LONGLEAF PINE AGROFORESTRY

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ABSTRACT

While ecosystem restoration of longleaf pine (*Pinus palustris* Mill.) forests represents a worthy ideal, it is not always a practical alternative for landowners. Agroforestry systems, which can be developed in existing agricultural land, natural forest stands, plantations, or pasturelands, offer the opportunity to provide multiple benefits: high value timber production, continual agricultural production, and improved wildlife habitat when compared to agricultural land. The possibilities for multiple income sources associated with agroforestry are plentiful and, for forest landowners, may mean the difference between profit and loss in times of commodity price fluctuations. Agroforestry can provide a range of income alternatives, including agricultural products, wildlife, medicinal plants, mushrooms, carbon credits, pine straw or biofuels, providing landowners with a stable income until the trees become merchantable. We discuss alternative income possibilities and the necessity to locate and secure dependable markets to supply a steady cash flow for forest landowners.

INTRODUCTION

Research needs for longleaf pine (*Pinus palustris* Mill.) ecosystem restoration are many and of critical importance. These fire-driven ecosystems, which once occupied over 90 million acres in the southern United States, were logged extensively in the late 19th and early 20th centuries (Frost 2006). A number of factors contributed to the decline of longleaf pine, among them a massive regeneration failure. This led to the replacement of longleaf pine primarily with slash pine (*P. elliottii* Engelm.) and loblolly pine (*P. taeda* L.) plantations throughout much of what was the longleaf pine range. These two species became the focus of the intensive management practices required to maximize economic returns (Garrett and others 2004).

An effort is now underway to restore longleaf pine to an approximation of its former prominence (Regional Working Group for America's Longleaf 2009). While some major restoration efforts will concentrate on both the overstory and understory, it is important to remember that 80 percent of the forested land base in what was the longleaf pine range occurs on privately held lands. It is critical that landowners and forest managers involved in restoration activities consider the ecosystem services and silvicultural practices that could serve as incentives for private landowners to establish and maintain longleaf pine forests. Connor and others (in press) suggested that agroforestry might be an attractive land use alternative in areas where row cropping, grazing, or pulpwood markets are no longer viable or where there is a threat of insect and disease epidemics. The combination of intensively managed timber with livestock forage, wildlife habitat, other agricultural or nursery crops, and biofuel crops presents an attractive prospect to those wishing to maintain a productive, pastoral land base.

Land ownership patterns have shifted dramatically in the South (Wear and Greis 2002). As urbanization and development spread further into what were once rural areas, cohesive blocks of forested land are subdivided, and ownership may transfer to those less familiar with traditional forestry practices, such as burning, thinning, and other forest management tools (Clutter and others 2007; Wear 2007; Wear and others 2007). Another effect of urbanization has been changes in land valuation. Since income from traditional forest uses or forest land sale is rarely able to compete with income from real estate development, finding alternate income sources from land management activities is a daunting task. Fluctuating and declining pulpwood markets, insect infestations, plant diseases, and storm events have impacted the values of loblolly pine and slash pine plantations. Land managers now have an unprecedented opportunity to convert these plantations to either longleaf pine plantations or to longleaf pine agroforestry systems.

The environmental benefits of retaining land in forests are many and include positive impacts on water and air quality, soil conservation, and wildlife habitat. However, landowners are not yet rewarded for good stewardship (Shrestha and Alavalapati 2004) and must look elsewhere for economic returns. The objective of this article is to discuss crop alternatives for managers and private landowners interested in longleaf pine agroforestry.

INTERCROPPING

The list of species for intercropping is extensive (Gray and others 2003; Rao and others 2004), and includes traditional crops such as corn, soybeans, and cotton but may also include less traditional crops such as mushrooms and medicinal herbs. However, an investment in planning and marketing surveys prior to beginning any venture is essential for success. In addition, a good business plan should be developed and information on appropriate species that can be grown on the site should be compiled. A good place to start on the latter is the USDA Plants Database (2011). Websites such as Richter's Herbs (2011) can also be useful. Also, some basic site evaluations, such as soil analyses, soil surveys, and nutrient analyses, must be

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completed. Once these tasks are performed, plans can be analyzed for potential economic success. The following are some possible income sources from land maintained in agroforestry:

MEDICINAL PLANTS AND HERBS

Medicinal and aromatic plants were valued worldwide at $1.6 billion in 1996 and almost $4 billion in 1998 (Brevoort 1998; Gray and others 2003). Lists of herbs and understory plants that can be grown as cash crops can be found at various internet sites (e.g. Richter's Herbs 2011) or in reference texts (Clason 2003; Garrett and others 2004). Either shade tolerant or intolerant species are possible candidates, depending on alley width and/or the growth stage of the overstory trees (Jose and others 2004; Lin and others 1999). Some examples of medicinal herbs commonly mentioned as marketable are (nomenclature from USDA Plants Database [2011]):

1. American ginseng - *Panax quinquefolius* L.
2. Black cohosh - *Actaea racemosa* L.
3. Bloodroot - *Sanguinaria canadensis* L.
4. Blue skullcap - *Scutellaria lateriflora* L.
5. Catnip - *Nepeta cataria* L.
6. Echinacea - *Echinacea angustifolia* D.C.
7. Goldenseal - *Hydrastis canadensis* L.
8. Valerian - *Valerian officinalis* L.
9. Wild indigo - *Baptisia australis* (L.) R. Br

Shrubs with medicinal properties include:

10. American witchhazel - *Hammelis virginiana* L. (leaves, bark).
11. Slippery elm - *Ulmus rubra* Muhl. (inner bark)
12. Wild hydrangea - *Hydrangea arborescens* L. (bark and roots)

Habitat requirements and intolerance to extreme temperatures limit many of the herbs listed above from growing well in the South. In addition, some species may have undesirable characteristics which should be considered before planting. If land managers are considering livestock grazing on some of portion of their property, consider, for example, that although common St. Johnswort (*Hypericum perforatum* L.) is reportedly of value as an anti-depressant (Linde and others 2008), it is not native to North America and is considered invasive in some areas. This, combined with its toxicity to livestock, would negate its value as an intercrop species in areas where it might spread to pastures (USDA Plants Database 2011).

Growing herbs can be a risky venture even with the best considered plans. Market and price instability can adversely affect even a well-researched business venture. For instance, U.S. consumer sales of common St. Johnswort, estimated at $400 million dollars in 1998 (Monmaney 1998), has dropped precipitously. The size of the initial investment, scale of the project, and future market all influence profit margins. Burkhart and Jacobson's (2006) paper on goldenseal is an excellent, in-depth study on growth, collection, and marketability of an herb. If a product is to be exported, a set of laws, regulations, reports, and licenses must be considered, especially if the species in question is on the endangered species of flora list.

AROMATICS AND ESSENTIAL OIL/COOKING HERBS

The aromatics, such as rosemary (*Rosmarinus officinalis* L.) and kitchen sage (*Salvia officinalis* L.) are possible species for intercropping. These plants are naturally occurring in the Mediterranean countries and grow well on poor, sandy soils. Caper (*Capparis spinosa* L.), also a Mediterranean species, was at one time cultivated in the United States. Caper thrives in a semi-arid environment, so its success in an area with higher humidity is problematic. Other potential crop species include, but are not limited to:

1. Cayenne pepper - *Capsicum annuum* L. var. glabriusculum (Dunal) Heiser & Pickersgill
2. Sweet basil - *Ocimum basilicum* L.
3. Wild chives - *Allium schoenoprasum* L.
4. Dill - *Anethum graveolens* L.
5. French shallots - *Allium cepa* var. ascalonicum
6. Parsley - *Petroselinum crispum* (Mill.) Nyman ex A.W. Hill
7. Peppermint - *Mentha x piperita* L. (pro sp.) [aquatica x spicata]
8. Spearmint - *Mentha spicata* L. var spicata
9. Garden thyme - *Thymus vulgaris* L.

All species would require further investigation before planting. Preferred climate and soils, tolerance to temperature and humidity extremes, ease of cultivation, and markets may all be limiting factors. While some of the above listed species are not normally found in the southern states, some will survive and flourish here if soil and climatic conditions are conducive to growth and development. However, it may be necessary to consider that some non-native or non-local plants, as previously mentioned, can become invasive or are otherwise undesirable.

MUSHROOMS

Edible and medicinal mushrooms present intriguing alternative crop possibilities. Freshly cut 5 to7 inch diameter hardwood stems (e.g. small sweetgum [*Liquidambar styraciflua* L.] removed from a planting site or during clean-up of existing stands) can be inoculated with shitake (*Lentinula edodes* [Berk.] Pegler) and oyster (*Pleurotus* spp.) mushroom spores. Holes are drilled into the wood, the spores implanted, and the drill hole painted with a coating of paraffin to prevent desiccation. Propped against longleaf or other pine crop trees, the inoculated logs are kept out of alleys so they do not interfere with mowing or use of the alleys for other cash crops. Informational

sources on species of edible mushrooms that can be grown in this manner are Cannon-Crothers (2009) and http://www.mushroommountain.com.

FRUIT CROPS

Installing fruit orchards in rows between crop trees may have limited application. It generally takes at least 4 to 5 years for fruit trees to become established and produce a crop. In this interval, rapidly growing crop trees may overtop and shade the fruit trees, substantially reducing yields. Additionally, the droughty, poor quality soils suitable for pine production may not be appropriate for fruit trees.

Soft fruits (stoneless fruits, such as strawberries, raspberries, blueberries, blackberries, and grapes), however, are potential crop species and market possibilities can include a pick-your-own variation (with appropriate insurance for protection against injuries). If this is not an option, other sales avenues must be assessed, as should skills necessary to maintain the canes of blackberries and raspberries to maximize fruit production. Grapes require the construction and maintenance of a trellis infrastructure, adding to startup costs.

LANDSCAPE PLANTS

Ornamental trees and shrubs—Landscape trees and shrubs could be grown either in the ground or in containers under longleaf pine trees. The latter application offers the greatest versatility, since soil conditions would not limit species selection. A newly planted agroforestry system would favor shade-intolerant species, while shade-tolerant species could be grown in mature systems. Hagan and others (2009) found that shade-tolerant native understory species American beautyberry (*Calliocarpa americana* L.), wax myrtle (*Morella cerifera* [L.] Small), and inkberry (*Ilex glabra* [L.] A. Gray) performed poorly as an intercrop under a 15-year-old longleaf pine stand. However, unlike an agroforestry system with upwards of 12 m between tree rows, the overstory trees in this study were planted with 1.5 m between trees and 3 m between rows. Additionally, intense intraspecific competition may have been exacerbated by limited rainfall. In any intercropping system, especially for plants cultured in containers, supplemental water would be critical for success in areas with sporadic or limited rainfall.

Crop trees would provide shade and wind protection for the landscape plants, while the landscape plants could be a lucrative yearly crop for the landowner. It would be necessary to mow among rows and containers or perform some other management activity to prevent uncontrolled herbaceous vegetation in open areas (Greg Ruark, pers. comm., July 23, 2009), but this might facilitate the harvest of other products, such as pine straw and pine seeds and cones. A new line of large-pot stock types have been developed for restoration efforts, a departure from traditional-sized pots (Landis and others 2002). These containers may readily adapt to use in landscape plant growing endeavors but may be too small for most ornamental trees and shrubs as the growing season progresses. Although there does not seem to be literature on the subject, it may also be possible to grow orchids and bromeliads on trunks of crop trees in areas where frosts are of limited occurrence and relative humidity is high.

Species for restoration or revegetation—Other stocktypes that could be grown either in-the-ground or in containers under a longleaf pine agroforestry system are grasses and woody plants commonly used in reforestation projects. Grasses can be grown and planted as plugs. Additionally, grasses may be harvested for seeds if they are planted in the ground and if seeds of the species are rare or hard to collect (Steinfeld and others 2007). For example, wiregrass, a desirable grass species in longleaf pine restoration efforts, is in great demand, and seed for sale to the public is often in short supply. Seed transfer zones for understory plants in longleaf pine ecosystems have been proposed (Walker and Hernandez in press) with the intent of increasing the availability of regionally adapted native plant material. Native plants grown under agroforestry crop trees could provide certified seed to a developing industry.

BIOFUELS

Where markets are available, intercropping can be focused on the production of biofuels and bio-oils. Switchgrass, hybrid poplars, and other cellulosic sources, such as tropical maize, can all be used to produce cellulosic ethanol (Rockwood and others 2004) while corn and soybeans can either be harvested as a food crop, silage, or used to produce oil. As with any product, markets, inputs (fertilizer, pesticides), harvesting costs, and transportation costs must all be considered in the business plan, as should issues such as soil pH, water availability, and the effects of shading. An advantage of corn and soybeans is that they have more than one outlet if the biofuel market fluctuates. However, they also require more intensive management which increases production costs, and plentiful sunlight, which may make them a good intercrop only when the longleaf pine crop trees are young (Jose and others 2004). Additional consideration about the use of crops like corn for biofuels is that such use competes with the use of the crop for human food and animal feed. A number of other biofuel crops are suitable and can be grown in longleaf agroforestry systems.

WILDLIFE

Compared to agricultural fields, most agroforestry systems offer improved habitat for enhancing wildlife populations (National Agroforestry Center 2008). Longleaf agroforestry systems are no exception. Whether for game species or songbirds, management activities can be adapted to enhance habitat or forage for wildlife. Lands that include fee hunting-related activities can yield up to 14 percent more value per acre than traditional silvopasture systems (Grado and Husak 2004). Acreage involved may limit some larger species, and the landowner must consider effects of larger animals on crop trees and other plant species during the

silvopasture establishment phase. Bobwhite quail (*Colinus virginianus* L.) and wild turkeys (*Meleagris gallopavo* L.) are ideally suited to agroforestry and silvopasture. Food, roost trees, and shelter considerations for either of these two species could readily be met in some agroforestry systems. For example, landowners may plant the necessary food and cover crops among trees on their acreage to attract and maintain wildlife populations while still growing agricultural row crops. Quail thrive in frequently burned longleaf pine forests, and a quail-blackberry or soybean-crop tree system should, with proper planning, be a manageable alternative. In addition to providing a soft fruit for market, blackberry canes would provide shelter for quail. Soybean seeds would provide food for the birds plus a biofuel. In addition, lease hunting opportunities are an achievable option for landowners who successfully establish and retain wildlife on their property.

CARBON CREDITS

Carbon credits give a monetary value to the above and below ground carbon stored in trees and other plants. Credits can be purchased to offset greenhouse gas emissions. Thus the carbon stored in trees in an agroforestry system can be sold as credits to companies or individuals to reduce their carbon footprint.Longleaf pine agroforestry systems offer opportunities for more carbon credits than traditional agricultural systems.

SUMMARY

The above are just some of the possibilities that exist for the landowner interested in agroforestry and land conservation. Agroforestry practices may not suit the needs of all landowners. The importance of a sound business plan, market research, and thoroughly examining plant growth habits and characteristics before investing in any intercropping system cannot be over-emphasized. Agroforestry systems offer an opportunity to re-establish longleaf pine on private lands that are currently in agricultural use. These are lands where there is a desire for continued agricultural use and a resistance for conversion of fields and pastures to plantations.

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