Establishing a Research and Demonstration Area Initiated by Managers: The Sharkey Restoration Research and Demonstration Site

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ABSTRACT

As forest scientists increase their role in the process of science delivery, many research organizations are searching for novel methods to effectively build collaboration with managers to produce valued results. This article documents our experience with establishment of a forest restoration research and demonstration area in the Lower Mississippi Alluvial Valley (LMAV), a region that has experienced extensive afforestation of former agricultural land over the past 15 years. Although basic establishment techniques for production plantations had been developed and applied on small areas, land managers lacked critical knowledge to implement operational-scale afforestation practices that would accommodate multiple forest restoration objectives. In 1993, managers with the US Fish and Wildlife Service made a 1,700-ac agricultural tract available to scientists interested in partnering research and demonstrating various aspects of bottomland hardwood ecosystem restoration. Through collaborative efforts, resource managers and scientists have installed numerous experiments on the Sharkey Restoration Research and Demonstration Site to address relevant issues in afforestation and restoration of bottomland hardwood ecosystems. Development of this research and demonstration area has provided a science-based resource for educating landowners, foresters, wildlife managers, and the general public on afforestation techniques appropriate for restoration of bottomland hardwood forests; has served as a platform for scientists and land managers to cooperate on the development of innovative approaches to forest restoration; and has provided a venue for education and debate among policymakers active in the LMAV. Early results showed the viability of low-cost techniques such as direct seeding oaks, as well as introducing the interplanting technique for rapid development of forest conditions. We recognize that the value of the research and demonstration site is attributed in part to site characteristics and experimental design, and expect continued work at the location to contribute to improved afforestation practices that will foster establishment of sustainable bottomland hardwood forests.

Keywords: science delivery, forest restoration, afforestation, LMAV, bottomland hardwood

The need for effective ways to move research results into practice have long been discussed and the proper roles of scientists and managers have been debated. Increasingly, agencies that fund research are mandating that scientists engage in some form of knowledge transfer beyond publishing journal articles. The value both to the individual professionally and to the organization corporately of acquiring new knowledge to stay competitive, increase productivity, or comply with regulations is widely recognized by research and management communities. Structural and financial barriers, however, preclude simple answers to the question of how to efficiently accomplish this task. A well-developed theory of innovation diffusion (Rogers 1995) provides a conceptual basis for this task, which has variously been called technology transfer, technology delivery, and, more recently, science delivery. The basic structure of the

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innovation process consists of three steps: research to produce an innovation, disseminating knowledge of the innovation outside of scientific circles, and implementation of the innovation within a user community. Presently, technology transfer (the dissemination step) is a participatory model of science delivery with a push–pull dynamic: scientists push out generated knowledge and respond to pulls from users and the marketplace of ideas for researchable topics.

Rogers (1995) connected the dissemination and implementation stages of the innovation process through the decision to implement a new technology. In our experience, the closer (physically as well as psychologically) researchers and managers are when at the crucial step of deciding to try an innovation the more likely that knowledge will be effectively and efficiently transferred. Studies in forestry and other natural resources management professions support the idea that closely linked social networks facilitate effective transmission of innovations (Baldwin and Haymond 1994, Haggith et al. 2003, Stanturf et al. 2003).

We propose that one highly effective technique for delivering needed results to users is by establishing a research and demonstration site where managers and researchers can work collaboratively to answer pressing practical questions while developing a test bed to explore new innovative techniques or theoretical developments. The basic idea of a demonstration site is not novel; it is the primary method used in agriculture by extension specialists and agribusiness service providers (Leeuwis and van den Ban 2004). A well-known example in forestry is the model forest network (Forestry Canada 1992). In these examples, however, the purpose is usually to demonstrate or validate research conducted under experimentally controlled conditions. We suggest that an even more effective approach is to involve resource managers in the design of the research and installation of the research and demonstration site. In the following discussion, we will illustrate this approach by presenting our experience with the Sharkey Restoration Research and Demonstration Site (SRRDS), where, at the urging of a regional program manager (US Fish and Wildlife Service [USFWS]), a research and demonstration area was initiated in which foresters, refuge managers, and scientists are working collaboratively to address multiple questions relevant to restoration of bottomland hardwood ecosystems.

Context

The Lower Mississippi Alluvial Valley (LMAV) in the southern United States is experiencing significant afforestation (Stanturf et al. 2000, Schoenholtz et al. 2001) for many of the same reasons that afforestation is escalating globally (Food and Agriculture Organization 2001, Weber 2005). The driving forces behind current forest restoration vary by region and ownership, but factors such as increased agricultural efficiency, biodiversity conservation, soil and water protection, carbon sequestration, demand for timber resources, and reduction of landscape fragmentation are among the most prevalent contributors to this shift in land use (Stanturf and Madsen 2005). Counteracting the deforestation of more than 70% of the 24 million ac in the LMAV that occurred over the last two centuries has been stimulated by Federal "Farm Bills" beginning in the mid-1980s and early 1990s (Kennedy 1990, Stanturf et al. 2000). Since the enactment of this legislation, bottomland hardwood tree plantations have been established on over 500,000 ac of former agricultural land in the LMAV, and additional area is pending approval and funding (Gardiner and Oliver 2005).

The significant afforestation on private land that began in earnest in the 1990s was preceded on public holdings as early as the 1960s. These earlier afforestation efforts concentrated on establishing relatively few species, particularly species that produce hard mast such as the bottomland oaks (*Quercus* spp.), which would provide a component of wildlife habitat (Allen 1990, Stanturf et al. 1998). Relying on an active research program on artificial regeneration techniques for bottomland oaks, managers were able to show successful establishment of forest stands through a few, relatively small-scale plantings (Kennedy 1993, Stanturf et al. 2001). Because of this success, these early afforestation techniques and practices were adopted as the model approach and were applied extensively throughout the region when current conservation programs were initiated in the late 1980s (Stanturf et al. 1998, Gardiner et al. 2002, Haynes 2004).

Despite the proven success of the approach developed in the 1960s and 1970s primarily for timber production, its deficiencies relative to changing priorities toward multiple resource management and biodiversity objectives became apparent by the mid-1990s. Allen (1997) questioned the suitability of this basic approach to provide for biodiversity. The approach was modified under the Wetlands Reserve Program (WRP) and the stocking density of the planted species was much reduced; diversity and additional stocking was to come from colonization by light-seeded species from nearby forests. Unfortunately, many of the restoration plantings were beyond the effective dispersal range of light-seeded species. Stanturf et al. (1998) argued that the low stocking densities common in WRP stands would produce inferior timber quality and subsequently reduce future stand-management options. Still, others argued that improved afforestation systems could be developed to catalyze various forest restoration processes and enhance certain ecosystem functions on bottomland sites such as habitat for neotropical migratory bird species, water quality protection, and carbon sequestration (Twedt and Portwood 1997, Stanturf et al. 2000, 2001). Thus, tremendous effort and resources were being allocated to establish forest stands that were marginal or inadequate for producing desired outputs, and it was also clear that this approach would not lead to the establishment of a sustainable forest resource in the region. Forest managers throughout the LMAV voiced a need to establish an infrastructure of afforestation and restoration research to expand existing knowledge and develop a forum for disseminating new afforestation practices appropriate for restoration of bottomland hardwood ecosystems.

In the early 1990s the USDA Farm Service Agency (formerly Farmers Home Administration) acquired through foreclosure and transferred several holdings of agricul-

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Table 1. Key characteristics of the Sharkey Restoration Research and Demonstration Site.

Location: 32°58′N, 90°44′W; ~ 5 mi east of Anguilla, Sharkey County, MS
Site area: 1,700 ac
Physiographic region: Mississippi Alluvial Plain
Dominant soil: Sharkey Clay (very fine, smectitic, thermic, chromic, Epiaquerts)
Climate: Humid subtropical region of the Northern Temperate Zone
Mean annual precipitation: 52 in.
Mean temperature—July: 82.0°F
Mean temperature—January: 45.5°F
Mean growing season length: 229 d

tural land in the LMAV to the US FWS, National Wildlife Refuge System. The transfer to the National Wildlife Refuge System mandated that this agricultural land be restored to wildlife habitat. The Service was interested in improving the success of their afforestation; in particular, they faced difficulty on wetter sites. Recognizing the potential value of such properties to advancing forest restoration knowledge in the LMAV, personnel with the Southeast Region of the US FWS proposed that a 1,700-ac tract located in Sharkey County, Mississippi, recently transferred to the Theodore Roosevelt National Wildlife Refuge Complex (formerly Yazoo National Wildlife Refuge Complex) be reserved for use as a research and demonstration area highlighting bottomland hardwood afforestation and forest restoration practices (Table 1).

The invitation by the US FWS to work on a site reserved for research and demonstration attracted parties from several organizations and launched collaboration between managers and researchers. The initial planning sessions in 1993 and subsequent annual meetings provided a forum for exploring research topics, sharing resources, and coordinating installation of experimental infrastructure that established the Sharkey Restoration Research and Demonstration Site (SRRDS). Designation of the research and demonstration site eventually drew together an extensive group of cooperators whose primary interest is "seeking to improve our ability to restore bottomland hardwood forests after agriculture abandonment" (Shepard 1996). Among those active on the site were federal agencies, represented by the USFWS, US Forest Service, Natural Resources Conservation Service (NRCS), US Geological Survey, and the US Army Corps of Engineers (USCOE); State agencies and universities including Mississippi State University and Stephen F. Austin State University; nongovernmental organizations including the National Council for Air and Stream Improvement (NCASI); and private industry including Crown Vantage Corporation and International Paper Company (Table 2). From the beginning, governance was loosely structured; despite holding veto power, the FWS only required that activities be coordinated and within general refuge regulations.

Because the site was large enough to accommodate all needs and scientists in general used their own resources, there were few conflicts. Scientists from the several agencies had their own research agendas and developed their questions and studies in collaboration with their own set of managers. The NRCS, lacking their own research staff, funded universities to look at its specific questions that were not being addressed by scientists from other agencies.

Beginning with initial field installations in 1994, a broad range of research and demonstration experiments have been established on the site over the past 10 years (Figure 1). A prominent installation on the site is a large-scale (240 ac) study of alternative afforestation practices for forest restoration. This experiment contrasts four afforestation options that allowed us to compare passive (native recolonization) with active restoration (direct seeding and planting of Nuttall oak [*Quercus nuttallii* Palmer]), operational techniques on the same site (direct seeding and planting), and standard treatments with the most intensive treatment of interplanting two species that differed in successional status (early successional eastern cottonwood [*Populus deltoides* Bartram ex Marsh. ssp. *deltoides*], with the midsuccessional Nuttall oak). A second installation on the site is a 25-ac study of natural regeneration on abandoned agricultural land. This research focuses on the patterns of natural invasion by woody tree and shrub species on former agricultural land relative to distance and orientation from existing forest edge. The SRRDS also holds a 20-ac fenced area (for protection from animal damage) for studying silvicultural techniques to establish nontraditional afforestation species. This area is currently being used to investigate black willow (*Salix nigra* L.) establishment techniques for rapid growth and carbon sequestration on frequently flooded wetland sites. Another valuable component of the site's infrastructure is an impoundment system designed with 12, 1-ac cells that can be independently flooded and drained. This Flooding Research Facility (Lockhart et al. 2006) was designed to enable researchers to investigate the effect of different levels and timing of flooding on woody plants established on native soils. Initially, university researchers used the facility to look at several questions of immediate concern to the NRCS, including planting material, methods, planting date, and flooding regimes. Currently, a team of US Forest Service researchers is investigating the influences of soil inundation and light availability on physiology and growth of the endangered bottomland shrub, pondberry (*Lindera melissifolia* [Walt.] Blume) at the request of the USACE.

The greatest involvement of scientists from multiple disciplines and diverse agencies was directed toward the comparison of afforestation methods, in particular, the interplanting treatment. The public land managers and program managers (USFWS and NRCS) posed the core question of whether it was better to plant oak seedlings or sow acorns; although both techniques had been successful in research plots, there was mixed success in operational plantings and, indeed, little research had evaluated the techniques in side-by-side comparisons. The researchers who took on this question (US Forest Service and NCASI) added a "do nothing" treatment to provide a baseline of old field succession, with the same starting point as active restoration treatments. The researchers also wanted to include a treatment for establishing a mixture of species. A private land manager (Crown Vantage), who was not involved in the initial discussions, suggested trying a technique he was using on farmers' land, interplanting oak with cottonwood. Once the study was installed, additional questions were asked and other scientists became involved: what effect do small mammals have, especially on the direct-seeding treatment? Does the rapid accretion of vertical structure by the cottonwood attract birds? Whether the cottonwood benefits or harms the interplanted oak, what is the physiological response of the oak relative to seedlings planted in the open? The US Forest Service scientist leading the installation of the study recruited additional scientists (US Forest Service) to address these questions.

The development of the SRRDS has proceeded over 10 years. Because the entire site was not used immediately, scientists

Table 2. Partial list of collaborative organizations, their activities, and outcomes from their involvement on the Sharkey Restoration Research and Demonstration Site.

Core group	Activities	Outcomes
US Forest Service	Research, education, site development, management	Publications, tours, new technology, policy change development, management
US Fish and Wildlife Service	Site development, management, funding	Site restoration, partnerships
US Geological Survey	Research	Publications
US Natural Resources Conservation Service	Site development, funding	Publications, staff training
US Army Corps of Engineers	Research	Publications
Crown Vantage Corporation	Site development, management, research	Proof of concept, landowner acceptance
International Paper	Funding	Proof of concept
National Council for Air and Stream Improvement	Site development, funding	Proof of concept
Mississippi State University	Research	Publications, student training
Stephen F. Austin State University	Research	Publications, student training
Mississippi Valley State University	Research	Publications, student training

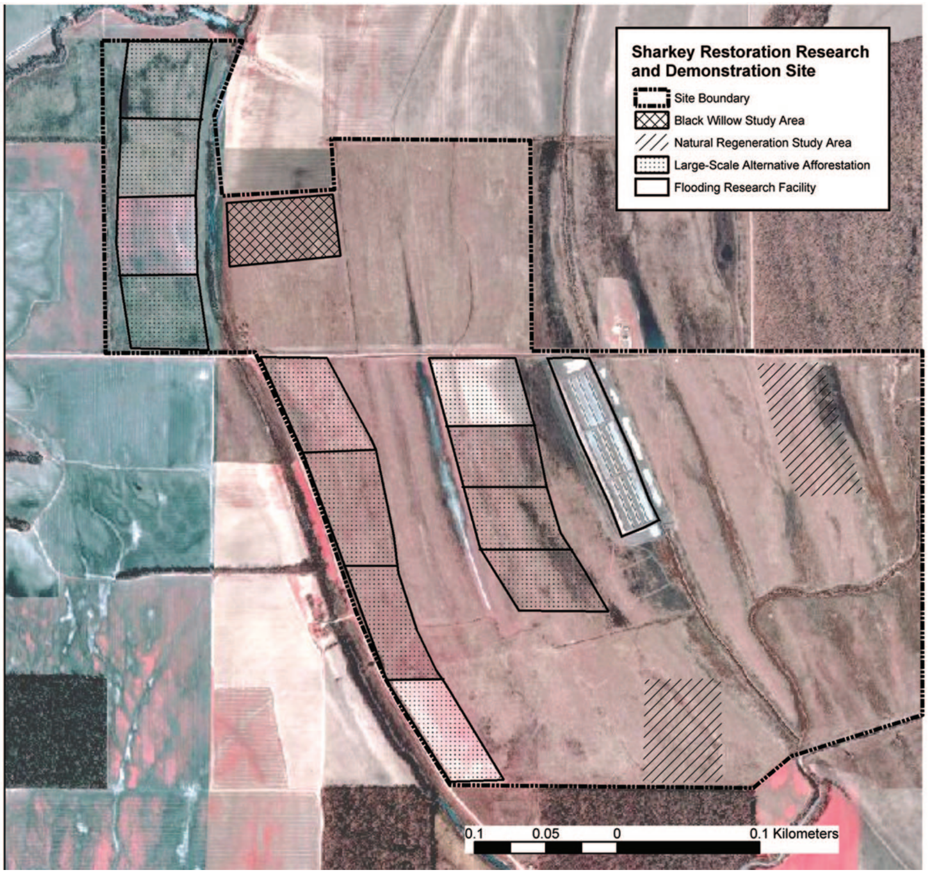

Figure 1. Aerial photo map of the SRRDS, including prominent experimental infrastructure.

have been able to stage installation of studies as resources became available and to follow-up on initial findings or new questions that arose. The design of the larger experimental areas has allowed for numerous smaller-scaled studies to be comprehensively imposed over larger-scaled projects. The Flooding Research Facility was designed to address questions that could be answered with short-term studies of relatively small plots, such as early stand development. This design provided flexibility to liquidate a study and install another. The large-scale study to examine alternative afforestation techniques, on the other hand, was designed as a long-term study and the large plot size was chosen to allow us to study utilization by wildlife. The large treatment plots also provided space to impose smaller studies of effects of four cottonwood clones on interplanted oak and disking 1 year versus 2 years to establish cottonwood. One particular advantage of using the fast-growing cottonwood is that we have completed a full rotation (12 years) and imposed alternative harvesting treatments (clearcut, thinning, and coppice). Because of the varied development of short-term and long-term research at the SRRDS, even repeating visitors find something new to see.

Outcomes

The effort on the SRRDS has resulted in many products; naturally, articles published in the scientific literature have been a primary output. Beyond peer-reviewed publications, at least three beneficial outcomes have developed from establishment of the site. First, the SRRDS has provided a platform for land managers and scientists to cooperate on the development of innovative approaches to forest restoration. Second, the site has provided a science-based resource for educating landowners, resource managers, and the general public on afforestation techniques and practices appropriate for restoration of bottomland hardwood forests. Finally, the site has been a venue for education and debate among landowners, nongovernmental organizations, and policymakers active in the LMAV. This section will highlight these outcomes providing additional detail of how some of these benefits have been realized on the SRRDS.

A Cooperative Platform for Innovative Bottomland Hardwood Ecosystem Restoration. A key reason to develop the SRRDS was to provide a platform where managers and researchers worked together to address important problems or questions on afforestation and restoration of bottomland hardwood forests. A cooperative spirit has resulted in the development of innovative practices for restoration of bottomland hardwood ecosystems. For example, foresters with Crown Vantage Corporation provided ideas that led to testing the innovative

Table 3. Categories of visitors to the Sharkey Restoration Research and Demonstration Site and outcomes relevant to the knowledge and awareness gained through site visits.

Visitor category	Outcomes
Educational groups	Student awareness of practical and technical issues
Policymakers	Awareness of potential user needs and changes in federal policies
Potential users (consultants, landowners)	Increased acceptance of innovation and alternative practices
Scientists	Experimental approaches, knowledge advancement

Figure 2. High school children assisting research scientists with wintering bird use sampling in habitat created by alternative afforestation practices.

Figure 3. Field discussion on conservation program policy between forest scientists, landowner advocate groups, and policymaking officials.

interplanting system for restoring bottomland hardwood ecosystems (Hamel 2003, Gardiner et al. 2004). This system establishes a complex plantation that promotes rapid stand development (Fisher et al. 2002), catalyzes development of ecosystem processes (Hamel 2003, Gardiner et al. 2004), and accommodates multiple management objectives (Gardiner et al. 2004).

A Science-based Demonstration Area for Bottomland Hardwood Ecosystem Restoration. A primary outcome of establishing the site has been the provision of a science-based demonstration area for bottomland hardwood ecosystem restoration. Annually, numerous field trips and workshops are hosted by the researchers and land managers at the site where landowners, managers, students, scientists, and policymakers observe firsthand operationally installed large-scale afforestation (Table 3). Although these operationally installed large-scale treatments are invaluable for demonstration purposes, supplementing these observations with research findings on critical topics such as stand productivity, wintering bird use, small mammal use, and changes in soil quality are essential for linking specific afforestation practices to restoration of particular ecosystem processes. Because the SRRDS was designed with both objectives in mind, visitors to the site receive visual images of various afforestation practices, as well as comprehensive knowledge of impacts on selected ecosystem processes. The efforts to promote the site as a demonstration area to educate interested parties on afforestation and restoration of bottomland hardwood ecosystems have been recognized jointly by the US Forest Service and Ducks Unlimited, Incorporated, through their "Taking Wing Award" for Public Awareness in 1997. The educational value of the site and accompanying research was realized in unexpected ways; a group of special needs children in a structured living center volunteered to assist in the wildlife fieldwork (Figure 2), earning them an award for volunteerism from the Director of the Southern Research Station.

A Venue for Policy Formation. The education of policymakers is of paramount concern to resource managers trying to adopt and implement innovative afforestation and forest restoration practices. Informing policymakers is particularly important because the primary thrust behind forest restoration in the LMAV is conservation easements offered and administered by agencies of the Federal Government. The SRRDS has provided policymakers with a convenient location to observe various afforestation practices and forest restoration approaches that are subject to scientific research (Figure 3). The value of the SRRDS for affecting policy was shown recently by a change that should increase the economic viability and sustainability of afforestation practices in the LMAV. In May 2005, the Farm Service Agency, which administers the Conservation Reserve Program, amended their guidelines for Conservation Practice 31, Bottomland Timber Establishment on Wetlands, to allow for establishment of cottonwood (*Populus* spp.) stands interplanted with oak (USDA, Farm Service Agency Notice CRP-496). Onsite visits to the SRRDS, extension of knowledge gained from research on the site, and debates between land managers, scientists, and Washington office staff visiting the site were pivotal to implementation of this recent policy change. To date, this practice is still not allowed on WRP.

Planning for Success

Several features of the SRRDS have contributed to its value as a source of information and usefulness as a demonstration area. In this section we highlight three important features associated with site selection and three features related to experimental design that have contributed to the success of the research and demonstration area. Although some of these features were of intentional design, the importance of others was realized retrospectively. These noteworthy aspects of the SRRDS are discussed as recommendations for consideration by managers and researchers who may plan similar sites in the future.

Sites Should Be Located on a Neutral and Secure Area. The SRRDS was established on an area within the National Wildlife Refuge System. No hurdles due to agency policies were encountered, possibly because the site was being restored from active farming for research purposes. Certainly, the enthusiastic support of the refuge manager and his staff also was a factor. Two primary advantages associated with public ownership of the site are neutrality and security. The neutrality of our site has attracted interest from and spawned collaboration between multiple organizations including federal and state agencies, universities, private industry and nongovernmental organizations. Furthermore, because the property is under federal management as part of the refuge system, researchers have practical assurance that the site will be secure for establishment of long-term experiments.

Selected Sites Should Be Representative of the Problem. To ensure the value of field research and extension of findings and recommendations to the intended audience, the selected demonstration site must be representative of the targeted problem area. The site chosen for installation of our research and demonstration area can be considered typical of afforestation sites throughout the LMAV for several reasons. First, because of the soil and hydrologic regime on the site, it can be classified as a farmed wetland and its land-use history is representative of most low-lying areas cleared in the 1960s and 1970s for soybeans. Second, the predominant soils on the site, Sharkey Clay, is also a dominant soil series in the LMAV (Pettry and Switzer 1996) and probably the most prevalent soil enrolled in conservation easement programs in this region. Additionally, the site is characteristic of other afforestation tracts in the LMAV because land adjacent to our site has remained in agricultural production, largely isolating the site from other forested tracts. These site characteristics increase the value of knowledge gained from experimentation established on the site by making it directly applicable to the majority of land enrolled in conservation easement programs in the LMAV.

The Research and Demonstration Area Should Be Easily Accessible. A demonstration area inaccessible to the intended audience is of little value. Our experience indicates that many visitors to our site are either unprepared or would be unwilling to trek long distances across inhospitable terrain to make observations on experimental plantings. This is particularly true of visitors, such as policymakers, who routinely do not work in the field. Thus, access should be accounted for during site selection as well as during the layout and configuration of experimental plantings. Because some of the experimentation on our site is adjacent to a public road, people traveling through the area can readily observe forest development in the agricultural landscape (Figure 1). Additionally, interior portions of the site can be easily accessed on foot through an established road and trail system. A disadvantage of such ready access is potential vandalism. For this reason, we did not install signage on the site because we considered it too tempting a target for local sharpshooters.

Sites Should House Large-Scale Research and Demonstrations. Establishment of large-scale research and demonstration has greatly benefited the educational value of our site. Although establishment of large-scale research will generally increase the installation and measurement costs over

Figure 4. Large-scale experimental plots, such as this 20-ac planting of cottonwood and oak, allow for operational-scale treatments including selectively harvesting the cottonwood and releasing the oak.

smaller-scale projects, we have observed several advantages of the large-scale installations on our site. First, the visual impact of a treatment effect is enhanced when experimental units encompass a relatively large area. Next, these large-scale experimental units enable visitors to visualize the treatment on other landscapes. Additionally, establishment of large experimental units allows for building comprehensiveness by layering of additional studies within the framework of the primary study. This could include examination of response variables that are influenced by area (e.g., certain wildlife species), temporal variation (e.g., forest stand development patterns), or various nested treatments applied in the future (e.g., intermediate stand practices or harvests).

Large-Scale Experiments Should Be Installed Operationally. When possible, large-scale experiments on the research and demonstration site were installed operationally, through which we have realized at least three pragmatic advantages (Figure 4). A primary advantage is the necessary involvement by managers on the design and installation of experiments. Second, it provides visitors the assurance that particular treatments can be installed on their sites with existing equipment and materials. Last, operational installation of experiments generates realistic inputs for cost accounting models of applied practices. Such information is critically important to landowners and managers looking to invest in new afforestation technology.

Experimentation Should Include Comparisons with Conventional Practices. Including an operational control of a conventional practice in the experimental design is very useful when conducting research or establishing a demonstration area on alternative afforestation practices. Doing so provides a familiar baseline from which to make direct comparisons of treatment inputs and results on a common site. Additionally, such experimental designs often allow for striking visual contrast of known practices to innovative alternative treatments.

Summary

Establishment of the SRRDS arose through the vision of managers and the cooperative spirit of researchers who were actively practicing and studying forest restoration in the LMAV. What began as an initiative to improve bottomland hardwood restoration has grown to a collaborative effort by land managers and scientists promoting the advancement of afforestation practices and forest restoration in bottomland hardwood ecosystems through comprehensive research and demonstration. Work accomplished on the site has had a positive impact on afforestation in the LMAV as techniques and practices evolve toward establishment of more complex plantations that are better suited to accomplish multiple objectives. Active dialogue between resource managers, scientists, landowners, and policymakers has been pivotal in transferring knowledge and implementing innovative practices developed on the site. The value of the site as a research and demonstration area is attributed to characteristics of the location and features of experimental design. Continued collaboration on the site should foster development of economically viable practices to establish ecologically sustainable forests for the advancement of restoration of this vital bottomland hardwood resource.

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