

## THE STATUS OF AGROFORESTRY IN THE SOUTH

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**Abstract:** Southern agroforestry has emerged as a significant research topic. Research results indicate that agroforestry can address such sustainability problems as erosion and water pollution, while improving economic performance in selected situations. Silvopastoral systems are the most commonly adopted agroforestry application in the region; less-common alley-cropping systems would seemingly help many landowners achieve specific economic objectives. Based on a survey of land-use professionals, the most important research topics related to southern agroforestry are: methods for improving economic returns, mechanisms for enhancing the productivity of alternative systems, and predicting and reducing damage to trees and soils by livestock and farming equipment.

### Introduction

Agroforestry is defined simply as "the intentional integration of agricultural and forestry-based land-use systems" (Agroforestry for Sustainable Development: A National Strategy to Develop and Implement Agroforestry 1994). With vast acreage in forestland, cropland, and pasture land, and a lack of sharp demarcations for obviously "optimal" land uses (Henderson 1991), southern agroforestry applications have considerable potential. The purpose of this paper is to review the status of agroforestry in the South, with special attention given to past and potential research related to the economics of this land use. Both an extensive literature review as well as a survey of 218 southern public land-use professionals (for details, see Zinkhan 1996) employed by the Natural Resource Conservation Service, state forestry divisions, and the Cooperative Extension Service are used as the basis of our analysis.

### Southern Agroforestry Systems

About one-half of the respondents to the survey of southern land-use professionals indicated familiarity with at least one agroforestry case. More than 74 percent of the respondents indicating familiarity identified a silvopastoral system with grazing as the case with which they were most familiar.

Bandolin and Fisher (1991) catalogued numerous southern agroforestry systems that produced at least two of the following outputs: sawtimber, pulpwood, plywood, veneer, firewood, nuts, fruit, livestock, and human food. These cases included a variety of softwoods such as cedar, loblolly pine, longleaf pine, Monterrey pine, and slash pine as well as a variety of hardwoods including American chestnut, apple, black walnut, cottonwood, hickory, honey locust, oak, Persian walnut, persimmon, red mulberry, sycamore, and yellow poplar. Bandolin and Fisher concluded that forest grazing dominates southern agroforestry, with 100 million acres (see Lewis 1980) in the states of Alabama, Florida, Georgia, and Louisiana capable of supporting pine-cattle systems.

The South has the greatest potential, in terms of feasible acreage, for silvopastoral systems in the U.S. (Pearson 1991). As shown in Table 1, a variety of silvopastoral systems have been reported by

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Table 1. Selected examples of observed silvipastoral systems.

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Loblolly pines/Cattle/Pasture
Mixed southern pines/Goats/Pasture
Natural oaks/Hogs
Pecan trees/Cattle/Pasture
Black locusts/Sheep/Fescue
Apple trees/Sheep/Pasture
Black walnuts and pecans/Cattle/Bahiagrass
Southern pines/Angora goats
Southern pines and bottomland hardwoods/Angora goats and cattle/Bahiagrass
Planted maples/Bees
Black locust, basswood, and persimmon/Bees and sheep/Pasture
Loblolly and shortleaf pines and mixed hardwoods/Dairy goats and wildlife/Hay
Southern pines, sweetgums, pecans, and oaks/Calves/Grass and clover
Apple and pear trees/Garlic and potatoes/Chickens
Mixed forest/Clover, wheat, and rye/Wildlife

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southern land-use professionals (Zinkhan 1993, 1996) and agroforestry producers (Henderson and Maurer 1993). The specific system most commonly cited by land-use professionals was the loblolly pine-grass-cattle mix. Cattle appear to be the dominant livestock component of southern silvopastoral systems. Of those southern land-use professionals both noting a silvopastoral system and specifying the livestock component for that agroforestry case with which they were most familiar, 94 percent listed cattle (Zinkhan 1993). Goats were the only other livestock mentioned.

In addition to cattle and goats, a survey of mid-south agroforestry producers by Henderson and Maurer (1993) reported silvopastoral systems incorporating sheep, chickens, bees, and rabbits (see Table 1). Weed or brush control was the most common purpose for including goats or sheep. For example, an Alabama producer reported the use of sheep and Angora goats to release young planted pine from grass and hardwood competition. A second Alabama producer noted that he allows sheep to graze the pasture under an apple orchard from late October to early March in order to keep orchard rows clean and free of weeds. A third Alabama producer, the manager of a pine-Angora goat system, plans to use goats in the place of periodic prescribed burns.

Tree-crop and tree-forage (without grazing) systems do not appear to be as common in the South as silvopastoral systems with grazing. Only 26 percent of the southern land-use professionals in the Zinkhan survey (1996) reported a tree-crop or tree-forage system as the agroforestry case with which they were most familiar. No specific system dominated the tree-crop and tree-forage systems in that survey; the most commonly cited crop components were soybeans and grains. Examples of tree-crop and tree-forage systems reported by southern land-use professionals (Zinkhan 1993, 1996) and mid-south agroforestry producers (Henderson and Maurer 1993) are listed in Table 2. Notice that both hardwoods and pines are represented in the list of cases.

Potential benefits of tree-crop and tree-forage systems include increased utilization of available growing space, enhancement of cash flows early in the rotation cycle, and positive spillovers between the system's components (e.g., enhancement of soil quality, fertilization, cultivation, weed control)

**Table 2. Selected examples of observed tree-crop and tree-forage systems.**

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Cottonwood/Soybeans
Loblolly pines/Corn or wheat
Loblolly pines/Watermelon
Loblolly or longleaf pines/Soybeans
Longleaf pines/Cotton
Loblolly pines/Bahiagrass
Longleaf pines/Natural grasses
Pecan trees/Bahiagrass
Apple trees/Potatoes, onions, peas and beans
Pecan trees/Vegetables and grains
Pecan, fruit trees and mixed hardwoods/Berries and pasture
Apple and pear trees/Hay
Moringa/Sweet potatoes and corn
Pecan trees/ Potatoes, vine crops, and sod
Pecan, walnut, and persimmon trees/N-fixing shrubs, raspberries, and dwarf fruit trees

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(Gold and Hanover 1987). Most alley-cropping systems generate the first two of these three benefits. For example, an Arkansas producer intercroops young apple trees with such early-maturing vegetables as potatoes, onions, peas, and beans (see Table 2). These vegetables utilize space between the trees to produce a source of early incremental revenue. A number of observed agroforestry systems benefit from positive spillovers between the components. A Florida producer, for example, combines planted pecans and fruit trees with pasture (Henderson and Maurer 1993). The producer observed that the components have synergistic relationships. The pecans provide beneficial shade for pasture and moisture conservation for the fruit trees while the presence of the pasture reduces the severity of soil erosion.

Attention has been given in the literature to fast-growing hardwood plantations with a crop component early in the rotation (Gold and Hanover 1987). For example, cottonwood, grown on 10-year rotations, has been interplanted with soybeans and cotton on the Mississippi Delta, and the growth of a young sycamore plantation in northern Alabama was stimulated by interplanting the trees with clover and vetch.

### **The Economics of Southern Agroforestry: A Review**

Most of the economics-related research of southern agroforestry has focused on silvopastoral systems. Some of economic evaluations of southern silvopastoral systems have been encouraging. Based on simulations of a loblolly pine- forage-beef cattle system in the Coastal Plain, Dangerfield and Harwell (1990) reported a net present value that was 71 percent greater per unit area than for a pure forestry operation. Possible sources of the incremental value created in the grazing-based agroforestry system included more intensive use of the land, a reduction of the time between cash inflows, and synergies such as utilization of the manure as a fertilizer by the trees and the climate-stabilizing effect of the trees on the animals' habitat (resulting in less energy consumption by the animals). In a five-year study in Louisiana, Clason (1995) found that establishment of a Coastal bermudagrass pasture in a maturing loblolly pine plantation achieved an internal rate of return (IRR) of 13.4 percent. In contrast,

the Coastal bermudagrass open pasture and timber management only alternatives earned IRRs of only 6.1 percent and 8.8 percent, respectively.

The effect of livestock grazing and trampling on seedling survival and soil productivity is a key issue associated with the economic potential of silvopastoral systems. In relation to the compaction problem, the static ground pressure exerted by mature cattle is approximately equal to the level exerted by a heavy-wheeled tractor. Bezkorowajnyj, Gordon, and McBride (1993) observed an increase in soil bulk density from even light cattle grazing. In a laboratory experiment, they found that medium and high levels of soil compaction reduce water infiltration and nitrogen cycling, resulting in slower growth of seedlings.

Research results associated with the impact of grazing on tree survival and productivity have been mixed. USDA Forest Service researchers reported that zinc dithiocarbamate, a repellent, was unsuccessful in preventing mechanical damage by cattle grazing within planted pine seedlings (Southeastern Forest Experiment Station 1960). In a five-year study of the effects of cattle grazing on natural regeneration of longleaf pine seedlings, Boyer (1967) found that even light grazing killed 23 percent of the seedlings and reduced diameter growth by 13 percent. In contrast, Pearson, Whitaker, and Duvall (1971) did not find a significant influence of light cattle grazing on tree survival in a young longleaf pine plantation, while Pearson and Whitaker (1973) estimated that, with good management, grazing within longleaf pines produced positive economic returns.

Although Lewis, Monson, and Bonyata (1985) found that year-nine survival was 15 percent less for grazed than ungrazed longleaf pine sites in north Florida, the trees were 50 percent taller on the grazed sites. Grazing reduced the level of plant competition and allowed full sunlight to reach the seedlings, thus enabling seedlings to break out of the grass stage much earlier. Heavily grazed slash pine sites in Louisiana experienced incremental losses of 18 percent of the planted pines in a 5-year period (Pearson 1991). However, tree survival was not affected significantly under light and moderate grazing conditions. The experiences of a forest products company manager with livestock grazing on forest range in Louisiana were consistent with these mixed empirical findings: "There is also some grazing damage to young pines, but this has not been a major problem" (Rials 1984, p. 159).

In addition to careful control of the density (and timing) of livestock grazing, producers have used electric fences to control damage to tree seedlings. Pearson, Baldwin, and Barnett (1990) found that pine trampling injury was 8 percent greater on a cattle-grazed site in central Louisiana than on either an ungrazed site or a grazed site when electric fences were used. By the end of the three-year study, the heights of loblolly pine seedlings were greater on the protected sites than on the grazed sites. In contrast, heights of slash pine seedlings were similar on both sites.

Lundgren, Conner, and Pearson (1983) suggest that the level of herbage production under standing timber determines whether or not a grazing system will be economically feasible. Thus, the availability of a shade-tolerant forage species is critically important (Muir and Pitman 1989). Searches for and evaluations of such species have been promising. For example, Muir and Pitman found that *Galactia elliotii* N., a naturally occurring legume, is adapted to shaded flatwoods environments and can contribute forage as well as nitrogen to an agroforestry system in the Gulf Coast. Further investigation of shade-tolerant forages for such southern systems is needed.

In terms of perceptions, the land-use professionals were directed to rate observed agroforestry systems relative to three criteria: compatibility between components, productivity, and economic performance (Zinkhan 1996). The silvopastoral systems with grazing generally received lower mean ratings than the two other observed categories of systems (alley-cropping and tree-forage production systems).

However, the professionals perceived silvopastoral systems with grazing to have provided a slightly greater level of landowner satisfaction. Perhaps the latter finding is due to less optimistic initial expectations of silvopastoral systems.

Much of the research associated with southern alley-cropping systems is preliminary and dependent upon various assumptions, including the transfer of research results to the South from other regions. Consider black walnut-crop management systems, one of the more commonly cited examples of U.S. agroforestry. Most attention has been placed on walnut alley-cropping systems in the Midwest. Kurtz *et al.* (1984) and Garrett *et al.* (1991) estimated that a timber-nut-winter wheat system in Missouri would achieve a greater IRR than either timber-only or timber-nut systems. Walnut is a good choice for an agroforestry system for a variety of reasons. It is one of the last tree species to break dormancy in the spring and one of the first to defoliate in the fall, thus providing a longer-than-ordinary period of close-to-full sunlight for an intercrop species such as winter wheat (Slusher 1991). Its root system accommodates crops which utilize the shallow zone of the soil surface. The spacing required for walnut crown development permits substantial sunlight to reach the soil surface (Garrett *et al.* 1991). Its wood is highly valued while nut production can supplement other sources of income. Finally, the annual income from the crop component is often welcomed by landowners facing a 60-70 year timber rotation.

Hatcher, Johnson, and Hopper (1993) recommended that black walnut plantations be considered for the southern USA, especially on small acreages of abandoned cropland that are inaccessible or too small to be economical when using larger row-crop equipment and in streamside management areas that have been set aside. They argued that the perception of poor quality of southern walnut timber is a result of poor management and past high grading. Using financial modeling on property with a site index of 75 (base age 50 years) and a 60-year rotation (with a veneer and sawlog harvest) with thinnings of sawlogs at age 26 years and veneer and sawlogs at age 40 years, Hatcher *et al.* estimated a before-tax IRR of 10 percent. Transferring the general findings of Kurtz *et al.* (1984) and Garrett *et al.* (1991) to the Southern USA, it is likely that incremental returns (relative to those estimated by Hatcher *et al.*) will be achieved on some sites through the addition of commercial nut production and a crop component.

### **Special Considerations when Evaluating the Economic Attractiveness of Southern Agroforestry Systems**

The unique feature of agroforestry systems is the interaction between the integrated, multiple components. Often, there is considerable uncertainty associated with the effects of this interface. When evaluating the economic attractiveness of a given agroforestry system, the following factors should be given special consideration:

- **Cost of establishing the system**—These costs can be considerable and represent one of the primary reported hurdles to adoption (Zinkhan 1996). For example, Clason (1995) reported a first-year cost of \$204 per acre (in 1985) for establishing forage under a thinned stand of planted pines.
- **Positive spillovers between components**—The economic benefit of one of the multiple components of an agroforestry system can extend beyond the value of its output, and should be considered in an economic analysis. Consider, for example, a leguminous tree component of a tree-crop system. With their deeper and more extensive root systems, leguminous tree species can increase soil fertility and enhance soil physical properties.

- **Negative interactions between components**—Sometimes, the presence of one component impairs the productivity of one or more of the other components of an agroforestry system. Cattle grazing, for example, can negatively impact the survival and growth of trees, especially if the load and timing of grazing is not carefully managed. Or, the shading effect of trees can obviously reduce the output of an underlying crop. Given the general lack of empirical data associated with integrated systems, bioeconomic modeling has been proposed to estimate the outputs from such systems (Wojtkowski and Cabbage 1991).
- **The risk associated with the systems' outputs**—Although additional research is needed to improve the accuracy of output estimates (and thus reduce the uncertainty) associated with integrated, multiple-output systems, another factor can mitigate the inherent risk of agroforestry: diversification of incomes. Lilieholm and Reeves (1991) and others have argued that less-than-perfectly positive correlations over time, both between the multiple outputs' prices and between their volumes, will tend to reduce a landowner's financial risk.
- **The value of strategic flexibility**—As regulations, technologies, and markets for outputs change, the potential to react to new conditions is advantageous. The ability to abandon one land use and then establish or emphasize another one, as conditions change, is a potentially valuable strategic option for the landowner and represents a source of flexibility (Zinkhan 1995). Given the greater ease of shifting between outputs within a multiple land-use system than between pure agricultural and forestry uses (Henderson 1991), agroforestry is a more flexible land use.
- **Long-term benefits to the productivity of the system**—In addition to their potential role in avoiding more extensive erosion, agroforestry systems have been recognized as a potential tool for rehabilitating already degraded properties (Bandolin and Fisher 1991). Simulations developed by Campbell, Lottes, and Dawson (1991) for the central U.S. revealed that tree-crop systems were able to meet a threshold soil loss tolerance level on low- and medium-quality sites; traditional agriculture was not capable of meeting this level.
- **Cost-share incentives**—Federal forestry incentive programs for private landowners have existed for over 50 years. Cost-share incentives have predominated, although tax-credits and deductions have also been used. Of the Federal programs, only the Stewardship Incentive Program (SIP) specifically includes agroforestry as one of the approved practices. However, practices not specifically labeled as agroforestry are eligible for cost-sharing in some of the other programs; for example, the Conservation Reserve Program (CRP) was amended in 1990 to allow cost-sharing for windbreaks, shelterbelts, and alley cropping with hardwoods without requiring enrollment of the whole field. Established by the 1990 Farm Bill, SIP provides up to 75 percent cost-share to landowners for implementing various forest practices identified in Landowner Forest Stewardship Plans. "Agroforestry Establishment, Maintenance and Renovation" is one of SIP's nine approved practices. Approved agroforestry practices are establishing, maintaining or renovating windbreaks, hedgerows, living snow fences, livestock shelters, and alley cropping. The initial response to agroforestry under this program has been anemic. From 1992-1995, agroforestry was adopted under SIP on only 203 acres on 6 farms in only one of the region's 10 states (Alabama).

## **Conclusions**

Given the South's diverse agricultural and forest landscapes, changing rural and urban lifestyles, and the need to resolve a variety of environmental problems associated with rural land use (e.g., erosion, water pollution, riparian zone degradation, threats to biodiversity and wildlife), considerable potential exists for expanding southern agroforestry over the next few decades. Zinkhan's (1993, 1996) survey of southern land-use professionals provides evidence for this conclusion. Despite rather modest

education, training, or professional experience with agroforestry, almost two-thirds of the professionals reported that they would consider recommending agroforestry for certain situations. However, several research, training, extension, and policy constraints will need to be overcome to realize significant numbers of agroforestry system adoptions in the South.

The most common reason for rejecting the agroforestry option by southern land-use professionals was the high degree of uncertainty associated with what they considered an unproven land use (Zinkhan 1996). Thus, expanding research and dissemination of research results represent one of the most critical needs for southern agroforestry. The critical agroforestry research needs identified by southern land-use professionals were (in rank order):

1. Improving the economic returns and costs of implementing and maintaining agroforestry systems,
2. Enhancing the productivity of alternative systems,
3. Predicting and reducing damage to trees and soils by livestock and farming equipment,
4. Quantifying the potential of agroforestry for solving environmental-related problems, including impacts on wildlife, and
5. Developing alternative approaches for educating the public and extension personnel about agroforestry.

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