Forage News
Mississippi State University Extension Service

# Silvopasture: How A Grazing System Can Add Value To Trees?

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Forestry occupies more acres than all crop and pastureland combined in Mississippi. By the same token, beef production is an important agricultural enterprise in the state that integrates into forested areas. Many landowners are accustomed to managing their forestland or pastureland for a single purpose. Silvopastoral systems could be a prominent agroforestry practice in Mississippi and the southeast. **Silvopasture** is a system characterized by integrating trees or shrubs with forage and livestock production in the same acreage to utilize space, growing season, and growth factors more efficiently. The goal of a silvopastoral system is to optimize, rather than maximize, production of all three components. A properly managed silvopasture operation could enhance soil protection and increase long-term income due to the simultaneous production of trees and grazing animals.

Silvopastures systems could be implemented using different approaches: 1) pastures where trees or shrubs can be added; 2) forested areas where forages can be added; or 3) land on which neither the desired trees nor forages exist in sufficient quantity to meet the land use objectives. Appropriate establishment methods depend on the following: site conditions, tree species, age, and spacing, and existing pasture conditions (climate, terrain, type of livestock, labor requirements, fencing, water supplies, and other vegetation). Tree spatial arrangement is an important factor to make a silvopasture system successful (**Table 1**).

**Table 1.** Silvopasture planting designs and trees per acre[1].

| | | Alley width (foot) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 15 | | | 20 | | | 30 | | | 40 | | |
| | | Tree to tree in row space (foot) | | | | | | | | | | | |
| Row Set | Row Spacing | 6 | 8 | 10 | 6 | 8 | 10 | 6 | 8 | 10 | 6 | 8 | 10 |
| One | 6,8,10,12[2] | 484[3] | 363 | 290 | 363 | 272 | 218 | 242 | 182 | 145 | 182 | 136 | 109 |
| Two | 6 | 691 | 518 | 414 | 558 | 418 | 335 | 403 | 303 | 242 | 315 | 337 | 189 |
| | 8 | 631 | 473 | 378 | 518 | 388 | 311 | 382 | 287 | 229 | 303 | 227 | 182 |
| | 10 | 580 | 435 | 348 | 484 | 363 | 290 | 363 | 272 | 218 | 290 | 218 | 174 |
| | 12 | 537 | 403 | 322 | 454 | 340 | 272 | 345 | 259 | 207 | 279 | 209 | 167 |
| Three | 6 | 807 | 607 | 484 | 680 | 512 | 409 | 512 | 390 | 311 | 419 | 315 | 252 |
| | 8 | 703 | 528 | 422 | 605 | 455 | 363 | 473 | 356 | 284 | 389 | 292 | 234 |
| | 10 | 622 | 468 | 374 | 545 | 409 | 327 | 435 | 328 | 262 | 363 | 273 | 218 |
| | 12 | 558 | 418 | 335 | 495 | 372 | 297 | 403 | 303 | 242 | 340 | 256 | 204 |

[1]Landscape and planting design may cause some variation in planting rates.
[2]Row spacing and alley width are the same for the single row sets.
[3]Red figures are outside the recommended planting rates (100 to 400 trees/acre) for silvolpasture.
***Source: SUAD-Agroforrestry Notes, December 2000. AF Note-22.***

Silvopasture establishment requires a number of different management steps depending on previous land use. Planting trees in an existing improved pasture is the easiest way to start the system. Another possible scenario is to thin existing timber stands and plant or seed forage species among the remaining trees. Adequate soil fertility, proper pH, and well-developed structure provide the foundation for a productive silvopasture system. Other building blocks include proper drainage and erosion control. Regular soil testing will help indicate when additional fertilizer or lime is needed to support forage production.

***What trees species and planting pattern can been used?***

In the Southeast, most commercially grown pines (loblolly, slash, and longleaf) are suitable for silvopastoral systems. Among southern pine species, slash pine is the most suitable for silvopasture, because of light crowns and good self-pruning abilities. However, trees that meet the following criteria are most suitable: they should be fast growing, open-crowned to allow good forage production, deep-rooted to avoid competition with forage for moisture, drought tolerant, genetically improved to resist pests and diseases, capable of providing high quality timber, and marketable.

For silvopasture, trees are planted or thinned to provide sufficient light for good forage production. Grouping trees into rows or clusters concentrates their shade and root effects while providing open spaces for pasture production. When trees exceed about 35% canopy cover, forage production falls off rapidly. Trees that provide shade or wind protection for the livestock can have a climate-stabilizing effect by reducing heat stress and wind-chill in the livestock. Some studies have shown that protection from trees can cut the direct cold effect by 50% or more and reduce wind velocity by as much as 70%. Under these conditions, livestock might require less energy and their performance could be improved.

**Table 2.** Average tree and forage response s of slash pine at age 13 when trees were planted in one or two row sets at a planting rate of 454 trees per acre.

| | | One | | | Two | | |
|---|---|---|---|---|---|---|---|
| | | Tree Spacing (feet) | | | | | |
| | | **8x12** | **4x24** | **2x48** | **6x8x24** | **4x8x20** | **2x8x20** |
| **Tree Characteristics** | | | | | | | |
| Survival | % | 61 | 68 | 68 | 67 | 67 | 74 |
| Height | ft | 35 | 35 | 36 | 32 | 36 | 34 |
| Diameter | Inches | 5.7 | 5.2 | 5.1 | 5.0 | 5.5 | 4.3 |
| Stand Basal area | $ft^2$/ac | 50 | 49 | 52 | 40 | 59 | 33 |
| **Wood volume** | $ft^3$/ac | **903** | **866** | **973** | **658** | **1086** | **580** |
| **Total forage production** | lb/ac | **1138** | **542** | **10069** | **1347** | **1264** | **2573** |

***Source: Lewis et al., 1984.***

Determining the desired row spacing planting trees in a silvopastoral system is important. Commercially valuable timber trees are typically planted equidistant in a traditional grid pattern. The grid pattern spreads the trees out, minimizing competition between trees, while maximizing competition between trees and the forage vegetation. Planting rates from 100 to 400 trees per acre are typically recommended for planting a silvopasture system. Trees may be grown in single rows or in aggregate rows (two or three) called sets with wide alleys for forage production between sets. Two and three row sets could be planted on 6, 8, 10, and 12 foot centers (**Table**

**1**). Trees planted in rows often perform poorly if they do not have at least one side in full sun and single or double rows are generally preferred over triple rows of trees. In a silvopastoral system, two-row 4x8 feet tree spacing with a 40 feet wide alleys between pairs of tree rows (also known as 4x8x40 ft spacing) (**Table 2** and **Fig. 1**) has been found to satisfy forage and timber growth requirements in Florida and Georgia. These spacing provides wide-open alleys for forage production and easy access for livestock grazing, hay harvesting, fertilizer spreading, spraying, and other agricultural practices. If trees are planted into an established pasture, rows should be oriented east to west when possible to allow for maximum sunlight exposure on the forage strips.

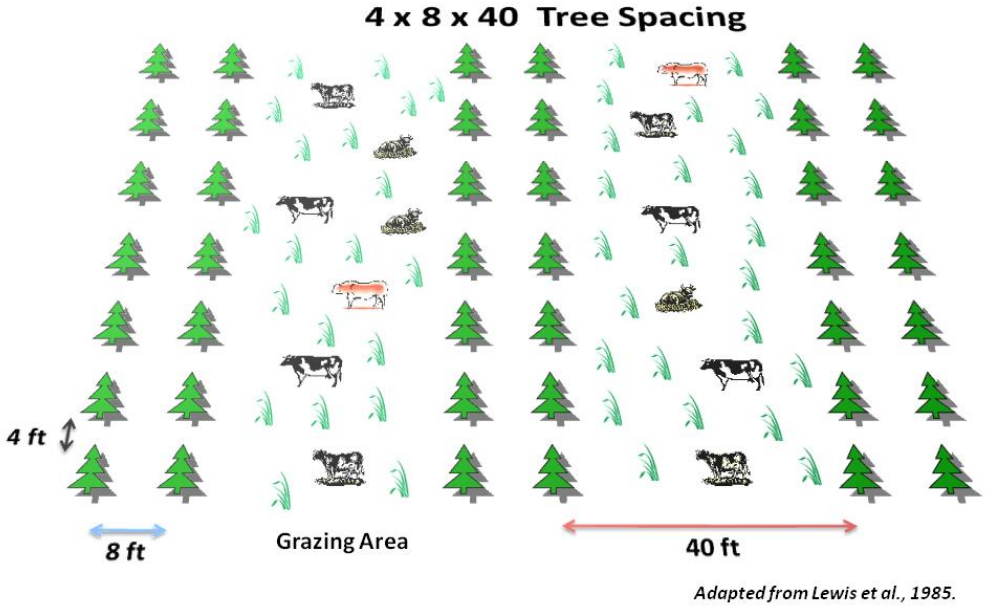



**Figure 1.** Two-row tree spacing with 40 feet wide alleys between pairs of trees rows. ***Source: Lewis et al., 1985.***

***What forage species fit a silvopasture system?***

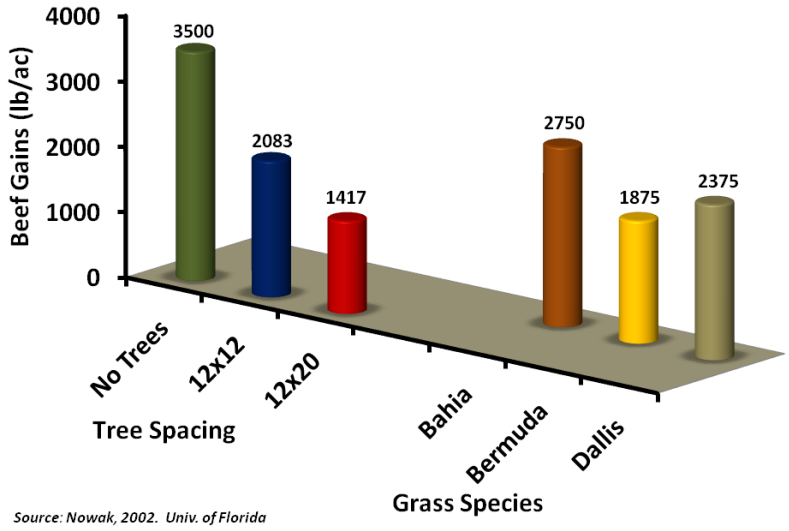
Forages species should be selected on perenniality, suitability for grazing, compatibility with the site characteristics (soil, temperature, precipitation), reducibility under partial shade and moisture stress, responsiveness to intensive management, and tolerance to heavy utilization. On areas where a new silvopasture will be put in place, establishing the pasture first is recommended. This will allow for soil preparation and allotting ample room for equipment needed for pasture establishment. It is a much simpler operation to spray out small strips or spots for tree planting.

A variety of perennial warm- or cool-season grasses and legumes can be used in silvopastures. Many landowners have adopted these systems using tall fescue, bahiagrass, and common and coastal bermudgrass. They tolerate shade and avoid competition with trees by growing in different seasons or rooting at different depths. Penscola bahaigrass, coastal bermudagrass and dallisgrass have shown to have good forage production under a tree canopy (**Fig. 2**). Some studies have reported that Dallisgrass could be more sensitive to shading conditions than bahiagrass or bermudagrass.

Cool season annual grasses (such as annual ryegrass, rye, wheat, or oats) could be over-seeded in silvopastures between wide-spaced rows of trees and legumes to extend the grazing

period. Crimson, red, arrowleaf, and white clovers, or vetch are examples of cool-season nitrogen fixing species that could be used in silvopastures systems. Incorporation of these species into the overall system may reduce the need for nitrogen fertilization of warm-season forages and trees. For cool season grasses, shade tolerance of some species might exceed 60 percent and still produce good forage yields. Depending upon the species of grass, trees might need thinning to keep canopy cover below the maximum shade tolerance level.

**Figure 2.** Animal gains under different tree spacing and grass species. ***Source: Nowak, 2002. Univ. of Florida.***




### *What type of livestock will optimize production?*

The selection of livestock suitable for a particular silvopastoral system will depend on landowner objectives and markets, as well as tree and forage species established. Beef cattle and sheep are the livestock of choice for many landowners although other species (goats, horses, and deer) also have potential. Certain breeds of cattle may fare better in a silvopastoral system than others. Cattle are more likely to trample young trees or compact wet soils while sheep are more likely to browse trees. Careful observation of herd behavior is necessary to detect and correct potential problems with browsing or rubbing of trees.

### *What are the water and fencing requirements?*

It is important that the location and distribution of water, minerals, or supplemental feed is adequate when needed to avoid over-utilization of the silvopasture areas. Water supply options for silvopasture include wells, creeks, ponds, spring developments and even municipal or rural water systems when accessible. Water requirements vary for the kind, size, age, and breed of livestock. In a silvopasture system, consider installing water within 600 feet travel distance. Animals acquire water through drinking and from the moisture in the forage they eat. As air temperature increases, water requirements also increase. The need for available drinking water is compounded because forages become drier at higher temperatures and reduction in water intake can directly affect forage intake (**Fig. 3**). One distinct advantage of a silvopasture system is that shade is distributed throughout the pasture and greatly reduces high temperature stress on livestock.

Electric fencing or individual tree guards may be necessary to protect trees if animals are introduced when trees are still small. Fencing is also used in rotational grazing methods to better control forage consumption. High tensile wire is recommended when using energized fences for border areas and is also used for cross fencing. The number of strands depends upon the type of livestock being grazed. Generally, a minimum of four- to six-strands is recommended for border fencing and one to three strands for cross fencing cattle. An energized fence is primarily a barrier and can only be effective if the fence carries enough current to deliver a "deterrent" shock. Have a properly-sized energizer.

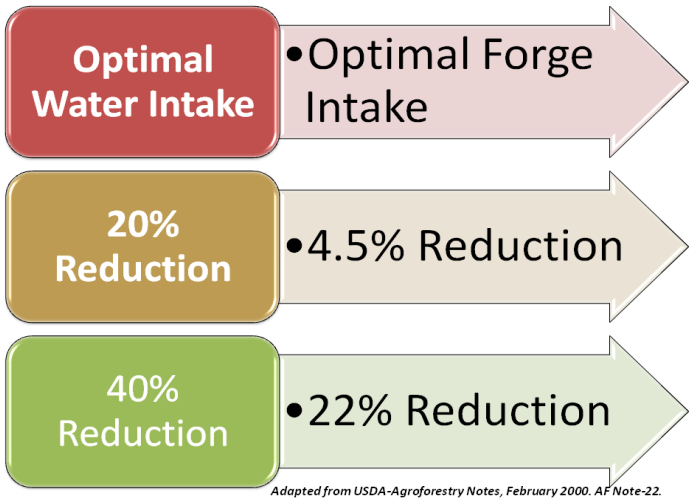



**Figure 3.** Livestock water and forage intake relationship. ***Source: USDA-Agroforestry Notes, February 2000. AF Note-22.***

***What grazing management is more suitable in a silvopastoral system?***

Livestock grazing should be closely managed. It requires understanding forage growth characteristics and managing the timing and duration of grazing to avoid browsing of young tree seedlings or elongating shoots. Grazing should be deferred until the average height of the tree's terminal bud exceeds the browsing height of the livestock or thick enough to resist breakage. This will minimize damage by trampling and rubbing. In this case, those areas with forage production could be used for hay production. Improper grazing techniques could reduce the establishment of the desirable woody and herbaceous species by overgrazing and increased soil compaction. Similar to any other managed grazing system, fertilizer should be applied based on soil test recommendations to maintain optimum forage production. Some studies have shown a 20 to 30% increase on stem production of wood in response to fertilizer management for forage production.

Some forage species tend to be lower in fiber and more digestible when grown in a tree-protected environment. Continuous grazing is not recommended for silvopasture systems. A rotational grazing system in which pastures are grazed and rested in a planned sequence should be developed. The grazing management plan should maintain an adequate balance between livestock numbers and forage production. Make paddocks as near to square as possible and follow landscape lines for paddock boundaries. Also, make paddocks of similar carrying capacity and plan lanes for livestock movement. Overgrazing increases the potential for soil compaction, decreasing water infiltration, and aeration of the soil. These effects decrease the health and vigor of the trees being grown in the silvopasture for timber production. Grazing can control grass competition for moisture, nutrients, and sunlight, and subsequently

enhancing tree growth. Well managed grazing provides economical control of weeds and brush by eliminating or reducing herbicide use.

***Are there economic benefits of incorporating a silvopastoral system?***

In the long-term, silvopastoral systems could provide economic advantages since integrating tree, forage, and livestock create a management system that provides different marketable products. Comprehensive and well-managed land utilization in a silvopastural system could generate a short-term cash flow from livestock sale and selective sale of trees or timber products, while in the long-term producing a high-value timber component. Silvopasture can improve the overall economic performance of a farm enterprise through diversification. The benefits primarily involve those gained in forage production in combination with tree spacing and timber production that will increase internal rate of returns (**Figure 4**).

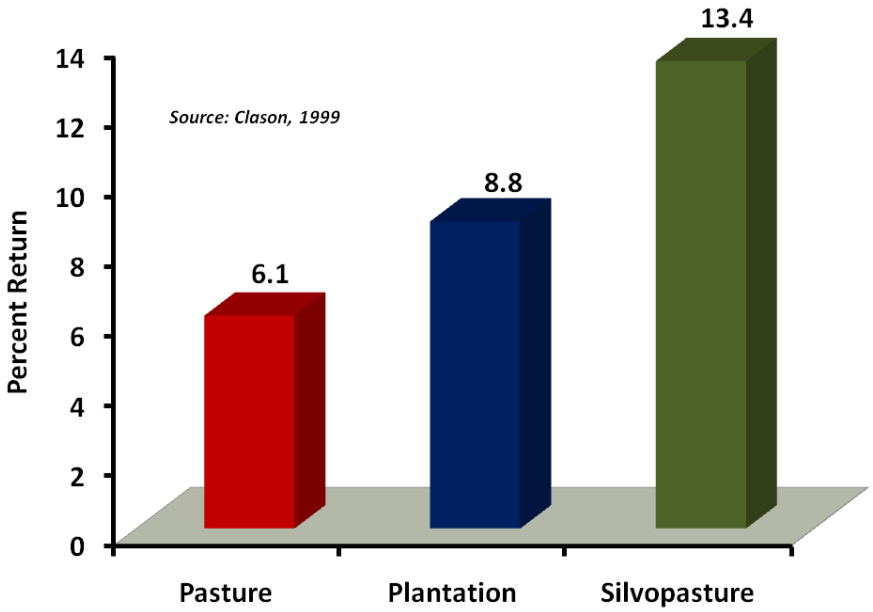



**Figure 4.** Internal rate of return for silvopasture compared to other management options. ***Source: Clason, 1999***.

***Summary***

In a silvopastoral system, matching the tree and forage species to the site is critical. Silvopastures are usually established by planting trees in existing pastures when starting from ground zero, and manage your herd carefully. This eliminates costs of forage establishment, shrub and brush control, or removal of timber harvest residues. Adequate fence and water systems facilitate the rotational grazing of livestock through a series of pastures essential for the successful management of the forages as well as the trees in a silvopasture system. Before new silvopastoral systems are established, implications of merging forestry and agricultural systems should be explored thoroughly for economic and environmental considerations along with local land use, zoning, cost-share program, and tax regulations. Silvopastoral systems are designed to produce a high-value timber component, while at the same time providing a short-term cash flow from the livestock operation.