ABSTRACT

SHAW, JASMINE DIANE. Landowners' Knowledge, Attitudes, and Aspirations towards Woody Biomass Markets in North Carolina. (Under the direction of Dennis Hazel and Robert Bardon.)

Non-industrial private forest (NIPF) landowners are often not included in discussions of emerging woody biomass markets for energy, yet they will likely be principal suppliers of the resource. In order to determine landowners' knowledge, attitudes, and aspirations towards participating in emerging woody biomass markets, surveys were administered to 475 forest landowners before and after a forestry extension education program in ten counties across North Carolina. Data on program impact, effective marketing strategies, and preferred methods of information delivery was also collected. Three hundred ninety-five surveys were returned and indicated that landowners have low knowledge levels of woody biomass but, as a result of participating in the training, they increased knowledge, had more positive attitudes, and developed aspirations to harvest woody biomass on their land. However, landowners would like more specific information before committing to participate in emerging woody biomass markets. Extension agents were the most effective marketing strategy. Short programs of one to two hours and printed materials were the preferred methods of information delivery. It is recommended that Extension agents specify local and practical applications of woody biomass and dedicate more attention to addressing concerns of landowners to improve the education program in North Carolina. Extension professionals wishing to develop similar woody biomass education programs should use a similar short program format and a variety of teaching methods to engage the audience. Outreach to minority and traditionally underserved landowners also requires considerable development. If Extension professionals do not make a conscious effort to reach out to these populations they

will be effectively excluded from this woody biomass market opportunity. Overall, the findings of this study strengthen the perception of the importance of woody biomass educational programs as a component of renewable energy adoption plans.

Landowners' Knowledge, Attitude, and Aspirations towards Woody Biomass Markets in North Carolina

by
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BIOGRAPHY

Jasmine Shaw knows where she started (Long Beach, California), but not where she'll end up. She loves biking, community transportation systems, yoga, almonds, and recycling. Her eclectic career path has included inorganic chemist, art gallery assistant, and wildlife biologist. Don't let The Man keep you down: "Nous cherchons tous l'inspiration: le meilleur moyen de la trouver est d'être réceptif."

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CHAPTER 1. INTRODUCTION

Forests evoke images of majestic trees, wildlife, camping, or timber production. Woody biomass or downed woody debris does not typically come to mind. Nonetheless, woody biomass is an important component of forest ecosystems and has been used at small scales by humans for thousands of years as a source for cooking, heating, and fertilizer (Carmichael-Timson 2006, Law 2001, Remedio 2002). As world leaders seek to improve energy generation, distribution, and consumption, interest in wood energy is being revived. It has captured high level media and political attention as a potential large-scale supply of renewable energy (e.g. Cutler 2009, Daley 2009, Milstein 2008).

North Carolina is well positioned to become a leader in the promotion and utilization of woody biomass for energy, with 18 million acres of forestland (59% of the total area of the state) and biomass plants already in place or planned. However, non-industrial private forest (NIPF) landowners, who own three-quarters of the forestland in North Carolina (Brown 2002), are often left out of woody biomass energy discussions. Landowners' perspectives of acceptability, profitability, and the need for incentives of woody biomass harvesting are an important area to focus research.

The Cooperative Extension Service, a national land-grant-affiliated educational institution, has initiated landowner education programs and materials focused on woody biomass energy across the United States. This research study is intended as a thorough evaluation of one such program designed and piloted by Forestry Extension at North Carolina State University, aimed at changing the knowledge, attitudes, and aspirations of

landowners with regard to woody biomass utilization for renewable energy. Data on marketing and preferred methods of delivery has also been analyzed. The results inform recommendations for successful design of woody biomass outreach programs. The first three chapters of this study include a brief introduction to the issue, a review of Extension education and evaluation research, and scope and methods. The fourth chapter presents data corresponding to the following research questions with regards to woody biomass education:

- Which marketing strategies and teaching methods work best for educating landowners?
- What impact did the program have in changing knowledge, attitude, and aspirations of landowners?
- Were landowners satisfied with the information presented?
- What are landowners' main concerns and questions?

The fifth chapter summarizes key conclusions and recommendations.

Importance of the Current Study

The research goal was to enhance understanding of NIPF landowners' knowledge, attitude, and aspirations about the emergence of woody biomass energy markets. The limited research available suggests that many NIPF landowners are unaware not only of the social, political, and environmental context, but also very basic information about woody biomass. Woody biomass feedstocks, even though abundant in North Carolina, may be difficult to obtain because harvesting depends on landowner desires and concerns. Emerging woody

biomass markets have the potential to supplement and diversify income. However, if NIPF landowners are unwilling to participate in biomass markets, policy makers may be overestimating available supply. Therefore, the results presented here will help Extension professionals and other assistance foresters to develop effective woody biomass educational programs for forest landowners, with the goal of supplementing landowners' knowledge, and informing their attitudes toward and aspirations for woody biomass markets.

Issue Focus: Woody Biomass Energy

In this report, woody biomass is defined as:

*"**Woody biomass** is the material from trees and woody plants, including limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, farm, rangeland, or wildland urban interface environment, that are the by-products of forest management, ecosystem restoration, or hazardous fuel reduction treatments"* (USDA, 2007).

This is wood traditionally classified as "non-commercial" or "non-merchantable," because of insufficient value in existing markets. It includes forestry byproducts and small diameter, low-value, diseased, or storm-damaged trees. However, wood from short-rotation tree crop plantations or pulpwood that could be harvested for energy is not included.

Energy from woody biomass is obtained through combustion and co-firing of materials such as wood chips and bark with coal (Cassidy 2007) for process steam, heating and chilling, and electricity production. Scientists are also breaking down plant cellulose to produce bioethanol or biodiesel (Gomez et al. 2008). In addition to energy production,

woody biomass can be used as firewood, fencing, livestock fodder, or converted into "biochar" / charcoal, artwork, soil amendments, mulch, and walkways (Law 2001).

New equipment to handle harvesting of small-diameter wood is being designed (see e.g. Hannum 2009). However, standard timber harvesting equipment and chippers are currently being used. In previously high-graded stands, woody biomass may be the only material left to harvest (Hicks et al. 2004, Nyland 1992). More typically woody biomass is an additional product produced in connection with a conventional harvesting or silvicultural operation such as a pre-commercial thinning (Mead et al. 2007).

Environmental Costs and Benefits of Harvesting Woody Biomass

While many NIPF owners do not have timber production as a primary management goal, harvesting woody biomass could help landowners reach both their timber and non-timber related goals. Removing logging slash may improve visual appeal or reduce the risk of wildfire. Thinning can also lessen mortality caused by diseases and insects such as Southern pine beetle (*Dendroctonus frontalis*) (Price 1994). In the Western United States, for example, where bark beetles ravage Rocky Mountain forests, entrepreneurs are selling "the brittle corpses" of pine trees as doors, furniture pieces, and fuel pellets. According to one such entrepreneur, "it brings a tear to your eye but at least we're trying to do something constructive" (Riccardi 2007).

Woody biomass may be a "carbon-neutral" energy source (Atkins 2008). Although CO_2 emissions from collecting and transporting the material may not be accounted for

(Palosuo et al. 2000), woody biomass energy offers a reduction in CO_2 emissions in comparison to certain fossil fuels (Megalos 2009).

Impacts of increased woody biomass harvesting on wildlife are not clear. The absence of woody debris is detrimental to biodiversity and ecological processes (USDA 1993) and results in reduced habitat for some bird, amphibian and reptile species. Fungi, lichens, bryophytes, and arthropods also require woody debris habitat (Carroll 1996). In the absence of research-based threshold volumes of woody debris required by different species, some wildlife biologists take the position that the more left behind the better, particularly in short-rotation plantations (Moorman et al. 1999).

In an effort to mitigate these and other potential negative environmental effects, some states have begun to develop guidelines for biomass harvesting. In Minnesota, for example, it is recommended that at least 20% of trees / logging residues be left on site to be distributed evenly, rather than piled, to maintain soil and habitat quality (Fernholz et al. 2009). It is recommended that extraction be weighed against potential harm to the ecosystem, and integrated with landowner objectives, forest type, site characteristics, and market opportunities (Rural Voices for Conservation 2005, Sample 2007).

Global Status and Political Context

Biomass provides 10.6% of the world total energy supply and 79.4% of the total renewable energy supply (International Energy Agency 2006). Although there is a tendency to connect biomass burning with less-industrialized countries, many industrialized countries

are also users (Food and Agricultural Organization 2005). In Sweden, woody biomass accounts for approximately one-fourth of the total energy supply (Swedish Energy Agency 2006). Indeed, consumption of wood-based energy is predicted to increase globally even in locations where energy feedstocks are imported. MGT Power Limited (United Kingdom) is currently scouting for a steady source of wood chips for a massive $815 million renewable energy plant to be located in northeast England (MGT Power Ltd. 2009).

In the United States, market and policy barriers have generally limited the use of woody biomass as an energy feedstock; however, a convergence of factors support an expansion of wood energy (Silveira 2005, Silveira and Foster 2007). Policies perceived as supporting expansion of and funding for renewable energy programs include the Biomass Research and Development Act (2000), Healthy Forests Restoration Act (2003), Energy Policy Act (2005), Food, Conservation, and Energy Act (2008), and American Clean Energy and Security Act (2009). The Forest Service's national strategy plan also advocates the utilization of woody biomass from national forestland (Society of American Foresters 1979, USDA 2007). However these policies focus on development of large-scale rather than small-scale facilities, and federal programs are limited in scope (Nazzaro and Bixler 2005).

Several individual states have adopted a Renewable Energy Portfolio Standard (REPS) (Becker and Lee 2008)[1]. These are designed to meet a specified percentage of their energy needs from renewable resources by a target date. In August 2007, North Carolina

[1] For a comprehensive source on state, local, utility, and federal incentives and policies that promote renewable energy and energy efficiency see: http://www.dsireusa.org/

became the first state in the Southeastern region to design a REPS, requiring that at least 12.5% of the state's energy come from renewable sources and/or efficiency measures by 2021 (General Assembly of North Carolina 2007). It has been projected that wood energy will constitute a significant portion (~69% or 852 MW) of North Carolina's REPS based on the state's large forestland area and industrial base (Brown 2002, Research Triangle Institute 2002).

CHAPTER 2. LITERATURE REVIEW

Cooperative Extension Education

The Cooperative Extension Service ("Extension"), which is part of the National Institute of Food and Agriculture (NIFA) of the USDA, is a research-based educational service. Operating in each of the fifty states and territories, it consists of a three-tier system: researchers at experiment stations and land grant universities, state extension specialists (generally faculty members at land-grant universities), and agents working at the county or multi-county level across the nation (Barden et al. 1996). Its original goal has not changed: to deliver research-based knowledge generated by land-grant institutions to the general public so that they could make better-informed decisions about their land (Rasmussen 1989). As Kistler and Briers (2003) conclude, "since its establishment in 1914 ... [Extension] has grown to become the largest youth and adult education organization in the United States, if not the world" (p. 213).

Although strongly rooted in agriculture, after passage of the 1924 Clarke-McNary Act, Extension initiated programs in forestry education. Over the years, additional legislation such as the 1937 Norris-Doxey Cooperative Farm Forestry Act, the 1962 McIntire-Stenis Forestry Research Act, the 1978 Renewable Resources Extension Act (RREA), and various Farm Bills have resulted in increasing numbers of Extension staff focused on forestry. Today forestry is a major Extension program area (Wicker 2002).

Woody Biomass Extension Education

In recent years, Extension in the United States has expanded its educational focus to include woody biomass harvesting for energy. In 2004, researchers and specialists from the University of Georgia, Texas A&M University, Southern Forest Research Partnership, Inc., Southern Regional Extension Forestry, and the USDA Forest Service received a USDA grant to develop a woody biomass education training notebook for adult educators to use at landowner meetings, community meetings, and other educational events (Hubbard et al. 2007). In North Carolina, Extension sponsored the 2006 conference "Energy from Wood: Exploring the Issue and Impact for North Carolina" targeted toward policy makers, regulatory agency staff, industry, scientists, and environmental interest groups. In 2007 the "Wood to Energy" education program (part of the *Technology Transfer and Education Programs for the Southern U.S.: Interface Fuels for Bioenergy*) was initiated at the University of Florida. This was designed to help wildland-urban interface (WUI) communities in the Southeast consider the feasibility of local woody biomass energy. Outreach materials including a slide presentation, fact sheets, case studies, and community economic profiles have been compiled into a "Biomass Ambassador Guide" (Monroe et al. 2007).[2]

In 2008 and 2009 woody biomass Extension education activity continued to spread throughout the United States. For example, the Internet-based *Encyclopedia of Southern*

[2] Additional information on the Interface Project is available at: http://www.interfacesouth.org/.

Bioenergy [http://www.forestencyclopedia.net/p/p2] was produced and maintained through collaboration between the U.S. Forest Service Southern Research Station and Southern Regional Extension Forestry. This website synthesizes published scientific information about bioenergy in the southern United States. It is intended to facilitate the transfer of scientific knowledge to natural resource professionals, landowners, and the general public (Gan et. al. 2008). The National Association of Conservation Districts (NACD), in partnership with the Department of the Interior and the U.S. Forest Service, published the "Woody Biomass Desk Guide and Toolkit." This woody biomass outreach material is specifically for use by conservation district, Resource Conservation and Development and Extension professionals (Ashton, McDonell, and Barnes 2009). Another initiative, "Bioenergy: Optimum Incentives and Sustainability of Non-Industrial Private Forests in the U.S. South," is a research partnership of the Universities of Florida, Arkansas, and Virginia Tech formed to conduct research on bioenergy policies that affect private landowners' decisions (Cooperative State Research, Education, and Extension Service 2009).

Despite the number of education and research efforts, there has been no published evaluation of a successful woody biomass education program for forest landowners. Therefore, the current study addresses this research gap, and illustrates North Carolina NIPF landowners' thoughts about participation in emerging markets for woody biomass energy.

Understanding NIPF Landowner Knowledge of and Attitudes toward Woody Biomass Energy

A major obstacle to promoting woody biomass energy is the lack of information (or presence of misinformation) that can produce public opposition. For example, a lack of awareness regarding biomass energy production and harvesting resulted in failed development of a biomass electricity plant in the United Kingdom (Upreti and van der Horst 2004). In Florida, Oxarart (2008) found that participants in a general public focus group were interested in learning more about wood energy, but they were skeptical about the information presented. The focus group expressed feelings of mistrust about forest and energy industries, information sources, and government agencies. This was presumably due to misconceptions about using wood for energy. Almquist (2006), studying environmental organizations in the Pacific Northwest, found both variation in level of awareness regarding utilizing woody biomass and a wariness of subsidies. Holt (2009) found similar confusion among forest contractors and individuals from the timber industry in Oregon, as well as concerns that the biomass industry was "driven by politics" rather than science. Owners and managers of regional sawmills in the Midwest expressed concerns about sustainability, profitability, and delivery. In the same region, however, professional foresters thought that biomass energy markets would encourage landowners to be more proactive in forestry management (Schulte et al. 2007).

Attitudes among landowners are the most important to consider because they are the ones ultimately making management decisions for their land. Williamson (2007) interviewed

NIPF landowners and representatives of the forest industry in Oregon and found profitability to be a primary factor in motivating landowners to harvest woody biomass. Texas landowners showed positive attitudes about potential environmental and economic benefits of woody biomass for energy such as carbon neutrality, reduced reliance on foreign oil, reduced brush control costs, increased income, enhanced rural economies, and utilization of waste (Xu et al. 2008). While some landowners are concerned that renewable energy legislation will limit landowner rights, even in the early 1990s a survey of landowners in the Tennessee Valley (MS, AL, GA, TN, KY, VA, NC) indicated that 76% felt their property rights should be limited, if necessary, to protect the environment (Bliss et al. 1994).

These previous studies provide insights into NIPF landowners' knowledge, attitudes, and aspirations for woody biomass. This evaluation study will provide further insight into NIPF landowners in North Carolina and serve as a reference point for Extension professionals in how to design a woody biomass energy education program that best fits landowner needs.

Target Audience: Non-Industrial Private Forest Landowners

As shown in past surveys, NIPF landowners have indicated preference for education over government cost-share programs as a means to encourage woodland management (Jones et. al 1995). Education can be a powerful motivator and lead to changes in knowledge, attitudes, and behaviors. However, in order for it to reach its full potential, educators should be acquainted with their clientele (Decker et al. 1988, Downing and Finley 2005).

At more than 11.3 million, NIPF landowners are the dominant forestland ownership group in the United States. In the most recent National Woodland Owner Survey (Butler 2008) it was estimated there are 525,000 family forestland owners in North Carolina alone. They own approximately 15.5 million acres of forestland, more than three-quarters of the total forested acreage of the state. Most own tracts of 50 acres or less, but together they have a large collective impact on forests (Birch 1996).

North Carolina NIPF landowners have been surveyed periodically since the 1960s. The average North Carolina NIPF in 1964 was approximately 55 years old, with a junior high education, and land tenure of 21.6 years. Twenty-four percent cited that growing timber for sale was one reason they owned forestland (Pomeroy and Yoho 1964). The following year a survey showed 22.1% had sought service from Extension, a factor that was positively correlated to tract size, higher educational levels, and regional location (i.e. the Mountains) (Muench 1965). Today, compared to the 1960s, the average North Carolina NIPF landowner has a higher income, higher educational level (at least some college), but is of about the same age (62) and experience (~25 years) (Miller 2006).

Just as North Carolina's landscape varies from the Coastal Plains to the Mountains so do its landowners. Megalos (2000) found that Mountain region landowners are more likely to own their forests for green space and private residence while landowners in the Coastal Plains have more farm- and timber-related objectives. Coastal Plain landowners preferred technical assistance or educational incentives compared to Piedmont and Mountain landowners. However, urban county landowners were less likely to be interested in

educational programs, demonstrations, and tours. In the same study, it was found that only 16% of North Carolina's NIPF landowners had management plans. Those not harvesting timber believed their tracts were too small or in too many locations. They did not know where to start, or it was not a personal priority, or did not like the aesthetics of a harvested area.

Minority and Underserved Landowners

Extension's mission statement includes the goal of helping "a diverse people improve their lives." However, many Extension professionals do not succeed in reaching minority and traditionally underserved landowners and communities (Hughes et al. 2005). For minorities that do participate in Extension programs, they have been found to have somewhat lower quality experiences with Extension services in comparison to whites (Israel and Galindo-Gonzalez 2009).

It is sometimes difficult for populations that are traditionally underserved to seek and accept forestry assistance. There may be distrust of federal and state agencies, relatively lower educational attainment, less familiarity with technical forestry, as well as cultural, racial, or ethnic disparities between landowners and assistance foresters (Warren et al. 2002).

When programs clearly lack minority and traditionally underserved landowner participation, it is up to program planners to make specific outreach targeting these groups. In a focus group held in North Carolina in 2006 traditionally underserved landowner participants agreed that there are many existing programs that could be helpful to them.

Some research has shown, however, that information about such programs needs to be more user-friendly (e.g. by providing materials for limited vision or limited literacy materials) (Mance et al. 2004, Warren et al. 2002). Formal advisory committee meetings, informal conversations with diverse clientele, and having an Extension agent of the same race or ethnicity can improve program delivery for these specific audiences. However, Extension is "not always met with open arms" (Tuttle et al. 2009). Thus it is generally recommended that Extension partner with community groups.

Cultural differences to take into account include Guion and Kent's (2005) suggestion to adjust to preferences for oral communication, by including open discussion sessions. Tuttle et al. (2009), working extensively with Native Americans in Arizona and New Mexico, advise agents to allow for time modification because some participants arrive between fifteen minutes to an hour late. Also, the use of face-to-face, oral, quick and simple evaluation (e.g. Likert or Borich scale) is more likely to produce consistent feedback (Tuttle et al. 2009).

Program Evaluation

Cooperative Extension is required to document the impact of their services in the form of evaluations (Duttweiler 2008, Radhakrishna and Martin 1999). Program evaluation is the systematic collection, analysis, and reporting of information to monitor whether program goals are being met and to address questions of program quality, performance, impact or merit (Wholey et al. 2004). Sponsors and policy / decision makers need these data to justify

program expenses, but, with a limit of resources, time, and money, not every program can be evaluated. Programs worth evaluating have well-defined, achievable goals and the potential to make a contribution to increasing knowledge (Wholey et al. 2004).

Pre- and post-activity reaction questionnaires by themselves do not provide a rigorous method for isolating cause-and-effect relationships, nor do they necessarily address the "how and why" questions. Evaluation's contribution to the process is indirect at best, but can be of use in influencing program direction, improving existing practices, informing public policy or eliminating ineffective programs (Wholey et al. 2004). The evaluation process is not seeking so much to make decisions as to inform them as a "catalyst" for program change (Sandison 2006, p.15).

Generally, there are two forms of evaluation: "formative" and "summative" (Scriven 1967). Formative evaluation examines the inputs, context, and methods by which a program is formed. It emphasizes program improvement and revision. Summative evaluation concerns the outcomes, impacts, and benefits of the program as a means to prove its effectiveness and potential for continuation. These forms of evaluation are not mutually exclusive and often, as in this research study, evaluators use a combination of the two.

In a review of ten years of evaluation studies published in the *Journal of Extension* (1998–2007), Duttweiler (2008) found a "typical" program evaluation has the dual purpose of outcome documentation and educational process improvement, is statewide in scope, and employs survey methods. Few studies focused on program documentation or program fidelity while approximately 70% involved program improvement. Two-thirds were single-point-in-

time, 10% used pre- and post-testing, 9% focus groups, and 8% qualitative interviews (Duttweiler 2008). This demonstrates the dominance of short-term and quantitative evaluation efforts in Cooperative Extension for the purpose of enhancing programs.

Evaluation Models

Various individuals and organizations have developed their own methods for implementing evaluations. *Bennett's Hierarchy* and its expanded version *Targeting Outcomes of Programs* (TOP) are widely used evaluation models in Extension (Rockwell and Bennett 2004). Both are based in logic model theory that uses a simplified diagram of a program illustrating relationships between five core components: inputs, outputs, participation, outcomes, and short-term, medium-term, and long-term changes (Braverman and Engle 2009). Evaluation is integrated across the entire model. A logic model was developed for this woody biomass evaluation study [**Figure 1**].

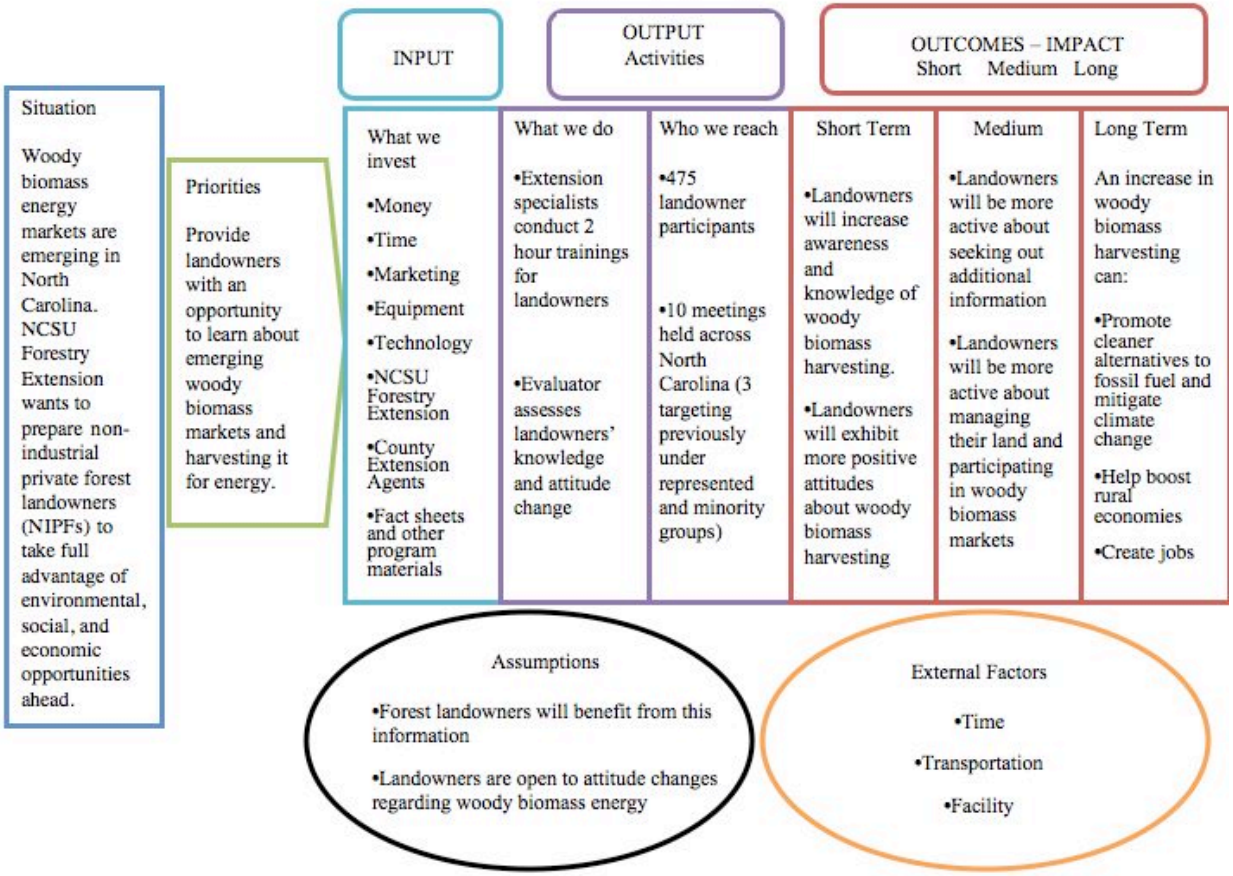


Figure 1. Logic Model Developed for the NC Woody Biomass Landowner Trainings

Bennett, an Extension agent, developed the hierarchy model in 1976 because at the time many program objectives were vague, or nonexistent, or were not being implemented in a way to achieve useful results. The hierarchy consists of seven components linked together in a stair-step "chain of events."

The first step is inputs, or resources expended in order to put on the program. Second, inputs are used to develop activities and educational materials. Third, clients are targeted to obtain program participation. Those participants have positive, negative, or neutral reactions, the fourth step. The fifth step is where teaching and learning take place. If learning occurs participants develop new *knowledge*, change *attitudes*, gain *skills*, and *aspire* to change behaviors (KASA changes). Sixth, participants exhibit behavior or practice change. The seventh step and ultimate aim of the framework is the possibility of improving the *social*, *economic*, and/or *environmental* (SEE) conditions of society (Bennett 1975).

Bennett's Hierarchy is easy to use and well adapted for research studies; however, it oversimplifies reality and the actual sequence of events does not necessarily proceed in that order (Bennett and Rockwell 1995). Another weakness is that as one ascends the hierarchy, the difficulty and cost of obtaining evidence of accomplishments increases due to other sources of influence and greater time lag. Since it is often not possible to measure end results during the program, educators tend to rely on assessing resources, activities, participation, and reactions to demonstrate program value, rather than changes in KASA, practices, or SEE conditions (Morford et al 2006).

In the expanded two-part TOP model, the links in the hierarchy remain the same as in the original, with the assumption that program planning is a reflection of the evaluation process [**Figure 2**] (Bennett and Rockwell 1995). This is an improvement over Bennett's single hierarchy because, by first mapping out the program, evaluations are more likely to contain appropriate questions that truly measure whether objectives are met. However, one must be cautious in the use of any evaluation model as an over-simplified, top-down approach in which program participants are viewed as passive recipients. Potential cause-effect relationships are numerous, not contained to predetermined boxes and arrows (some use circular arrows and loops to help correct this) (Taylor-Powell and Henert 2008). The relationship between knowledge and action unfolds over time and programs do not necessarily lead to definite knowledge, attitude, and behavior transformation. Relapse or discontinuance is possible at any point (Hubbard and Sandmann 2007, Moxley and Lang 2006, Prochaska et al. 1992).

The evaluation approach of this study is based on the TOP model. Its limitations are acknowledged.

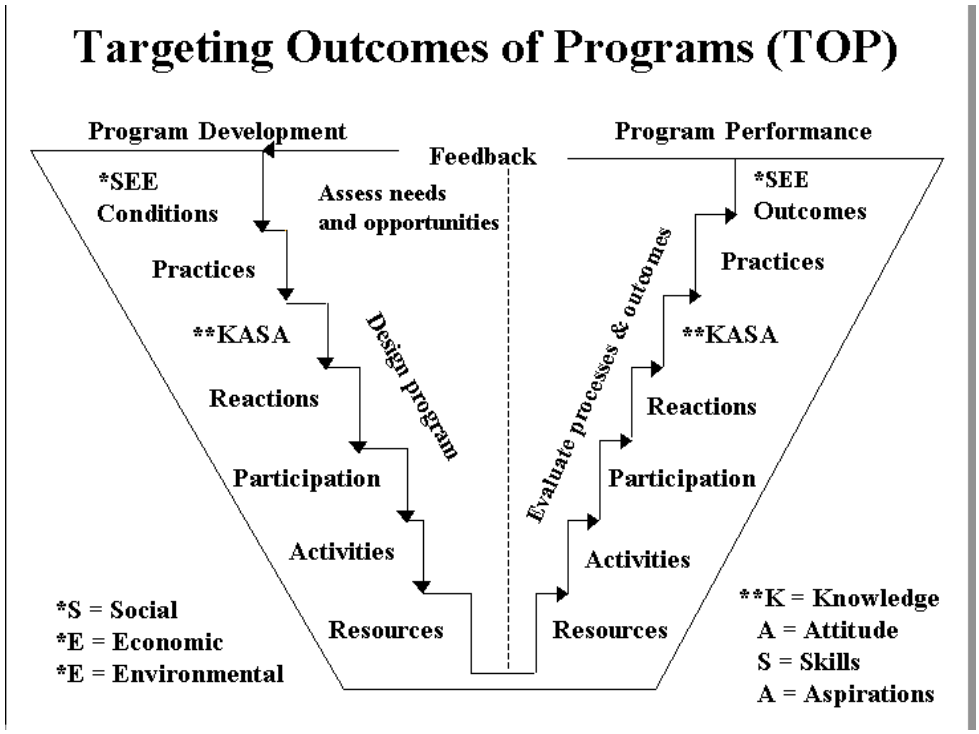


Figure 2: Targeting Outcomes of Programs [TOP Model] (Rockwell and Bennett 1995)

CHAPTER 3. SCOPE AND METHODS

In 2008 North Carolina State University (NCSU) Forestry Extension developed a NIPF landowner outreach educational program entitled, "Utilizing Woody Biomass for Renewable Energy in North Carolina: What it Means for Forest Landowners." This study examines the methods by which the program formed, and documented the outcomes and benefits of the program in order to examine its effectiveness and recommend whether it should be continued. The evaluation was designed to answer the following research questions:

- What marketing strategy was the most effective?
- What delivery method do landowners prefer?
- What was the program's impact in terms of changing knowledge, attitude, and aspirations of participants?
- Were landowners satisfied with the information presented?
- Were any concerns or questions not addressed?

The study hypotheses were: 1) Extension county agents are the most effective marketing strategy for meetings, 2) NIPF landowners prefer short meetings, 3) NIPF landowners in North Carolina have a low knowledge base of woody biomass, and 4) as a result of participating in the program NIPF landowners would increase in knowledge of, attitudes about, and aspirations for harvesting woody biomass on their land.

The Program

The two-hour educational training consisted of presentations given by four Forestry Extension professionals from NCSU. While Extension agents at the county level serve as front-line educators and information resources in this arena, the majority of county agents do not have backgrounds in natural resources or forestry (Bardon 2001). As a result they rely on the expertise of university-based Extension specialists to provide educational opportunities for current developments in forestry research such as woody biomass energy.

Topics included renewable energy legislation, market information, and potential environmental and social impacts of woody biomass harvesting. The presenters used a variety of teaching methods from PowerPoint presentations to flip charts. Afterwards a question-and-answer discussion gave participants an opportunity to query presenters on specific points needing clarification or to voice their concerns. In order to maximize attendance, the meetings were conducted on a weeknight and dinner was served (with the exception of one weekday morning and one Saturday meeting). Ten woody biomass trainings were conducted across North Carolina between September 2008 and February 2009 [**Table 1**]. Follow up activities such as enhancement of a website [http://www.ces.ncsu.edu/forestry/biomass.html] with links to fact sheets are ongoing.

Table 1
Woody Biomass Training Locations and Dates

Training location	Date
Wilkes County, Cooperative Extension (CE) center	09.04.08
Stanly County, CES center	09.09.08
Lenoir County, CES center	09.11.08
Rutherford County, CES center	09.24.08
Edgecombe County, CES center	09.25.08
Alamance County, CES center	10.06.08
Webinar, various	10.07.08
Harnett County, CES center	10.21.08
Wake County, North Raleigh Hilton Hotel	01.10.09
Halifax County, Tillery community center	01.15.09
Pender County, Willing Workers office / farmhouse	02.19.09

One of the main objectives of the program was to raise NIPF landowners' awareness of the role of woody biomass markets in their future forest management plans. Educators highlighted woody biomass harvesting as a "tool" by which other management objectives, and not only those associated with the production of commercial timber, could be obtained. The focus was on increasing knowledge, but NCSU Forestry Extension also hoped for changes in attitudes and intended behavior.

In addition to the ten county meetings, the training team hosted one webinar with the same content as the in-person trainings. A webinar is a workshop delivered over the Internet that may include, as in this case, interaction between the audience and the presenters. This technology is more likely to attract an audience of younger landowners with high levels of education and income based on Bardon et al.'s (2007) research study on their preferred information delivery methods.

Participants

North Carolina has one hundred counties within which forest resources are unevenly distributed (Brown 2002). To ensure landowners from different regions of the state would be represented, we stratified the sample to include one county from all but one of North Carolina's seven Cooperative Extension districts. In order to maximize efficiency of program delivery, educational efforts were mostly targeted in the Piedmont and Coastal Plain regions and in rural areas (Megalos and Cubbage 2000). In addition, locations for the meetings were in areas that exhibited potential for emerging woody biomass markets and had a reliable county agent to help organize and market the meeting. The initial list of seven counties was: Alamance, Edgecombe, Harnett, Lenoir, Rutherford, Stanly, and Wilkes. Because of low minority landowner representation at the seven initial trainings, Forestry Extension worked with community groups and subsequently targeted Halifax, Pender, and Wake counties to obtain better minority representation [**Figure 3**].

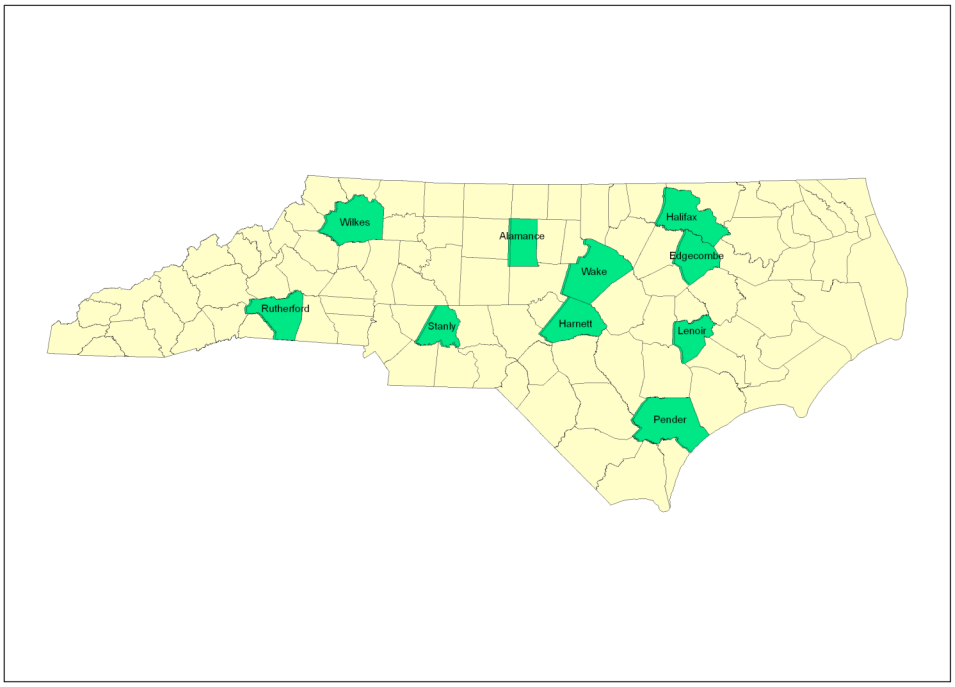


Figure 3: North Carolina Counties Where Woody Biomass Trainings Were Held

Probability sampling is regarded as the preferable method in survey research (Taylor 1993). Sampling errors are minimized and results can be generalized to the entire group. However, when conducting a program evaluation, probability sampling is impractical or even unethical (Wholey et al. 2004). Therefore, this study uses a nonprobability sampling technique that is a combination of convenience sampling and purposive sampling (Wholey et al. 2004). In a convenience sample a unit is self-selected and easily accessible (e.g. participants voluntarily attend a training). In purposive sampling, researchers select participants on the basis of attributes important to the

evaluation. Thus, three county meetings were specifically targeted at obtaining minority and traditionally underserved forest landowner participation.

Attendance at the programs is representative of only a small fraction of overall state woodland ownership. Results cannot be extrapolated to the larger population of North Carolina's NIPF landowners. Participants had a heightened interest in the subject, which may translate into earlier adoption of the knowledge, attitude, and aspiration changes hoped for by Extension staff. For a more rigorous impact study, a survey of all the NIPF landowners in a county or region and not just those participating in the program should be undertaken.

Pre- and Post-Test Method

Experimental design, in which participants are assigned randomly to either a control or an experimental group, is the most rigorous assessment of a program's impact. However, it is costly and withholding information to the control group may be unethical or even impossible because Extension releases information through public media (Wholey et al. 2004). Quasi-experiments are more practical for Extension program evaluation. We used the pre- and post-test design in which participants are "tested" before and then again after the program with the assumption that differences seen between the two times are attributed to the program. This procedure is commonly used to evaluate programmatic impact in Extension (Cloughesy 2001).

The Evaluation Instrument

Evaluation surveys are the most frequently used data collection method in educational and evaluation research and a relatively inexpensive way to gather information from a large number of people. In a review of 748 agricultural and Extension education research studies, Radhakrishna, Leite, and Baggett (2003) found that 64% used questionnaires. However, in order to avoid the quantitative limitations of survey data, our research study also utilized open-ended response questions and participant observation.

The pre- and post-evaluations used for this research can be found in **Appendix A**. The three-page pre-test survey is composed of 32 questions and the four-page post-test consists of 36 questions, 20 of which are repeated from the pre-test. The evaluation instrument was designed in consultation with the program planners and made use of Dillman's (2009) recommendations for writing and ordering questions and answers, selection of appropriate scales of measurement, and formatting. The survey included rank-order, forced choice, five-point and four-point Likert-scale, open-ended, close-ended, and partially close-ended questions. An Internet version of the Webinar evaluation was administered using SurveyMonkey [http://www.surveymonkey.com/]. It utilized the same questions as the printed version except that participants could only see one question at a time and the computer program facilitated skip logic.

In survey science the questions asked are of central importance (Dillman 2009). Demographic information on sex, age, ethnicity, education level, years of experience, and acreage owned was collected in order to analyze how these attributes vary with other

types of information. Participants were asked how they found out about the training and the reason for attending – useful information for extension agents looking to market similar woody biomass programs in the future. Since woody biomass energy is a new topic, questions on the participants' preferred method of delivery of information were also asked (Roucan-Kane 2008).

Ten true and false questions were included to test what landowners knew and how well they understood the topic. Care was taken to avoid general knowledge questions and attitudinal statements. To document changes in knowledge the same set of questions were asked before and after the educational session. Similarly, 10 questions were asked to measure changes in attitude using a five-point Likert scale. In the post-test, 4 aspiration questions were included to determine the likelihood that participants would apply what they learned. Because learning environment can contribute to changes in knowledge, attitudes, and aspirations, participant satisfaction was also documented with this program (Terry and Israel 2004).

While not a large component of this research, responses to open-ended questions and participant observation at the meetings supplemented the quantitative survey data. Participant observation data was collected by watching, listening, and documenting reactions and behavior of participants at the meetings. Data were then sorted by content, categorized, and coded by common themes (Patton 2002). In coding the data, this study applied emergent rather than preset categories.

Reliability and Validity

Validity is the amount of systematic or built-in error in the measurements (Norland 1990). The study instrument was assessed for validity by a panel of four North Carolina State University faculty with expertise in research methods, forestry extension, and evaluation. Points of confusion or misunderstanding were corrected before the printing of the final instrument.

Reliability is random error in measurement and indicates the accuracy of the measuring instrument when used again with the same group of individuals (Norland 1990). The statistic *Cronbach's alpha* summarizes the internal consistency of items in an index (Carmines and Zeller 1979). An *alpha* of 0.7 is considered to indicate good internal consistency, although an *alpha* of 0.6 is acceptable for exploratory research (Richman et al. 1980). To test for reliability a pilot test of the evaluation was conducted in Chatham County, North Carolina. Eight local landowners, consulting foresters, and other natural resource professionals participated. Results indicate an *alpha* of 0.60, which is acceptable for the exploratory study. The pilot test data was not included in the final analysis.

Sources of Error

Most scholars recommend a minimum of 50 to 85% response rate to a survey to protect against nonresponse error (Lindner et al. 2001). A high response rate is probable with a captive audience, especially if the participants are made aware of the importance

of the study. In this study the evaluator was present at delivery of the survey, thus making it easy to clarify questions. In order to further enhance response rate, the evaluation was brief and utilized large font in anticipation of an older audience (Dillman 2009).

Certain internal and external validity problems are associated with ensuring that changes measured are a result of the educational program. Sources of potential threats to internal validity in our study include attrition (participants not completing the program / post-test), and the natural tendency of data to move toward the mean (Wholey et al. 2004). Problems also arise when there is a discrepancy between the true situation and the test results. The program being evaluated in this research study is made up of volunteer participants; participants are aware they are being measured, and the same questions are used on the pre- and post-test. These factors raise the likelihood of a false positive or type I error, in which the program does not have the desired effect but the statistics suggest that it does.

Ethical Considerations

Before conducting this research, it was ensured that the evaluation instrument and study design complied with both the American Evaluation Association's Standards for educational evaluation and the NC State Institutional Review Board's (IRB) guidelines for research on human subjects. A consent form accompanied the evaluation, communicating to participants the evaluation's purpose, duration, procedures, and any benefits or possible risks. In addition, participants were volunteers and able to withdraw

at any time without penalties or loss of benefits. To allow for the protection of sensitive information, numerical codes were used to match pre-test and post-test scores.

Data Analysis

Statistical Package for Social Sciences (SPSS) software (version 16.0) was used to analyze the quantitative data with descriptive statistics, t-tests, and Person's correlation coefficient. The reported frequencies are valid percentages, percent total that responded to the question, and do not include non-respondents.

IV. RESULTS AND DISCUSSION

Four hundred and seventy-five participants attended the meetings, a mean of 42 per meeting, representing 60 of North Carolina's 100 counties. Of the total 475 surveys administered, 395 partially or fully completed questionnaires were returned and entered into the final data set. This comprised an overall response rate of 83.2%. Socio-demographic statistics were collected to define the audience.

Female to male ratio was similar to previous surveys of NIPF landowners in North Carolina [**Table 2**] (Miller 2006). Prior to hosting the last three meetings targeted at minority and underserved landowners, African-American attendance totaled two participants. NCSU Forestry Extension addressed the issue by targeting their participation at three additional trainings. It was only with additional efforts made by the research team that minority attendance increased from 0.3 to 12.1% [**Table 3**].

Table 2
Sex Distribution of Participants at NC Woody Biomass Trainings (N=344)

Sex	*n*	%
Male	236	68.6
Female	108	31.4

Table 3
Ethnic Distribution of Participants at NC Woody Biomass Trainings (N=340)

Ethnicity	*n*	%
Caucasian (Non-Hispanic)	299	87.9
African-American	37	10.9
Mixed Race	4	1.2

Collaboration with non-governmental organizations such as The Conservation Fund was essential in helping contact underserved landowners in North Carolina. Also, rather than hosting meetings in Extension facilities, "neutral" territory such as old farmhouses and community centers were used.

However, we found that building acceptance of extension efforts and continued relationships will not occur immediately. Extension must return frequently to work with these landowners, making their presence known and trusted. At some of the later meetings serious topics such as discrimination surfaced. One participant noted,

> "Here in Halifax County we just get lip service, [Extension] comes but no one does the follow-up. We have lots of timberland but haven't had access to the information and are still dealing with racial divides."

Another commented,

> "Without any connection to Cooperative Extension we have been duped. Loggers come in and people don't know any better, also we don't know what programs exist and what to take advantage of."

While minority and underserved landowners clearly benefited from the woody biomass energy education program, in many cases they lacked basic forestry knowledge. This lack of basic knowledge indicates a greater need for general forestry Extension programs.

Educational level demographics of the audience at this training program were similar to those collected in recent surveys of NIPFs in North Carolina (Butler 2008, Miller 2006). Over three-fourths (78.4%) of participants attending the training possessed some college or higher level of education [**Table 4**]. The majority of participants (58.3%) purchased their land [**Table 5**].

Table 4
Distribution of Participants at NC Woody Biomass Trainings by Education Level (N=341)

Education	*n*	%
Grade 8 or less	2	0.6
Some high school	7	2.1
High school diploma or equivalent	65	19.1
Some college	61	17.9
Associate's or technical degree	46	13.5
Bachelor's degree	95	27.9
Graduate degree	65	19.1

Table 5
Distribution of Participants at NC Woody Biomass Trainings by Land Acquisition (N=314)

Land acquisition	*n*	%
Purchased	183	58.3
Inherited / gifted	137	43.6
Marriage	32	10.2

Average acreage owned was larger (152.42 acres) than state averages for landowners participating in the woody biomass training [**Table 6**] (Butler 2008). This may be because harvesting woody biomass is a more feasible option on larger tracts of land and thus attracts those with larger landholdings. However, one-third of participants were attending their first Extension meeting, 42.1% did not have a management plan and 36.6% had never consulted a professional forester [**Table 7**].

Table 6
Distribution of Participants at NC Woody Biomass Trainings by Age, Acreage, and Duration of Forest Land Ownership

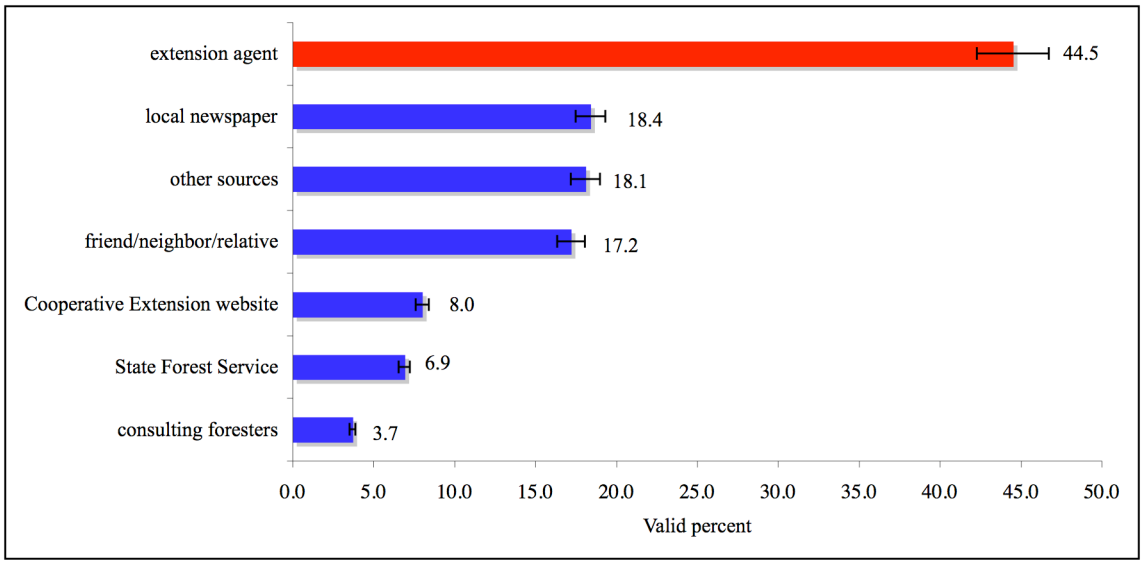
Experience	*n*	Mean	SD
Average age (years)	338	60.62	13.70
Acreage owned	327	180.38	365.22
	324	152.42*	219.03
Length of time owned land (years)	311	27.58	22.07
	306	26.00*	16.56

*Mean with outliers removed.

Table 7
Distribution of Participants at NC Woody Biomass Trainings by Additional Characteristics

Additional characteristics	*n*	%
Have attended Extension meetings in the past	232	68.0
First Extension meeting	109	32.0
Have management plan	187	57.9
Do not have management plan	136	42.1
Have used a professional forester	204	63.4
Have not used a professional forester	118	36.6

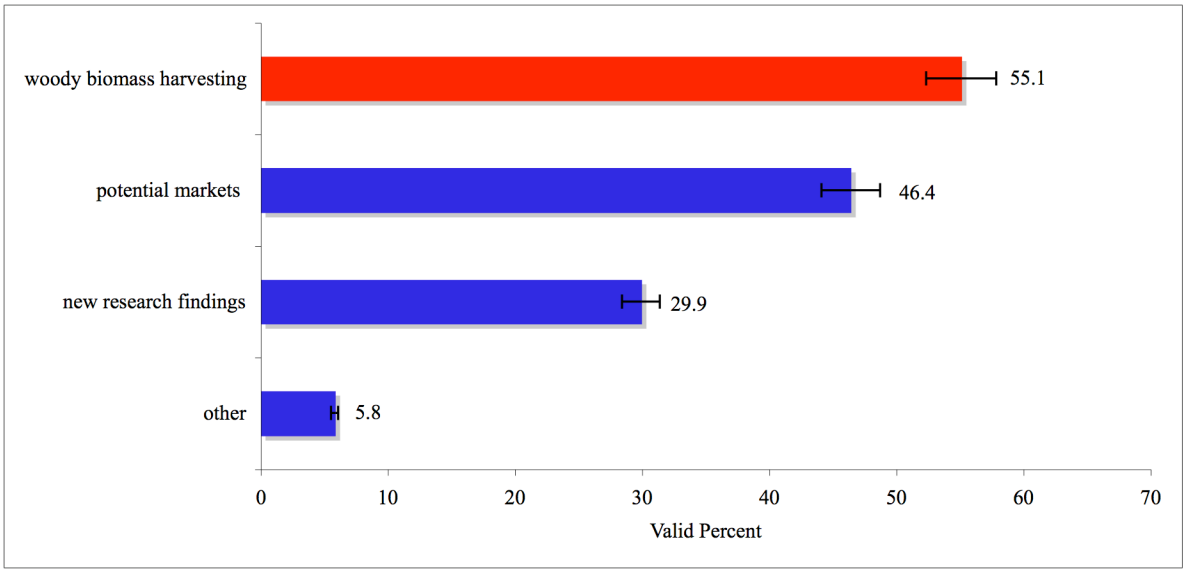
Although participants learned about the program from a variety of modes including newspaper, Internet, and word of mouth, Extension agents were the most important in marketing the program successfully [**Figure 4**]. 18.1% learned about the training from sources other than those we had anticipated: this group was primarily minority and underserved landowners, who do not have a strong relationship with county Extension agents. They learned about the program from non-governmental organizations operating in communities. Only 8% of all participants learned about the trainings from the Cooperative Extension website.



Error bars represent 95% confidence intervals.

Figure 4: How Landowners Learned About the NC Woody Biomass Trainings

In marketing the program, it was found that more landowners were interested in all the aspects of biomass harvesting, as opposed to specifically in "potential markets" [**Figure 5**].



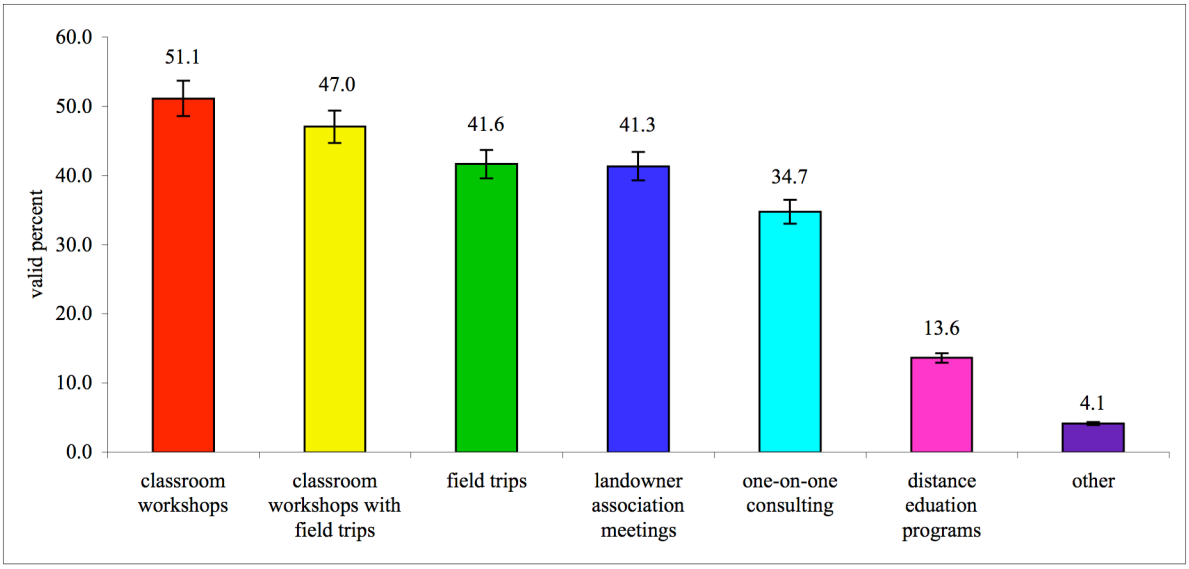
Error bars represent 95% confidence intervals.

Figure 5: What Landowners Came to Learn at the NC Woody Biomass Trainings

Landowners preferred traditional methods for receiving information about woody biomass harvesting [**Figure 6**]. Findings revealed that 51.1% of the participants preferred classroom workshops, 47% classroom workshops combined with field trips, and 41.6% preferred field trips. Only 13.6% of the participants preferred distance education as a method for receiving information.

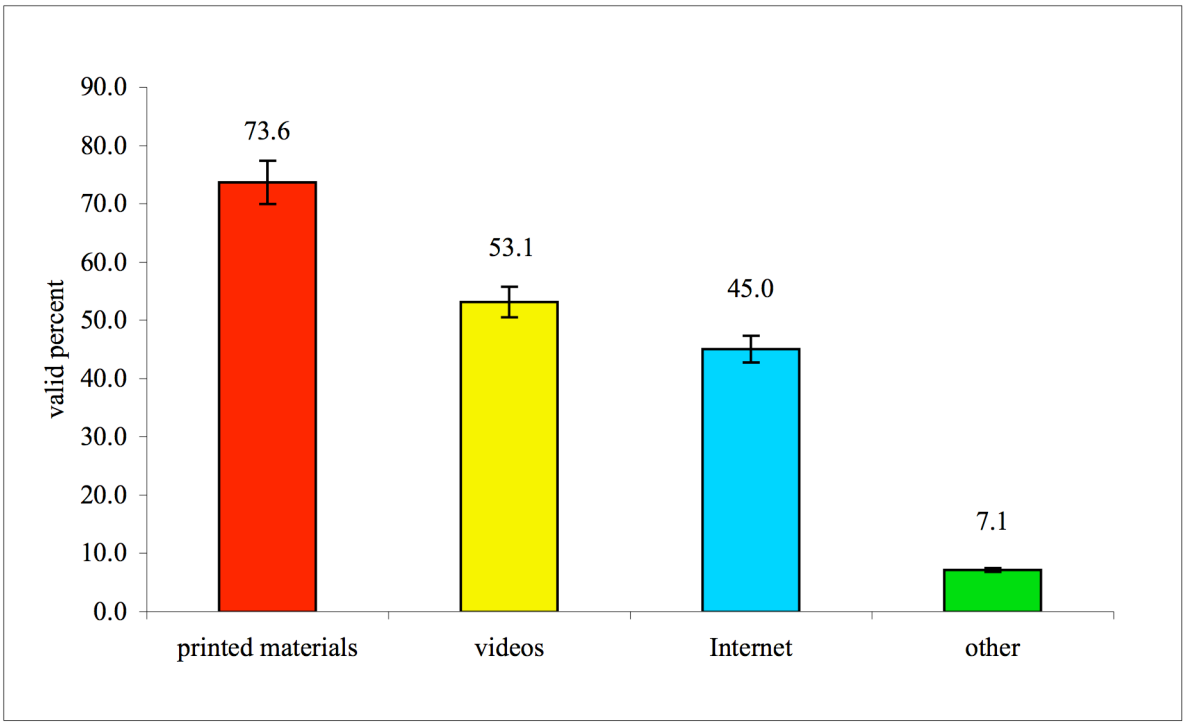
The majority (76%) of the participants identified printed materials as the most preferred medium of receiving information. Videos (49.8%) and Internet (44.4%) were identified as second and third most preferred mode of receiving information [**Figure 7**]. When developing woody biomass education programs, educators should have success with traditional formats such as short programs. They should provide a variety of

resources for accessing the information, particularly printed materials which were most preferred by program participants. Webinars have the potential to reach a younger demographic of landowners; however, without enough participants in our webinar to make a statistically valid comparison of results to the in-person meetings it is unclear whether the same changes in knowledge and attitude would occur.



Error bars represent 95% confidence intervals.

Figure 6: Preferred Methods of Learning of Participants at the NC Woody Biomass Trainings



Error bars represent 95% confidence intervals.

Figure 7: Preferred Resources for Additional Information by Participants at the NC Woody Biomass Trainings

Program Outcomes

An important objective of the study was to find out what North Carolina's landowners know, think, and are aspiring to do about woody biomass harvesting as a result of attending an Extension education program. Ten true and false type questions were used to test participants' knowledge about woody biomass harvesting. The mean of the correctly answered questions at the pre-test was 4.4 and the mean of the correctly answered questions at the post-test was 8.1. The comparison of pre- and post-test means indicates that participants' knowledge improvement was statistically significant at the

p<0.001 level [**Table 8**]. The comparison of pre- and post-test scores for individual participants indicates that 87.6% of them were able to improve their knowledge about woody biomass harvesting [**Table 9**]. Although most landowners in the study were well educated, overall they had little prior information on the topic and were unaware of future opportunities in woody biomass markets.

Table 8
Comparison of Pre- and Post-test Knowledge Score Means of Participants at NC Woody Biomass Trainings (N=314)

Variable	Pre-Test Mean	Post-Test Mean	*t*	*p*
Knowledge test score (out of 10)	4.37	8.08	24.08	0.000**

**significant at p<0.001 (2-tailed)

Table 9
Distribution of Participants at NC Woody Biomass Trainings by Change in Knowledge

Change category	*n*	%
Participants who had positive change	275	87.6
Participants who had no change	33	10.5
Participants who had negative change	6	1.9

Their attitudes towards woody biomass harvesting became more positive as well, but with some reservations. A ten-item scale was used to record participants' attitudes toward biomass harvesting. The aggregated value on this scale ranges from 10 being the most negative to 50 being the most positive attitude about biomass harvesting. The mean of the participants' attitudes toward woody biomass harvesting at the pre-test was 34.9 and the mean of the participants' attitudes at the post-test was 37.9. Even though this was

a relatively small change, it was statistically significant at the p<0.001 level [**Table 10**]. The comparison of pre- and post-test attitude values for individual participants indicates that 67.6% of the participants were able to develop more positive attitudes toward woody biomass harvesting [**Table 11**]. The greatest change in attitude was for the statement: "I can lower my reforestation costs through biomass harvesting." The statement that participants most readily agreed with was "North Carolina needs to develop renewable energy."

Table 10
Comparison of Pre- and Post-test Attitude Score Means (N=309) of Participants at NC Woody Biomass Trainings

Variable	Pre-Test Mean	Post-Test Mean	*t*	*p*
Attitude test score (out of 50)	34.90	37.87	9.22	0.000**

**significant at p<0.001 (2-tailed)

Table 11
Distribution of Participants at NC Woody Biomass Trainings by Change in Attitude

Change category	*n*	%
Participants who had positive change	209	67.6
Participants who had no change	29	9.4
Participants who had negative change	71	23.0

Pearson's correlation coefficient was used to test relationships (2 tailed, p<0.001) between some of the NIPF landowner variables and changes in knowledge and attitude. Certain segments of the audience demonstrated a greater program impact in the form of knowledge and attitude change.

Age was negatively correlated with post-test knowledge and attitudes and overall knowledge and attitude change [**Tables 12 & 13**]. Acreage was not significantly correlated to knowledge or attitude levels of participants [**Tables 14 & 15**].

Table 12
Correlation Between Knowledge and Age of Participants at NC Woody Biomass Trainings

Comparison Value	Correlation with Age	*p*
Pre-test Knowledge	-0.001	0.982
Post-test Knowledge	-0.195	0.001**
Knowledge Change	-0.137	0.017*

*significant at p<0.05 (2-tailed)
**significant at p<0.001 (2-tailed)

Table 13
Correlation Between Attitude and Age of Participants at NC Woody Biomass Trainings

Comparison Value	Correlation with Age	*p*
Pre-test Attitude	-0.048	0.383
Post-test Attitude	-0.226	0.000**
Attitude Change	-0.131	0.024*

*significant at p<0.05 (2-tailed)
**significant at p<0.001 (2-tailed)

Table 14
Correlation Between Knowledge and Acreage of Participants at NC Woody Biomass Trainings

Comparison Value	Correlation with Acreage	*p*
Pre-test Knowledge	0.073	0.188
Post-test Knowledge	0.008	0.896
Knowledge Change	-0.052	0.377

Table 15
Correlation Between Attitude and Acreage of Participants at NC Woody Biomass Trainings

Comparison Value	Correlation with Acreage	*p*
Pre-test Attitude	0.070	0.210
Post-test Attitude	0.097	0.100
Attitude Change	0.022	0.710

Land tenure was positively correlated to pre-test knowledge but negatively correlated to overall knowledge change [**Table 16**]. There was no significant correlation between years of land tenure and attitude [**Table 17**].

Table 16
Correlation Between Knowledge and Years of Land Tenure of Participants at NC Woody Biomass Trainings

Comparison Value	Correlation with Years of Land Tenure	*p*
Pre-test Knowledge	0.131	0.021*
Post-test Knowledge	-0.098	0.105
Knowledge Change	-0.204	0.001**

*significant at p<0.05 (2-tailed)
**significant at p<0.001 (2-tailed)

Table 17
Correlation Between Attitude and Years of Land Tenure of Participants at NC Woody Biomass Trainings

Comparison Value	Correlation with Years of Land Tenure	*p*
Pre-test Attitude	0.011	0.851
Post-test Attitude	-0.081	0.180
Attitude Change	-0.059	0.329

Correlations between knowledge and attitude were significant. Pre-test knowledge was positively correlated to post-test knowledge, pre-test attitude, and post-test attitude, but negatively correlated to attitude change. In contrast, post-test knowledge was positively correlated to attitude change. Post-test knowledge was positively correlated to pre and post-test attitude scores. Pre-test attitude and post-test attitude were positively correlated. Not surprisingly, knowledge change and attitude change were positively correlated as well. Participants who improved their knowledge of woody biomass also exhibited more positive attitudes about harvesting it. These correlations are summarized in **Table 18**. It is hoped that that knowledge and attitude change are also ultimately correlated to practice change.

Table 18
Correlation Between Knowledge and Attitude of Participants at NC Woody Biomass Trainings

Comparison Value	Post-test Knowledge	*p*	Pre-test Attitude	*p*	Attitude Change	*p*	Post-test Attitude	*p*
Pre-test Knowledge	0.274	0.000**	0.435	0.000**	-0.287	0.000**	0.229	0.000**
Post-test Knowledge	-	-	0.212	0.000**	0.060	0.295	0.478	0.000**
Knowledge Change	-	-	-0.303	0.000**	0.317	0.000**	-0.008	0.890
Pre-test Attitude	-	-	-	-	-	-	0.435	0.000**

**significant at p<0.001 (2-tailed)

Independent samples t test was used to compare mean scores of population subgroups. The 32% of participants attending their first Extension meeting had lower pre-test knowledge scores but showed greater knowledge change than those who had

previously attended Extension meetings [**Table 19**]. The two groups did not demonstrate significant differences in changes in attitude [**Table 20**].

Table 19
Comparison of Knowledge Change with Extension Experience of Participants at NC Woody Biomass Trainings

Comparison Value	Mean for Previous Attendees of Extension Meetings	Mean for Participants Attending First Extension Meeting	*t*	*p*
Pre-test Knowledge	4.69	3.33	4.374	0.000**
Post-test Knowledge	8.14	7.93	1.096	0.274
Knowledge Change	3.36	4.40	3.124	0.002*

*significant at p<0.05 (2-tailed)
**significant at p<0.001 (2-tailed)

Table 20
Comparison of Attitude Change with Extension Experience of Participants at NC Woody Biomass Trainings

Comparison Value	Mean for Previous Attendees of Extension Meetings	Mean for Participants Attending First Extension Meeting	*t*	*p*
Pre-test Attitude	34.97	33.81	1.562	0.119
Post-test Attitude	37.78	38.04	0.486	0.627
Attitude Change	2.60	3.70	1.554	0.121

Males had a higher pre-test and post-test knowledge score than females but overall knowledge change was not significant [**Table 21**]. Males also had a greater pre-test and post-test attitude score; however, females showed greater attitude change than males [**Table 22**].

Table 21
Comparison of Knowledge Change with Sex of Participants at NC Woody Biomass Trainings

Comparison Value	Mean for Male	Mean for Female	*t*	*p*
Pre-test Knowledge	4.58	3.54	3.308	0.001**
Post-test Knowledge	8.24	7.72	2.629	0.009*
Knowledge Change	3.55	4.04	1.448	0.149

*significant at p<0.05 (2-tailed)
**significant at p<0.001 (2-tailed)

Table 22
Comparison of Attitude Change with Sex of Participants at NC Woody Biomass Trainings

Comparison Value	Mean for Male	Mean for Female	*t*	*p*
Pre-test Attitude	35.87	31.69	5.740	0.000**
Post-test Attitude	38.25	36.96	2.439	0.015*
Attitude Change	2.14	4.79	3.772	0.000**

*significant at p<0.05 (2-tailed)
**significant at p<0.001 (2-tailed)

Pre-test and post-test knowledge and knowledge scores for Caucasians were significantly higher than African-Americans at the p<0.05 level. Interestingly though, there was no significant difference between racial groups for knowledge or attitude change overall [**Tables 23 & 24**]. This was true even though the framework (marketing, dinner, and facilities) for the last three landowner meetings targeted at minority and underserved landowners was completely different than the first seven meetings. The framework was different (no dinner, meetings held away from traditional Extension centers, marketing conducted through minority groups) due to lack of funding and the need to reach the minority audience, but changing the framework did not appear to affect

program impact. This is good news in difficult economic times when Extension professionals increasingly have to operate with fewer resources. Only Caucasians and African-Americans are compared because there were only four individuals in other ethnic groups, which was not adequate to include in this comparison.

Table 23
Comparison of Knowledge Change with Race of Participants at NC Woody Biomass Trainings

Comparison Value	Mean for Caucasians	Mean for African-American	*t*	*p*
Pre-test Knowledge	4.41	3.41	2.103	0.036*
Post-test Knowledge	8.14	7.23	2.756	0.006*
Knowledge Change	3.67	3.62	0.098	0.922

*significant at $p<0.05$ (2-tailed)

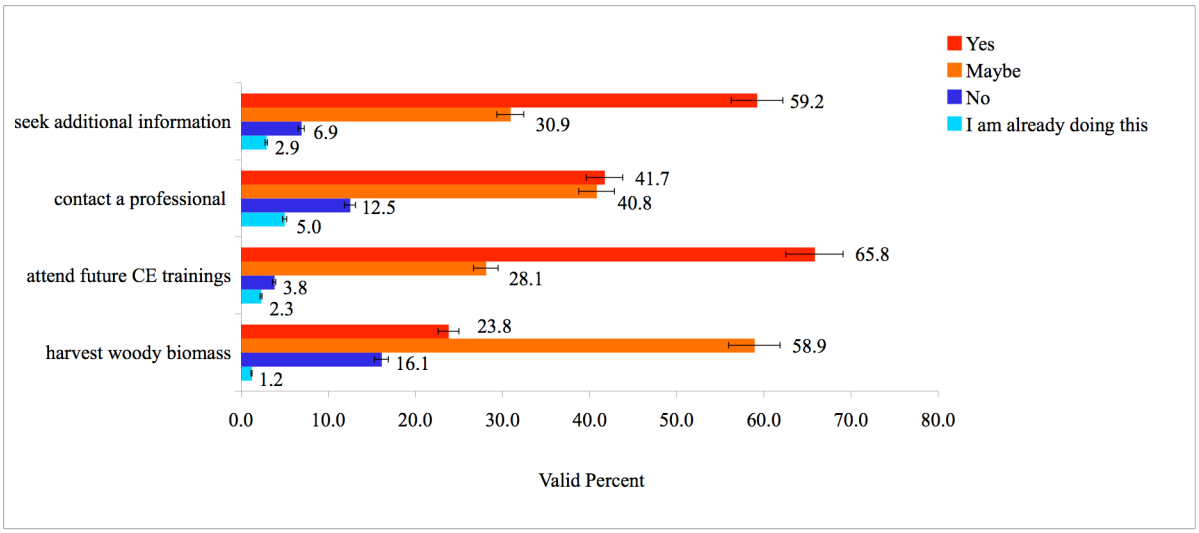
Table 24
Comparison of Attitude Change with Race of Participants at NC Woody Biomass Trainings

Comparison Value	Mean for Caucasians	Mean for African-American	*t*	*p*
Pre-test Attitude	34.91	32.03	2.498	0.013*
Post-test Attitude	38.04	35.54	2.835	0.005*
Attitude Change	3.00	2.80	0.166	0.868

*significant at $p<0.05$ (2-tailed)

Over 80% of respondents reported that as a result of this training, they intend to seek out additional information and/or modify current land use practices on their properties. Participants were more definite about seeking further educational opportunities for learning about woody biomass harvesting rather than actually harvesting

woody biomass on their land [**Figure 8**] indicating they would like more information before committing to adopting practices in the management of their land. Presented with a list of reasons for harvesting woody biomass and asked to rank their top three, respondents ranked highest: "to manage for higher value products," "cleaner harvest" and "market for thinning" [**Table 25**]. The top two are timber-related goals.



Error bars represent 95% confidence intervals.

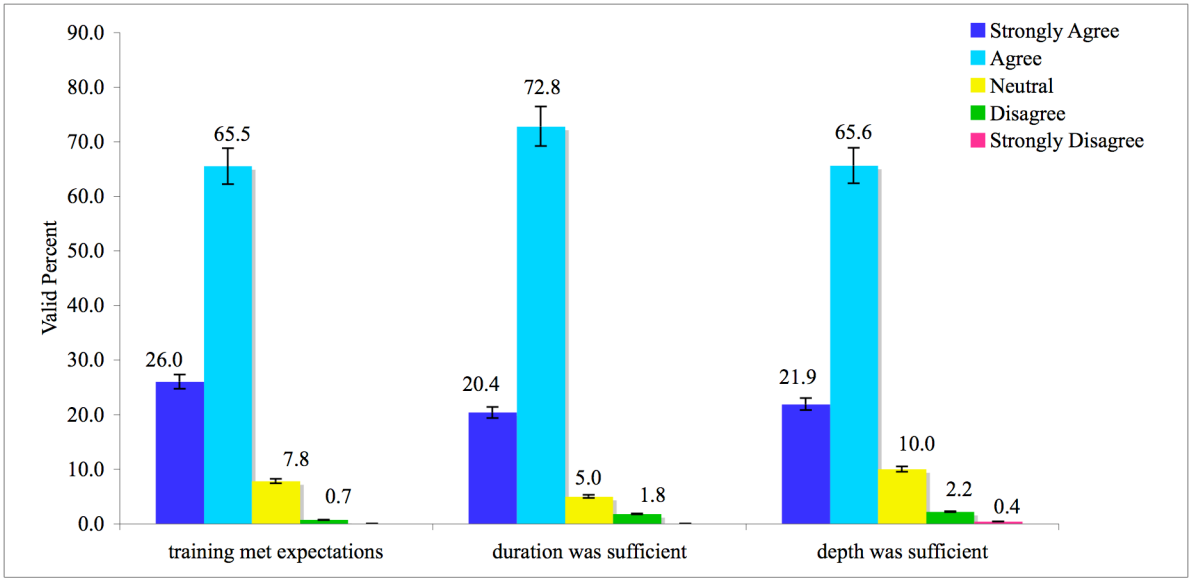
Figure 8: Aspirations of Landowners at NC Woody Biomass Trainings

Table 25
Importance of Reasons for Harvesting Woody Biomass Ranked by Participants at NC Woody Biomass Trainings

Reasons for Biomass Harvesting	*n*	Mean	Weighted Mean	Order of Importance (1 = Most Important 10 = Least Important)
manage for higher value products	140	2.55	357	1
cleaner harvest	134	2.59	347	2
market for thinning	117	2.46	288	3
use of storm damaged, diseased, low quality trees	110	2.47	272	4
support renewable energy	108	2.27	245	5
reduce wildfire risk	99	2.35	233	6
improve aesthetics	94	2.21	208	7
manage for wildlife	85	2.25	191	8
reduce establishment costs	77	2.36	182	9
other reasons	1	3.00	3	10

Participants' Satisfaction, Suggestions, and Concerns

Of the participants, 91.5% agreed or strongly agreed that the training met their expectations, that the duration was sufficient for materials covered (93.2%), and that the depth of the material covered was sufficient (87.5%) [**Figure 9**].



Error bars represent 95% confidence intervals.

Figure 9: Participant Satisfaction at the NC Woody Biomass Trainings

Participants enjoyed the training for the subject area itself. Because most participants were not aware of woody biomass harvesting prior to attending, they found the training informative and timely. As one participant summed up, "what I liked best was learning that biomass marketing may help me clean up my logging mess." Another commented, "I enjoyed learning information I didn't know before and learning that my forest management plan may ultimately incorporate biomass harvesting." Participants also appreciated the diversity and expertise of speakers, the "practical solutions," and "balanced view considering pluses and minus."

Positive comments outweighed negative ones, but some constructive criticism was offered, pointing to areas needing improvement. Three main themes emerged as the least

favorite parts of the training: lack of depth, lack of local markets, and lack of venue comfort. “I would like more details, more easily understood info – the presentation was too high tech” one participant complained and many agreed that the training was “short on future directions of biomass use.” Others believed “too much time was spent on basics that most of us woodland owners already know.” Another major source of frustration was participants not seeing the local applicably of the training’s information. As one lamented, “Nice to know but what good is this information to me? How does it apply to my forest?”

Of the participants, 97.8% would recommend the program to others. When asked why, the majority said, as above, that it was for raising awareness about possibilities on their woodlands. One enthusiastic landowner exclaimed, “Anyone with trees should know about this!” Many thought the training would “get more people involved in forestry” and “encourage them to seek professional management” which they saw as positive outcomes. For some the information came too late (“should have known this before timber was cut”), but they still recommended the program. Of the few who would not recommend the training, reasons given related to not being able to see the local applicability of the topic. In designing future trainings Extension professionals should be sure to emphasize real potential of local markets in the area where the meeting is being held and practical application on the land.

When asked what additional information they would like to receive, landowners’ responses came down to who, what, when, where, and how:

- Who are specific practitioners and companies that do biomass harvesting?
- What are the costs?
- When will this become an option locally?
- Where is the closest facility to sell?
- How do I get started?

Once they realized that much of this information has yet to materialize, many voiced that they would like to be kept up to date through future Extension trainings.

Although the majority of participants were overall satisfied with the training program, respondents also voiced a number of concerns for soil, wildlife, air quality, sustainability, forest health and productivity impacts of woody biomass harvesting. Although the training specifically allocated time to address such concerns, several landowners remained unsatisfied with the answers given. "You didn't convince me that woody biomass harvesting could be used to manage wildlife, I would like to debate this point," remarked one. Others rejected biomass harvesting completely: "I am already very aware of the energy and climate crisis and I don't consider my forest to be a product. If I want to plant something it will be food not pines!" Extension needs to address these concerns early on to avoid a situation similar to that for agricultural biofuels, which quickly went from being considered "green" to being an environmental disaster (Hance 2008).

V. CONCLUSION AND RECOMMENDATIONS

Harvesting of woody biomass is a new topic in Extension education. Extension agents and adult educators planning and conducting these woody biomass Extension programs for forest landowners can use the program described here as an effective model with measurable program impacts. Extension professionals should have success with woody biomass education programs for landowners in regions similar to North Carolina with abundant forestland, a large number of NIPF landowners, and access to wood energy markets.

With regard to program impact, it was discovered that forest landowners in North Carolina have low knowledge levels of woody biomass harvesting. Knowledge level increased as a result of participation in the program. Landowners' attitudes also became more positive after participating in the training; however, landowners still have several reservations about participating in woody biomass markets due to potential social, environmental, and economic impacts. It remains to be seen if landowners will increase harvesting of woody biomass on their land as a result of participation in this program. Landowners indicated they would seek additional information and professional consultation, but were more reluctant to agree to harvesting woody biomass on their land, partly due to lack of convenient markets. The positive correlation between knowledge and attitude change could potentially correlate to behavior change, but it will likely be landowners with timber-related objectives as opposed to non-timber related objectives participating in these markets.

In the continuation or development of new woody biomass education programs, the following is being recommended to NCSU Forestry Extension:

- specify local and practical applications of woody biomass harvesting at trainings
- make a conscious effort to include minority and underserved landowners in programs so that these populations are not excluded from biomass opportunities
- pay more attention to addressing social, environmental, and economic concerns of landowners
- target audiences with the greatest changes in knowledge and attitudes such as younger landowners, females, and those attending their first Extension meeting.

Since the diverse audience included first-timers to an Extension meeting, those who do not have a management plan, and those who have never used a consulting forester, some time has to be spent on basic forestry. Above all, it is important to present locally applicable information on how to get woody biomass harvesting endeavors started.

Future studies could assess longitudinal impact of the program and measure landowner behaviors as they relate to woody biomass harvesting. It remains to be seen whether the Internet and distance education could reach a different demographic of landowner and is another area needing further research.

Other Extension professionals looking to develop similar woody biomass education programs can utilize these findings in their program planning process. For example, participants indicated they preferred short programs, a variety of teaching methods and printed materials over video or Internet resources. Indeed, while only a few

hours in length, short Extension programs are useful to landowners and can result in increased knowledge, more positive attitudes, and increased aspirations among participants about harvesting woody biomass energy. In addition, one should work with local county Extension agents to market the program, but also contact non-governmental organizations to reach minority and underserved landowner groups.

Policy makers should support woody biomass educational programs as an important component of renewable energy adoption plans. However, they must be cautious in overestimating the amount of woody biomass available based on the number of NIPF landowners in an area. Landowner willingness to participate in future woody biomass markets is dependent upon several factors and if local markets do not emerge in the next few years, interest may fade. While landowners are interested and want to support renewable energy, their support is not guaranteed.

LITERATURE CITED

Almquist, B. 2006. Environmental group perspectives on woody biomass utilization related to hazardous fuels reduction. University of Oregon: Eugene, OR.

Ashton, S., McDonell, L. and Barnes, K. Woody biomass desk guide and toolkit. 2009. National Association of Conservation Districts. Retrieved from http://nacdnet.org/resources/guides/biomass/pdfs/Introduction.pdf

Atkins, D. 2008. The role of forests in energy and climate change. Paper presented at the Woody Biomass Heat: Making It Work for Communities. May 1-2, Bend, OR.

Barden, C. J., Jones, S. B. and Biles, L. E. 1996. Extension forestry education: reaching the people who make decisions. Journal of Forestry 94(3): 31-35.

Bardon, R.E. 2001. Evaluation of forestry programming: leading to recommendations for improvement. Journal of Extension [Online]. Retrieved from http://www.joe.org/joe/2001june/rb3.php

Bardon, R.E., Hazel, D. and Miller, K. 2007. Preferred information delivery methods of North Carolina forest landowners. Journal of Extension [Online]. Retrieved from http://www.joe.org/joe/2007october/a3.php

Becker, D.R. and Lee, C. 2008. State woody biomass utilization policies. Staff paper series no. 199. St. Paul, Minnesota.

Bennett, C. 1975. Up the Hierarchy. Journal of Extension 13(2): 7-12.

Bennett, C. and Rockwell, K. 1995. Targeting Outcomes of Programs (TOP). Retrieved from: http://citnews.unl.edu/TOP/english/overviewf.html.

Birch, T. W. 1996. Private forestland owners of the United States, 1994. USDA Forest Service Resource Bulletin NE-134. Radnor, PA.

Bliss, J.C., Nepal, S.K., Brooks, R.T. Jr., Larsen, M.D. 1994. Forestry community or grandfalloon? Journal of Forestry 92(9): 6-10.

Braverman, M.T. and Engle, M. 2009. Theory and rigor in extension program evaluation planning. Journal of Extension [Online]. Retrieved from http://www.joe.org/joe/2009june/a1.php

Brown, M. J. 2002. Forest statistics for North Carolina, 2002. USDA Forest Service Resource Bulletin SRS-88. Asheville, NC.

Butler, B. J. 2008. Family forest owners of the United States, 2006: a technical document supporting the Forest Service 2010 RPA assessment. Gen. Tech. Rep. NRS-27. USDA Forest Service Northern Research Station: Newtown Square, PA.

Carmichael-Timson, K. 2006. Magical soils of El Dorado. Permaculture Magazine 50: 41-3.

Carmines, E. G. and Zeller, R. A. 1979. Reliability and validity assessment. Sage Publications: Beverly Hills, CA.

Carroll, C. R. 1996. Coarse woody debris in forest ecosystems: an overview of biodiversity issues and concepts. In: Biodiversity and coarse woody debris in Southern forests: proceedings of the workshop on coarse woody debris in southern forests: effects on biodiversity. October 18-20, Athens GA. General Technical Report SE-94. United States Department of Agriculture.

Cassidy, P.D. 2007. Utilizing biomass. Encyclopedia identification p1138. In: The forest encyclopedia network. Retrieved from www.forestencyclopedia.net

Cloughesy, M., Zahler, D. and Rellergert, M. 2001. Using pre- and post-tests to evaluate the achievement of short course learning objectives. Journal of Extension [Online]. Retrieved from http://www.joe.org/joe/2001april/tt4.php

Comer, M. M., Campbell, T., Edwards, K. and Hillison, J. Cooperative extension and the 1890 land-grant institution: the real story. Journal of Extension [Online]. Retrieved from http://www.joe.org/joe/2006june/a4.php

Cooperative State Research, Education, and Extension Service. 2009. Retrieved from http://www.csrees.usda.gov/nea/nre/in_focus/forests_if_woody.html

Cutler, K.S. 2009, Feb. 14. Farmer turns wood chips into boiler fuel. Washington Daily News. Retrieved from http://www.wdnweb.com

Daley, B. 2009, July 26. On wood, burning questions. The Boston Globe. Retrieved from http://www.boston.com/bostonglobe

Decker, D. J., Lassoie, J. P., Goff, G. R., and Parrish, K. 1988. Do workshops work? Journal of Extension [Online]. Retrieved from http://www.joe.org/joe/1988winter/a5.html

Diem, K.G. 2002. A step-by-step guide to developing effective questionnaires and survey procedures for program evaluation and research. Rutgers NJAES Cooperative Extension: New Jersey.

Dillman, D. A. 2009. Internet, mail, and mixed-mode surveys: the tailored design method, 3rd edition. Wiley & Sons: Hoboken, New Jersey.

Downing, A. K., and Finley, J. C. 2005. Private forest landowners: What they want in an education program. Journal of Extension [Online]. Retrieved from http://www.joe.org/joe/2005february/rb4.shtml

Duttweiler, M.W. 2008. The value of evaluation in cooperative extension. New Directions for Evaluation 120: 87-100

Egan, A.F. and Jones, S.B. 1993. Do landowner practices reflect beliefs? Journal of Forestry 91: 39-45.

Fernholz, K. 2009. Energy from woody biomass: a review of harvesting guidelines and a discussion of related challenges. Retrieved from: http://dovetailinc.org/files/DovetailBioGuides0709.pdf

Food and Agriculture Organization 2005. State of the World's Forests 2005. Rome, Italy.

Gan J., Rauscher, H. M., Smith, C.T., Ashton, S., Biles, L., Cassidy, D., Foster, D., Howell, M. R., Hubbard, W. G., Jackson, B., Mayfield, C., Mead, D. J., Silveira, S., and Taylor, E. 2008. The Southern US forest bioenergy encyclopedia: making scientific knowledge more accessible. Southern Journal of Applied Forestry 32(1): 28-32.

General Assembly of North Carolina 2007. Senate Law 2007-397, Senate Bill 3. Retrieved from http://www.ncleg.net/Sessions/2007/Bills/Senate/HTML/S3v6.html

Gomez, L. D., Steele-King, C. G., and McQueen-Mason, S. J. 2008. Sustainable liquid biofuels from biomass: the writing's on the walls. New Phytologist 178: 473-485.

Green, J. J. 2001. Small, limited resource and minority farmers discuss conservation: analysis of focus groups. Working paper Number 1A Program Responsiveness Series. University of Missouri-Columbia.

Hakkila, P. 2002. Operations with reduced environmental impacts. In: Richardson, J., Bjorheden, R., Hakkila, P., Lowe, A.T., and Smith, C.T. Bioenergy from sustainable

forestry: guiding principles and practice. Dordrecht, The Netherlands: Kluwer Academic Publishers: 244-261.

Hance, Jeremy (2008). "Cellulosic biofuels endanger old-growth forests in the Southern U.S." Retrieved from: http://news.mongabay.com/2008/1016-hance_quaranda_interview.html

Hannum, L.C. 2009. Developing machinery to harvest small diameter woody biomass transforming a fire hazard into an energy crisis solution.
Retrieved from http://www.lib.ncsu.edu/theses/available/etd-07082009-101816/

Hicks, R. R. 1998. Ecology and management of central hardwood forests. New York: John Wiley and Sons.

Hicks, R.R., Conner, W.H., Kellison, R.C., and Van Lear, D. 2004. Silviculture and management strategies applicable to Southern hardwoods. In: Rauscher, H.M., and Johnsen, K. Southern forest science: Past, present, and future. Gen. Tech. Rep. SRS-75. Asheville, NC: USDA Forest Service, Southern Research Station: 51-62.

Holt, B. 2009. Perception to inception: assessing contractor capacity to utilize woody biomass for energy production in the Southern Willamette Valley, Oregon. University of Oregon: Eugene, OR.

Hubbard, W., Biles, L., Mayfield, C., and Ashton, S. (Eds.). 2007. Sustainable forestry for bioenergy and bio-based products: trainers curriculum notebook. Southern Forest Research Partnership, Inc.: Athens, GA.

Hubbard, W.G. and Sandmann, L.R. 2007. Using diffusion of innovation concepts for improved program evaluation. Journal of Extension [Online]. Retrieved from http://www.joe.org/joe/2007october/a1.php

Hughes, G., Measells, M. K., Grado, S. C., Dunn, M. A., Idassi, J. O., and Zielinske, R. J. 2005. Underserved forest landowner workshops: Opportunities for landowners and extension. Journal of Extension [Online]. Retrieved from http://www.joe.org/joe/2005august/a5.shtml

International Energy Agency 2006. Renewables Information. Paris: IEA Statistics.

Israel, G. D. and Galindo-Gonzalez, S. 2009. Diverse market segments and customer satisfaction: does extension serve all clients well? Journal of International Agricultural and Extension Education 16(1): 89-103.

Jones, S. B., Luloff, A.E., and Finley, J.C. 1995. Another look at NIPFs: facing our "myths." Journal of Forestry 93(9): 41-44.

Kistler, M. J. and Briers, G.E. 2003. Change in knowledge and practices as a result of adults' participation in the Texas A&M ranch to rail program. Journal of Southern Agricultural Education Research 53 (1): 212-223.

Kuhns, M. R., Brunson, M. W., and Roberts, S. D. 1998. Landowners' educational needs and how foresters can respond. Journal of Forestry 96: 38-43.

Law, B. 2001. The woodland way: a permaculture approach to sustainable woodland management. Hampshire, England: Permanent Publications.

Lewis, B. J. The Chip Mill Experience in Missouri: Implications for Long-Term Sustainability of Missouri Forests

Lindner, J. R., Murphy, T. H., & Briers, G. E. 2001. Handling nonresponse in social science research. Journal of Agricultural Education 42(4): 43-53.

MGT Power Ltd. UK firm to build 295 MW biomass plant. In Biomass Magazine. Retrieved from http://www.biomassmagazine.com/article.jsp?article_id=2870

Mance, K.E., Sills, E. and Warren, S. 2004. Outreach to Limited Resource Forest Landowners: Extension Innovation for Low Literacy Audiences. In David M. Baumgartner, ed. Proceedings of Human Dimensions of Family, Farm, and Community Forestry International Symposium, March 29 – April 1, 2004, Washington State University, Pullman, WA, USA.

Mead, D.J., Foster, C.D., and Mayfield, C.A. 2007. Bioenergy production from southern forests. Encyclopedia identification: p1135. In The forest encyclopedia network. Retrieved from www.forestencyclopedia.net

Megalos, M. A. 2009. Air quality and North Carolina wood energy. North Carolina Cooperative Extension: Raleigh, NC. Retrived from http://www.ces.ncsu.edu/forestry/biomass/pubs/WB010.pdf

Megalos, M. A. 2000. North Carolina landowner responsiveness to forestry incentives. North Carolina State University: Raleigh, NC.

Megalos, M. A. and Cubbage, F.W. 2000. Promoting forest sustainability with incentives – how landowners rate the options. Proceedings of the Forest Fragmentation 2000 Conference. Sampson Group Inc.: Alexandria, VA.

Meunch, J. 1965. Private forests and public programs in North Carolina. American Forestry Association: Washington D.C.

Miller, K.T. 2006. Reaching non-industrial private forestland owners with their preferred methods of information delivery. North Carolina State University: Raleigh, NC.

Milstein, M. 2008, Dec. 20. Fall in wood products market redirects environmentalist strategy. The Oregonian. Retrieved from: http://www.oregonlive.com/news/index.ssf/2008/12/fall_in_wood_products_market_r.html

Monroe, M.C., McDonnell, L., and Oxarart, A. 2007. Wood to energy biomass ambassador guide. University of Florida: Gainesville, FL.

Moorman, C. E., Russell, K. R., Sabin, G. R. and Guynn Jr., D. C. 1999. Snag dynamics and cavity occurrence in the South Carolina Piedmont. Forest Ecology and Management, 118 (1-3), 37-48.

Morford, S., Kozak, R., Suvedi, M. and Innes, J. 2006. Factors affecting program evaluation behaviors of natural resource extension practitioners – motivation and capacity building. Journal of Extension [Online]. Retrieved from http://www.joe.org/joe/2006june/a7.php

Moxley, R.L. and Lang, K.B. 2006. The importance of social context influences on new farm technology sustainability: community and sub-community characteristics in Jamaica. Technology in Society, 28: 393-406.

Munsell, J.F. and Germain, R.H. 2001. In this case, talk is far from cheap: a landowner's role in extension and outreach. New York Forest Owner. 39(6): 10-11.

Munsell, J.F., and R.H Germain. 2007. Woody biomass energy: An opportunity for silviculture on non-industrial private forestlands in New York. Journal of Forestry. 105(8): 398-402.

Nazzaro, R. M., and Bixler, D. P. 2005. Federal agencies are engaged in various efforts to promote the utilization of woody biomass, but significant obstacles to its use remain: report to the chairman, committee on resources, House of Representatives. Retrieved

from http://purl.access.gpo.gov/GPO/LPS61924.

Norland-Tilburg, E. V. 1990. Controlling error in evaluation instruments. Journal of Extension [Online]. Retrieved from http://www.joe.org/joe/1990summer/tt2.php

Nyland, R. D. 1992. Exploitation and greed in eastern hardwood forests. Journal of Forestry 90(1): 33-37.

Oxarart, A. 2008. Exploring written communication techniques for complex natural resource issues. University of Florida: Gainesville, FL.

Palosuo, T., Wihersaari, M., and Liski, J. 2000. Net greenhouse gas emissions due to energy use of forest residues - impact of soil carbon balance. Paper presented at the Woody Biomass as an Energy Source – Challenges. Europe, Joensuu, Finland.

Patton, M. Q. 2002. Qualitative research and evaluation methods, 3rd ed. Sage Publications: London, England.

Pomeroy, K.B. and Yoho, J.G. 1964. North Carolina lands: ownership, use, and management of forest and related lands. American Forestry Association: Washington D.C.

Price, T. 1994. Southern pine beetle in the Southern Appalachians. In: C. Ferguson and P. Bowman. Threats to forest health in the Southern Appalachians. Gatlinburg, TN.: Southern Man and the Biosphere Cooperative: 21-26.

Prochaska, J., DiClemente, C., and Norcross, J. 1992. In search of how people change. American Psychologist 47: 1102-1114.

Radhakrishna, R. and Martin, M. 1999. Program evaluation and accountability training needs of extension agents. Journal of Extension [Online]. Retrieved from http://www.joe.org/joe/1999june/rb1.php

Radhakrishna, R. B. Francisco, C. L., and Baggett. C. D. 2003. An analysis of research designs used in agricultural and extension education. Proceedings of the 30th National Agricultural Education Research Conference: 528-541.

Rasmussen W.D. 1989. Taking the university to the people: seventy-five years of cooperative extension. Ames, IA: Iowa State University Press.

Remedio, E.M. 2002. Wood energy and livelihood patterns: a case study from the Philippines. Unasylva, 211. Retrieved from http://www.fao.org/docrep/005/y4450e/y4450e04.htm

Research Triangle Institute 2002. Wood energy guide for North Carolina.

Riccardi N. 2007, Dec. 27. Building on the trunks of ruined pines: as bark beetles ravage Rocky Mountain forests, entrepreneurs scramble to find uses for the dead wood left behind. The Los Angeles Times. Retrieved from http://articles.latimes.com/2007/dec/27/nation/na-beetle27

Richardson, J., Bjorheden, R., Hakkila, P., Lowe, A.T., and Smith, C. T. 2002. Bioenergy from sustainable forestry: guiding principles and practice. Dordrect, The Netherlands: Kluwer Academic Publishers.

Richman, J., Makrides, L., and Prince, B. 1980. Research methodology and applied statistics. Physiotherapy Can 32: 253–257.

Rockwell, K. and Bennett, C. 2004. Targeting outcomes of programs (TOP). Retreived from http://citnews.unl.edu/TOP/english/introduction.html

Roucan-Kane, M. 2008. Key facts and key resources for program evaluation. Journal of Extension [Online]. Retrieved from http://www.joe.org/joe/2008february/tt2.php

Rural Voices for Conservation 2005. Community-based forestry perspectives on woody biomass. Portland: Sustainable Northwest.

Sample, A. 2007. Ensuring forest sustainability in the development of wood-based bioenergy: a national dialogue. Paper presented at the Scoping Workshop.

Sampson, N. and DeCoster, L.A. 1997. Public programs for private forestry: a reader on programs and options. American Forests: Washington D.C.

Sandison, P. 2006. The utilization of evaluations. In: Active Learning Network for Accountability and Performance in Humanitarian Action (Ed.), Key messages from ALNAP's review of humanitarian action. Retrieved from http://www.alnap.org/publications/RHA2005/RHA05KMS_English.pdf

Schulte, L., Tyndall, J., Hall, R., and Grubh, K. 2008. Rapid assessment of woody biomass capabilities in three regions of the U.S. Midwest. Retrieved from http://www.nrem.iastate.edu/landscape/Publications/FinalWoodyBiomassReport.pdf

Scriven, M. 1967. The methodology of evaluation. In: Tyler, R. W., Gagné, R. M. and Scriven, M., Eds. Perspectives of curriculum evaluation. Rand McNally: Chicago, IL.

Silveira, S. and Foster, C.D. 2007. Promoting bioenergy. Encyclopedia identification p1146. In: The forest encyclopedia network. Retrieved from www.forestencyclopedia.net

Society of American Foresters 1979. Forest biomass as an energy source. Study report of a task force of the Society of American Foresters. Society of American Foresters: Washington, D.C.

Swedish Energy Agency 2006. Energy in Sweden. Eskilstuna: Swedish Energy Agency.

Taylor, C.L. 1993. Data gathering designs to evaluate educational programs. University of Florida: Gainesville, FL. Retrieved from http://edis.ifas.ufl.edu/pdffiles/PD/PD01700.pdf

Taylor-Powell, E. and Henert, E. 2008. Developing a logic model: teaching and training guide. University of Wisconsin: Madison, WI. Retrieved from http://www.worldbridgeresearch.com/files/Logic_Models_Teaching_Manual.pdf

Terry, B.D. and Israel, G. D. 2004. Agent performance and customer satisfaction. Journal of Extension [Online]. Retrieved from http://www.joe.org/joe/2004december/a4.php

Tuttle, S., Dambeck, A., Masters, L. Livingston, M. and Crowley, T. H. Indian country and county extension: a comparison of programs in the university of Arizona cooperative extension service. Proceedings of the 25th Annual Conference, Association for International Agricultural and Extension Education. Intercontinental Hotel: San Juan, PR.

Tyson, C. B., Broderick, S. H., and Snyder, L. B. 1998. A social marketing approach to landowner education. Journal of Forestry 96(2): 34-40.

Upreti, B. R., and van der Horst, D. 2004. National renewable energy policy and local opposition in the UK: the failed development of a biomass electricity plant. Biomass and Bioenergy 26: 61-69.
Silveira, S. 2005. Bioenergy: realizing the potential. Elsevier, The Netherlands.

USDA Forest Service 1993. Biodiversity and coarse woody debris in Southern forests: proceedings of the workshop on coarse woody debris in southern forests: effects on biodiversity. October 18-20, Athens GA. General Technical Report SE-94. United States Department of Agriculture.

USDA Forest Service 2007. Woody biomass utilization desk guide. Retrieved from http://www.forestsandrangelands.gov/Woody_Biomass/documents/biomass_deskguide.pdf

Warren, S., Williamson, R. and Sills, E. 2002. Minority landowners and working forests in the South. Panel Discussion Society of American Foresters. Winston Salem-NC.

Wear, D. N., and Greis, J. G. 2002. Southern forest resource assessment. Gen. Tech. Rep. SRS-53. Asheville, NC: U. S. Department of Agriculture, Forest Service, Southern Research Station.

Weihuan X., Yanshu L., and Carraway, B. 2008. Estimation of woody biomass availability for energy in Texas. Texas Forest Service: College Station, Texas.

Wholey, J.S., Hatry, H.P. and Newcomer, K.E. 2004. Handbook of practical program evaluation (2nd edition). Jossey-Bass: San Francisco, CA.

Wicker, G. 2002. Motivation for private forest landowners. In: Wear. D. and Greis, J.G., Eds. Southern forest resource assessment. Southern Research Station: Asheville, NC.

Williamson, K. J. 2007. Oregon biofuels and biomass: woody biomass in Oregon: current uses, barriers and opportunities for increased utilization, and research needs. Oregon State University: Corvallis, OR.

APPENDIX

APPENDIX A

NC STATE UNIVERSITY | NC COOPERATIVE EXTENSION

DEPARTMENT OF Forestry and Environmental Resources

WOODY BIOMASS HARVESTING FOR ENERGY TRAINING

Pre-Presentation Questionnaire // Date : _____

Cooperative Extension is always looking for ways to serve you better. Please take a moment to complete this short questionnaire. It will help us know how we're doing, and how we can better serve your needs in the future.

This questionnaire should take approximately 10 minutes to complete. Please provide the last five digits of your telephone number. **This information will be used only for the purpose of matching your pre- and post-presentation questionnaires.** Thank you for your cooperation.

You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time. You are not guaranteed any personal benefits from being in a study. There are no perceived risks directly involved with this study. The information in this questionnaire will be kept strictly confidential.

Your answers will be separated from this cover sheet, and the cover sheet will be shredded following completion of data input. Data will be stored securely in a locked cabinet. No reference will be made in oral or written reports which could link you to the study. You will NOT be asked to write your name on these documents so that no one can match your identity to the answers that you provide.

If you have questions at any time about the study or the procedures, you may contact the researcher, Jasmine Shaw at jdshaw@ncsu.edu (562/682-9364), or her faculty supervisor, Dr. Dennis Hazel at dennis_hazel@ncsu.edu (919/515-6883). If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Deb Paxton, Regulatory Compliance Administrator, Box 7514, NCSU Campus (919/515-4514), or Joe Rabiega, IRB Coordinator, Box 7514, NCSU Campus (919/515-7515).

Last five digits of your telephone number: _____

Your residential zip code: _____

1

Please see next page

Please circle the response that best matches your opinions on each of the following statements.

Statement:	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1. North Carolina needs to develop renewable energy.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
2. I am concerned about impacts from the environment from woody biomass harvesting.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
3. There is potential for having woody biomass markets in my local community.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
4. Woody biomass harvesting does not benefit me financially.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5. Biomass markets will bring me more money than sawtimber markets.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
6. Harvesting woody biomass for energy markets is a great idea.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
7. Woody biomass is not a marketable product.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
8. Woody biomass harvesting can help me better manage my woodlands.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
9. Harvesting woody biomass is more difficult than conventional harvesting.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
10. I can lower my reforestation costs through biomass harvesting.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

Please see next page

Please circle your response for each of the following True-False statements.

Statement:	True	False	Don't Know
1. Woody biomass is currently being used for energy production in North Carolina.	True	False	Don't know
2. State law requires a percentage of North Carolina's energy be generated from renewable sources.	True	False	Don't know
3. Woody biomass harvesting has negative impacts on all wildlife.	True	False	Don't know
4. Woody biomass harvesting reduces growth on remaining crop trees.	True	False	Don't know
5. No additional logging equipment is necessary for woody biomass harvesting.	True	False	Don't know
6. Woody biomass is a lower priced product than sawtimber and chip 'n saw products.	True	False	Don't know
7. Woody biomass markets can be an alternative to pulpwood markets.	True	False	Don't know
8. There is current commercially proven technology for manufacturing ethanol and biodiesel from woody biomass.	True	False	Don't know
9. At least one half of North Carolina's forests have too many trees for healthy growth.	True	False	Don't know
10. Biomass harvesting is only done with storm-damaged trees.	True	False	Don't know

Please circle your response for the following questions.

How did you learn about this workshop?

Local newspaper	Extension agent	Cooperative Extension website	Friend / neighbor	State Forest Service	Consulting Forester

Other (Please specify) _____

What is your primary reason for coming to this training?

To learn about new research findings	To learn about woody biomass harvesting	To learn about potential markets for woody biomass

Other (Please specify) _____

Please see next page

1. **Are you:** ☐ Male? ☐ Female?

2. **How old are you?** _____ years

3. **How many acres of woodlands do you own in North Carolina?**

   _____ acres

4. **About how long have you owned your woodlands in North Carolina?**

   _____ years

Please circle your response for the following questions.

5. **How do you identify yourself?**

African American	American Indian / Alaskan	Asian Pacific Islander	Hispanic	White (Non-Hispanic)	Multi-Race

6. **What is the highest level of education you have completed?**

Grade 8 or less	Some high school	High School diploma or equivalent	Some college	Associate or technical degree	Bachelor's degree	Graduate degree

7. **What is the primary method in which you became a woodlands owner?**
   (Please circle one)

Inherited / gifted the land	Purchased the land	Through marriage

8. **Is this your first Cooperative Extension training?**

   ☐ Yes ☐ No

9. **Do you have a management plan for your woodlands?**

   ☐ Yes ☐ No

10. **Have you sought out the advice of a professional forester?**

    ☐ Yes ☐ No

Thank you for completing this evaluation. We appreciate your input as we make every effort to make Extension work for you.

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NC STATE UNIVERSITY | NC COOPERATIVE EXTENSION

DEPARTMENT OF Forestry and Environmental Resources

WOODY BIOMASS HARVESTING FOR ENERGY TRAINING

Post-Presentation Questionnaire

Cooperative Extension is always looking for ways to serve you better. Please take a moment to complete this short questionnaire. It will help us know how we're doing, and how we can better serve your needs in the future.

This questionnaire should take approximately 10 minutes to complete. Please provide the last five digits of your telephone number. **This information will be used only for the purpose of matching your pre- and post-presentation questionnaires.** Thank you for your cooperation.

You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time. You are not guaranteed any personal benefits from being in a study. There are no perceived risks directly involved with this study. The information in this questionnaire will be kept strictly confidential.

Your answers will be separated from this cover sheet, and the cover sheet will be shredded following completion of data input. Data will be stored securely in a locked cabinet. No reference will be made in oral or written reports which could link you to the study. You will NOT be asked to write your name on these documents so that no one can match your identity to the answers that you provide.

If you have questions at any time about the study or the procedures, you may contact the researcher, Jasmine Shaw at jdshaw@ncsu.edu (562/682-9364), or her faculty supervisor, Dr. Dennis Hazel at dennis_hazel@ncsu.edu (919/515-6883). If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Deb Paxton, Regulatory Compliance Administrator, Box 7514, NCSU Campus (919/515-4514), or Joe Rabiega, IRB Coordinator, Box 7514, NCSU Campus (919/515-7515).

Last five digits of your telephone number: _____

Your residential zip code: _____

Please see next page

Now we are interested what you think after this training. Please circle the response that best matches your opinions now.

Statement:	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1. North Carolina needs to develop renewable energy.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
2. I am concerned about impacts from the environment from woody biomass harvesting.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
3. There is potential for having woody biomass markets in my local community.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
4. Woody biomass harvesting does not benefit me financially.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5. Biomass markets will bring me more money than sawtimber markets.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
6. Harvesting woody biomass for energy markets is a great idea.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
7. Woody biomass is not a marketable product.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
8. Woody biomass harvesting can help me better manage my woodlands.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
9. Harvesting woody biomass is more difficult than conventional harvesting.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
10. I can lower my reforestation costs through biomass harvesting.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

Please see next page

Please circle your response now.

Statement:	True	False	Don't Know
1. Woody biomass is currently being used for energy production in North Carolina.	True	False	Don't know
2. State law requires a percentage of North Carolina's energy be generated from renewable sources.	True	False	Don't know
3. Woody biomass harvesting has negative impacts on all wildlife.	True	False	Don't know
4. Woody biomass harvesting reduces growth on remaining crop trees.	True	False	Don't know
5. No additional logging equipment is necessary for woody biomass harvesting.	True	False	Don't know
6. Woody biomass is a lower priced product than sawtimber and chip 'n saw products.	True	False	Don't know
7. Woody biomass markets can be an alternative to pulpwood markets.	True	False	Don't know
8. There is current commercially proven technology for manufacturing ethanol and biodiesel from woody biomass.	True	False	Don't know
9. At least one half of North Carolina's forests have too many trees for healthy growth.	True	False	Don't know
10. Biomass harvesting is only done with storm-damaged trees.	True	False	Don't know

Please help us understand your needs by answering the following questions that were not asked in the pre-training questionnaire. Please circle the response that is best applicable to you.

As a result of this program, do you intend to:	Yes	Maybe	No	I am already doing this
1. Seek additional information on woody biomass harvesting.	Yes	Maybe	No	I am already doing this
2. Contact a professional about better utilization of woody biomass on my land.	Yes	Maybe	No	I am already doing this
3. Attend future trainings hosted by Cooperative Extension on woody biomass.	Yes	Maybe	No	I am already doing this
4. Harvest woody biomass in near future.	Yes	Maybe	No	I am already doing this

Please see next page

What are your top three reasons for harvesting woody biomass for energy from your woodlands? (Please indicate by using 1 for the most important reason, 2 for the next most important and 3 for the third.) If you do NOT plan to harvest woody biomass in near future, please skip to the next question.

_____ Cleaner harvest

_____ Use for storm damaged, diseased and otherwise low quality trees

_____ Market for trees harvested during thinning

_____ To manage for higher-value products such as sawtimber

_____ To manage for wildlife

_____ To improve aesthetic value of your woodlot

_____ Reduced risk of wildfire

_____ Reduced establishment costs

_____ To support renewable energy

_____ Other (Please specify)_____

What are your preferred methods of learning about biomass harvesting? (Please choose all responses applicable to you)

☐ Classroom workshops

☐ Field trips

☐ Classroom training combined with a field trip

☐ One-on-one consulting

☐ Distance education programs (e.g. course taken through the internet)

☐ Landowner association meetings

☐ Other (Please specify) _____

What are your preferred types of resources for learning about woody biomass harvesting? (Please choose all responses applicable to you)

☐ Printed materials

☐ Videos

☐ Internet

☐ Other (Please specify) _____

Please see next page

Please circle the response that best matches your opinions.

Statement:	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1. The training met my expectations.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
2. The duration of the training was sufficient for the materials covered.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
3. The depth of the material covered was sufficient.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

Would you recommend this training to others? ☐ Yes ☐ No
Could you tell us why?

_____

_____

What did you like the most about this training?

_____

_____

What did you like the least about this training?

_____

_____

What additional information would you like to receive on topics related to woody biomass harvesting?

_____

_____

Additional Comments:

_____

_____

_____

Thank you for completing this evaluation. We appreciate your input as we make every effort to make Extension work for you.

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