CEFS

CENTER for ENVIRONMENTAL FARMING SYSTEMS

Agroforestry Research

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Significant areas of marginal croplands are present throughout the southeastern USA. These lands often have the following characteristics that make them marginal:

- Unpredictable crop yields due to coarse soil texture that causes susceptibility to drought
- Ill-suited lands that must be drained for better aeration
- Susceptibility to flooding
- Narrow corridors that limit equipment movements
- Poor access to favorable markets

A potentially more resource-efficient and flexible approach for marginal croplands could be attained with adoption of silvopasture, which combines the ecological and production strengths of long-term woody biomass with similar strengths of herbaceous forages.

Background

In 2007, a 17-acre (7 ha) tract of marginal cropland was established as an alley cropping system by Paul Mueller, Fred Cubbage, and others at the Center for Environmental Farming Systems (CEFS) in Goldsboro NC. The study was originally designed as a research and demonstration project to evaluate an alley cropping system of corn and soybeans in rotation between rows of loblolly pine (*Pinus taeda*), longleaf pine (*Pinus palustris*), and cherrybark oak (*Quercus pagoda*). Initial funding support for the project came from annual Hatch Act funds and USDA Natural Resources Conservation Service. Poor economic performance of grain crops during the first 6 years hastened the transition to a silvopasture design (Cubbage et al., 2012; Agroforest. Syst. 86:323-334).

Alleys were planted to annual ryegrass in fall 2013 (harvested in 2014) and then to a native warm-season grass mixture in late spring 2014. The perennial grass mixture included big bluestem (*Andropogon gerardii*), switchgrass (*Panicum virgatum*), indiangrass (*Sorghastrum nutans*), and eastern gamagrass (*Tripsacum dactyloides*). In 2015, an additional 11 acres (4 ha) was planted to native warm-season grass mixture as an open pasture control comparison. A narrow cropland strip separates the two perennial pastures (serving as a legacy reference condition for soil comparisons). Perennial pastures were grazed in late summer of 2016 and throughout the spring-summer beginning in 2017.

Objective and Hypotheses

The objective of the study is to evaluate production (timber, forage, livestock) and environmental (soil carbon and microbial activity, greenhouse gas emissions, nutrient cycling) responses to management.

Our hypotheses include:

- Shade of timber trees will improve animal performance and provide habitat for more diverse above- and below-ground ecology
- Marginal cropland can be converted to multi-species timber and forage for specialty markets of added value (e.g. sustainable grazing systems, production from native plant species, biofuel production).

Design

The experimental design consists of (a) three tree species (b) two alley widths – 12- and 24-m wide, and (c) six forage harvest strategies – grazed rotationally in alleys, grazed rotationally in open pasture, hayed once per year in alleys, hayed twice per year in alleys, biofuel harvest once per year in alleys, and conservation reserve without harvest in alleys. Silvopasture blocks are replicated 5 times, while open pasture and tilled cropland treatments are replicated 3 times.

Our multi-disciplinary team of soil, forage, animal, and timber specialists hopes to attract further engagement from ecological, engineering, and social disciplines. Our core team of principal investigators and students will be able to study (a) soil biogeochemical cycling of carbon and other nutrients, (b) biophysical attributes of temperature, water, and light, (c) nutritional analyses and botanical dynamics of native warm-season grasses, (d) animal production, behavior, and stress responses, and (e) ecological interactions of timber, forage, and livestock components with edaphic and climatic factors.

Many questions remain for us to answer, including:

- What is the effect of system configuration on production and ecological responses?
- What are the impacts of grazing management on soil, forage, and timber components and their interactions?
- How are productivity relations with management and environmental conditions altered?
- Which components of agroforestry system design contribute the most to sustainability?

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