communication, time, and social system. Diffusion of innovation includes both spontaneous spread of new ideas and a planned method of propagating a new idea (Rogers, 2005, p. 6). Rogers says that it is not an all-encompassing theory, but rather a culmination of several theoretical perspectives, all of which relate to the concept of diffusion. These processes involve the innovation-decision process, the individual innovativeness, and the rate of adoption of an innovation.

## Methods

All limited-resource farmers with prior engagement with Extension educators specializing in Forestry Services were identified to participate in the study. They were mailed a letter of introduction inviting them to participate in the study. The study was comprised of 150 limited-resource farmers listed in the North Carolina Agricultural and Technical State University's Cooperative Extension directory of small farmers. Experts in the field of agroforestry reviewed the surveys to ensure content validity. The survey instrument consisting of three sections was mailed to 150 limited resource farmers. Section one of the survey instrument included close-ended questions that collected limited-resource farmer demographic data and their awareness of agroforestry technologies. Section two included seven 5-point Likert-style items to assess the benefits limited-resource farmers believed they would receive from adopting agroforestry technologies. Section three included six 5-point Likert-style items to assess the limited-resource farmers' perceived barriers to adopting agroforestry technologies as well as their willingness to adopt agroforestry technologies.

Multiple mailings were used to give participants the opportunity to report their views on the topic (Dillman, 2000). Data collection was conducted in three stages that lasted 6 weeks. Letters of introduction, questionnaires, and prepaid return addressed envelopes were mailed on June 8, 2012 to the 150 limited-resource farmers. The letter of introduction requested the questionnaires be completed and returned within 2 weeks of receipt. The letter also stressed that the strictest confidentiality would be upheld during the study. Two weeks after the first mailing, 7(4.46%) of the participants responded. On June 25, 2012, a second mailing was made to all non-respondent 143 farmers stressing the importance of their participation in the study. As a result, 51 (37.7%) additional surveys were received. On July 6, 2012, a third and final mailing was sent to all 92 non-respondent farmers, and 34 farmers (37.00%) returned their surveys. Data collection ended on July 20, 2012. Out of 150 farmers, 92 returned their surveys, giving a final response rate of 61.30%.

The SPSS (Statistical Package for Social Sciences, v 20) was used to analyze the data. Descriptive and inferential statistics included frequency distributions, percentages, means, standard deviations, and chi square. According to Babbie (1990), 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. Such information would be helpful to Extension educators and policy makers because it will aid with assessing the need for implementing pragmatic steps and programs to encourage limited resource farmers to participate in educational programs and make informed decisions regarding the adoption of agroforestry technologies.

## Results and Discussion

### Profile of Limited-Resource Farmers

Table 1 details the profile of the limited resource farmers. Due to missing data, none of the variables were equal to 92. More than half (n=64; 73%) of the participants were male. Most farmers were age 40-49 (n=52; 61%). Seventy-three (85.9%) reported farming as their primary occupation. There was a moderate correlation between age and occupation ( $\Phi = .59$ ,  $p < .01$ ; Fisher's Exact Test =26.46). Almost half of the participants reported having incomes between \$30,000-\$49,999 (n=42; 46%), with fewer (n=6; 6.6%) reporting having incomes in the range of \$75,000 and greater. Educationally, almost one half (n=40; 45%) of the farmers reported earning a college degree, while 22 (24.75%)

reported completing some college, and 13 (14.6%) reported earning a high school diploma.

**Table 1.**  
Profile of Limited-Resource Farmers

<b>Variables</b>	<b>f</b>	<b>%</b>
<b>Gender</b>		
Male	64	72.70
Female	24	27.30
	88	100.00
<b>Age</b>		
30-39	11	13
40-49	52	61.20
50-59	8	9.40
60 and over	14	16.40
	85	100.00
<b>Primary Occupation</b>		
Farmer	73	85.90
Retired	12	14.10
	85	100.00
<b>Household Income</b>		
Less than \$10,000	6	6.60
Between \$10,001-\$29,999	13	14.60
Between \$30,000-\$49,999	42	46.20
Between \$50,000-\$74,999	24	26.00
Between \$75,000-\$110,000	3	3.30
More than \$110,000	3	3.30
	91	100.00
<b>Education</b>		
Some high school	6	6.67
Completed high school	13	14.44
Technical certification	5	5.56

Some college	22	24.44
College graduate	40	44.44
A graduate degree	4	4.44
	90	100.00
<i>Note:</i> Percent return based upon ninety-two; due to missing values none of the variables have a sample size equal to 92.		

Participants were asked to report their awareness of agroforestry technologies. Most reported a minimum to moderate level of awareness, including windbreaks/shelterbelts (M=2.66), alley cropping (M=2.65), forest riparian buffer (M=2.47), forest farming (M=2.30), and non-timber forest farming (M=2.26), with crop tree management (M=1.97) reported as the lowest level of awareness (Table 2).

**Table 2.**

Awareness of Agroforestry Technologies reported by Limited-Resource Farmers (n = 92)

<b>Technology</b>	<b>Mean<sup>1</sup></b>	<b>SD</b>
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
1Scale: 1=not aware, 2=minimum level of awareness, 3=moderate level of awareness, 4= maximum level of awareness		

## **Benefits of Adopting Agroforestry Technologies**

Participants were asked to report on the perceived benefits of adopting agroforestry technologies. Table 3 provides participants' responses. Overall, all agroforestry technologies were reported as important. Improves water quality (M=4.30) and protect soils (M=4.29) were reported as the most important, followed by improves wildlife habitat (M=4.23), increases biodiversity (M=4.22), provides shade for livestock (M=4.14), and increases financial security (M=4.11). The least beneficial was diversifies production (M=3.95) (Table 3).

**Table 3.**

Benefits of Adopting Agroforestry Technologies Reported by Limited Resources

Farmers (n = 92)

<b>Benefit</b>	<b>Mean<sup>1</sup></b>	<b>SD</b>
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
<sup>1</sup> Scale: 1=least important, 2=slightly important, 3=moderately important, 4=important, 5= very important		

## Barriers to the Adoption of Agroforestry Technologies

When asked to report the barriers to adopting of agroforestry technologies, the respondents reported that insufficient land was the most important barrier (M=2.04). This is followed by trees use too much water, (M= 2.22), lack of demonstration sites (M=2.25), lack of technical assistance (M=2.28), lack of seedlings (M=2.29), no market for agroforestry products (M=2.29), not familiar with technology (M=2.30), lack of information on agroforestry (M=2.44), and does not seem profitable (M=2.46).

**Table 4.**

Barriers of Adoption of Agroforestry Technologies Reported by Limited Resource Farmers (n = 92)

<b>Barrier</b>	<b>Mean<sup>1</sup></b>	<b>SD</b>
Does not seem profitable	2.46	1.50
Lack of information on agroforestry	2.44	1.44
Not familiar with the technology	2.30	1.56
No market for agro forestry products	2.29	1.51
Lack of seedlings	2.29	1.47
Lack of technical assistance	2.28	1.48
Lack of demonstration sites	2.25	1.52
Trees used much water	2.22	1.41

Insufficient land	2.04	1.32
<sup>1</sup> Scale: 1=most important barrier, 2=important barrier, 3=less important barrier, 4 =least important barrier, 5=not a barrier		

## Willingness to Establish Agroforestry Technologies

The respondents were asked about their willingness to establish agroforestry technologies (Table 5). They reported that their unwillingness was based on the fact that they have to rely on family members for labor and capital (M=1.88) and for paying out of pocket (M=1.85). However, the farmers reported being slightly more willing to enroll in a cost-sharing program (M=2.68) and take out a loan (M=2.51).

**Table 5.**  
Willingness to Establish Agroforestry Technologies Reported by Limited-Resource Farmers (n=92)

Action	Mean <sup>1</sup>	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	.41
Relying on family members for labor/capital	1.88	1.40
<sup>1</sup> Scale: 1=very unlikely, 2=unlikely, 3= neither likely nor unlikely, 4=likely, 5=very likely		

## Conclusions and Recommendations

It was concluded that participants were primarily male and older adults, suggesting the need to attract more females and younger individuals to adopt agroforestry technologies. An increase in female farmers would provide Extension educators the opportunity to offer educational programs to this population emphasizing to them the benefits of adopting agroforestry technologies for economic gains. The increasing number of diversified farm operators presents a new audience for Extension educators and administration, and the need to offer programs according to specific educational needs. The study reported here found that, as more farmers age, fewer individuals farm. This is important to note, because the agroforestry industry is threatened when individuals are less likely to adopt new technological innovations (Keil, Beranek, & Konsynski, 2005).

Furthermore, the study concludes that there is a lack of willingness by farmers for investing in agroforestry as a business opportunity due to having to pay out of pocket for items and the need to rely on family members for labor and capital. To address the lack of willingness, farmers could be educated during trainings on how to apply for soft loans and participate during on-farm demonstrations about agroforestry technologies. As it relates to finances being a barrier for farmers adopting agroforestry technologies, the findings support a study conducted by Sullivan, Huke, and Fox (1992). They found that many of the participants' concerns with adopting agroforestry technologies were related to costs.

The study augments the idea of Jacobson and Kar (2013), who conducted a study to learn about agroforestry Extension programs throughout the United States. They found that there were quite a few issues related to lack of familiarity, complexity, and the time-consuming nature of many agroforestry technologies. Additionally, they reported that more local studies on taking stock of what is out there, doing market development assessments for agroforestry products, and more training on agroforestry technologies would better equip the Extension professionals to ensure widespread adoption of agroforestry practices. Again, the study supports the findings of Jacobson and Kar (2013), who concluded that other major barriers to increasing the knowledge of agroforestry technologies have to do with lack of outreach, training, and demonstrations of agroforestry in action. The study also revealed that overall most respondents felt that agroforestry technologies have the potential to benefit their farming operations.

The study reported here has produced information related to the adoption of agroforestry technologies by limited-resource farmers and revealed prospects for conducting future research. The following recommendations are suggested.

1. Limited-resource farmers should be provided with training programs focusing on needed skills and knowledge to manage agroforestry technologies;
2. Information centers that are readily accessible for farmers with up-to-date information be provided to various counties in the region to cater to the farmers as a whole;
3. Cost sharing programs such as Environmental Quality Incentives Program (EQIP) that promote the adoption of agroforestry technologies should be encouraged for farmers to help their business and conservation practices.

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