

# Silvopasture Case Studies in North Carolina and Virginia

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## ABSTRACT

Silvopasture, the intentional combination and integrated management of trees, forage, and livestock on the same area of land, has drawn interest in the Southeastern United States because of potential environmental, economic, and animal welfare benefits. However, it is as yet not widely adopted in the region. Therefore, aspiring adopters do not have peer models to observe, and technical service providers and researchers do not have a firm grasp of practical issues adopters may face or their views of challenges, benefits, and adaptations for implementation. In particular, very little is known about how the scale of operation may affect establishment and management. The goal of this research was to observe and document four case studies of early adopters of silvopasture in the States of North Carolina and Virginia to help potential future adopters, technical service providers, and researchers understand practical issues related to establishment and management of the practice. Each of the four case study producers was a cow-calf farmer who had established silvopasture by thinning trees and then planting forages in the understory. There were many similarities in how the producers managed their silvopasture and whole farm, yet there were differences in how they viewed and ultimately addressed the practical implementation (such as stump removal, grazing rotation, etc.) and system outputs (marketing of beef products, production of sawtimber versus pulpwood, etc.) of silvopasture. Three of the four producers were generally satisfied and had a positive view of the system, and the fourth indicated he likely would not continue silvopasture in the future. Among this limited sample, scale did not seem to affect establishment and management of silvopasture specifically to a great degree, because small-scale silvopasture could be managed concurrently with operations on nearby conventional forest stands and pastures. Still, scale issues seemed to come into play at the whole-farm level.

**Keywords:** Adoption, agroforestry, cattle, farm management, forage, scale, silvopasture.

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## INTRODUCTION

Silvopasture, the intentional combination of trees and pasture for livestock, offers potential benefits for landowners and producers (NAC 2008). Although trees and livestock have been placed together for millennia, the practice of simply “turning livestock into the woods” involves little or no management of the system components and can be detrimental to both the woods and the livestock themselves (Brantly 2014). “Forest grazing” is another practice that uses livestock as agents to manage the forest understory, based on knowledge of ecosystem function (Brantly 2014), but with less intention or intensity than in many pasture systems. Silvopasture, on the other hand, uses numerous direct interventions to manage individual system components and their interactions. Well-managed silvopastures are described as following the “four I” principle in that component management is intentional, integrated, intensive, and interactive (NAC 2008).

For producers, perceived benefits of silvopasture include aesthetics, livestock stress abatement, greater production system diversity to buffer against weather and market risk, and protection of numerous ecosystem services such as water quality and wildlife habitat (Shrestha and others 2004, Workman and others 2003). Of these possible outcomes, risk mitigation through diversification may be especially appealing to smaller and more limited-resource producers. However, economies of scale may create barriers to silvopasture adoption for this sector of the farm community. For example, there are well-known economies of scale in timber harvesting operations (Cubbage 1982, 1983). Silvopasture to protect ecosystem services requires large, landscape-level adoption.

Although not widely adopted in the United States, interest in silvopasture systems appears to be growing. Better understanding of how landholding size impacts the profitability of silvopasture activities is necessary to improve research and outreach. Appropriate targeting of such efforts will be essential to silvopasture advancement.

For instance, if extension efforts emphasize benefits oriented towards small-scale producers, but silvopasture systems have large economies of scale that limit or prohibit entry and profitability for the small-scale producers who would deploy them, then these efforts will be wasted—and adoption will lag. Another concern is that many private family landholdings may be decreasing in size due to parcelization. As a consequence, practitioners may need to identify variants of production systems that can be profitable on smaller acreages.

Existing literature on silvopastures in the United States is somewhat limited but includes studies evaluating component interactions and the resulting economic yield and returns at the research plot scale (e.g., Ares and others 2006, Clason 1998, Husak and Grado 2002, Nair and others 2007). Other researchers have assessed perceptions and opinions of silvopasture among the overall population of farmers and farm technical service providers (e.g., Shrestha and others 2004, Workman and others 2003). Because of the relatively limited numbers of actual adopters, little research has engaged silvopasture practitioners directly. This may create biases because non-practicing producers who may respond to surveys about silvopasture view the system hypothetically, and researchers may manage experimental sites without understanding practitioners’ motivations and tendencies.

In order to address this gap, we observed four case studies of actual silvopasture practitioners in North Carolina and Virginia. While these “early adopters” of silvopasture may not be fully representative of the broader farming community and lack detailed, controlled research studies to back up their hypotheses about and experiences with silvopasture, they are real producers whose livelihoods depend on the outcomes of their farms. The objectives of these interchanges with producers were to understand similarities and differences among how producers establish and manage silvopasture systems, how silvopasture fits into their whole-farm context, their views on benefits and challenges, successes and failures, and the impact of the scale of the system on productivity, management, and marketing.

## METHODS

Prior interviews with key informants including technical service providers, extension agents, researchers, and others allowed us to identify land managers in North Carolina and Virginia who have implemented silvopastures. Although silvopasture is not widely practiced in these States, we identified approximately 20 producers who were in various stages of planning or practicing a production system that could fit within the description of silvopasture given in the introduction above. Of these, we selected and contacted four producers who had established silvopastures with trees and forages mature enough for grazing, and were currently managing them for production.

A set of procedures and questions (described in the Appendix) were developed for conducting interviews with the land managers. The farm visits were conducted in April and May of 2017. Interviews lasted 2 to 3 hours and were followed by visits to the silvopasture sites. These interviews were recorded and then summarized. The summaries were returned to the land managers for their input, validation, and consent before publication.

## RESULTS

Two of the selected producers were from Virginia and two from North Carolina. The locations of their farms ranged approximately 300 miles north to south, from the central Foothills region of Virginia to the southern Coastal Plain region of North Carolina. Landform varied from rolling hills in the north to relatively flat with some wetter depressions in the south. Temperature varied somewhat with annual average high temperatures ranging from about 66 °F in the north to 74 °F in the south, although the difference in average temperatures was less in the warmer months with average

July highs ranging from about 86 °F to 90 °F (Arguez and others 2010). Average annual precipitation through this region was relatively consistent at about 45 to 47 inches per year (Arguez and others 2010).

All four of the farms observed managed bovine (*Bos taurus*) cow-calf operations, and all four established silvopasture by thinning existing tree stands and then seeding forages. At farms 1 and 2 in Virginia, silvopastures were created using two different approaches. At farm 1, pine (*Pinus* spp.) trees were thinned from within rows, creating more uniform light/shade patterns across the site than in the alley configuration. This farm also had a second area with hardwood trees<sup>1</sup> that were thinned for silvopasture but with less attention to tree form and production than used with the pines. Farm 2, in the southern Piedmont, harvested strips of trees within an existing loblolly pine (*Pinus taeda*) stand and established forages in the resulting alleys. Hardwood trees on a separate site at this farm also were thinned for silvopasture, and tree form was not used as a primary deciding factor for which trees to leave. Farms 3 and 4 in North Carolina both started with relatively mature loblolly pine stands to create silvopastures. At farm 3, the silvopasture was established as part of a demonstration effort in collaboration with U.S. Department of Agriculture Natural Resources Conservation Service (NRCS). A unique feature at this site was that switchgrass (*Panicum virgatum*), a warm-season native grass species, was planted as the forage understory. The second site in North Carolina, farm 4, had created silvopastures from existing timber stands that had been originally established as part of a conservation planting.

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<sup>1</sup> In this region of the world, the term “hardwood tree” is typically used to refer to flowering trees (angiosperms), which are broad-leaved and usually (but not always) deciduous. Typical hardwood overstory trees in this region include oaks (*Quercus* spp.), maples (*Acer* spp.), hickories (*Carya* spp.), yellow-poplar (*Liriodendron tulipifera*), and sweetgum (*Liquidambar styraciflua*).

## FARM 1: VIRGINIA CENTRAL FOOTHILLS

### Farm Context

This farm is located in the Piedmont physiographic region near the Blue Ridge. Landform is rolling and sometimes steep. Farms in this area are intermediate in terms of land area with median size about 80 acres and mean size about 200 acres (NASS 2014). Still, typical farms in this area generate substantial income with gross revenues of about \$170,000 on average (NASS 2014). The farms in this area are more likely to generate revenue from crops, with only about one-quarter of average revenues from livestock, poultry, and their products (NASS 2014). Most of the livestock in the county are cattle (NASS 2014). Cattle farms in this area own about 70 head on average and sell approximately 35 on average during the year (NASS 2014).

### Farm Description

The producer manages a cow-calf operation with about 115 mature cows and 26 replacement heifers. These are split unevenly between fall (102 females) and spring (39 females) herds. Table 1.1 describes the allocation of land uses within the farm. Silvopasture occupies approximately 8 percent of

the total pasture area on the farm and 4 percent of the total farm.

### Silvopasture Purpose

The farmer made his decision to try silvopasture mostly on informal observation and from an older, unidentified pamphlet he found that discussed the practice. It seemed like an opportunity to maximize efficiency and use both cattle and timber. This producer was not a fan of monoculture systems. When opportunities to lease or acquire new land appeared, he was hesitant to clearcut the standing timber. When he talked to foresters about silvopastures, they told him not to do it, but the idea continued in his mind. Also, the producer was using cattle to control invasive kudzu (*Pueraria lobata*) in a Virginia pine (*Pinus virginiana*) stand, and the hay fed to the cattle provided a seed source that germinated.

### Silvopasture Description

The producer uses silvopasture with various types of tree species: mixed hardwoods such as oaks (*Quercus* spp.) and yellow-poplar (*Liriodendron tulipifera*), and pines such as Virginia, shortleaf (*P. echinata*), and loblolly. A representative photograph of a predominately loblolly pine silvopasture is presented in figure 1. Trees in a loblolly stand turned

Table 1.1—Allocation of land uses in farm 1

	Silvo-pasture	Woodland	Open pasture	Hay and row crops	Infrastructure and residential	Other	Total
Area (acres) <sup>a</sup>	40	495	455	—	—	—	990

— = No land area, or an insignificant land area attributed to this land use.

<sup>a</sup> Areas of individual land uses may not add up to the total farm area because of rounding/approximations by the producer.



Figure 1—Photograph of representative silvopasture site on farm 1.

silvopasture have been left approximately in single rows, with 30-foot-wide alleys. However, there is enough thinning within rows to give the trees a scattered, unpatterned feel. The cattle used throughout the farm are commercial Angus crosses. The producer has a mix of cool-season forages including clover (*Trifolium* spp.), Kentucky bluegrass (*Poa pratensis*), tall fescue (*Festuca arundinacea*), and orchardgrass (*Dactylis glomerata*), as well as forbs. The producer has never intentionally seeded tall fescue (although it may be a component in some of the seed mixes he has used), but it is naturalized to the region and abundant at his site.

### Integration of Silvopasture into the Broader Farm

The producer views silvopasture as a way to take advantage of space in existing timber stands. The silvopasture paddocks

are used like other paddocks and can be grazed in the summer to alleviate heat stress, or during other times of year according to pasture availability.

### Silvopasture Establishment

A detailed list of silvopasture establishment activities is given in table 1.2. The producer tried silvopasture for the first time in the late 1980s to early 1990s on a 12-acre tract. This was established by disking, fertilizing, liming, broadcasting seed, and dispersing hay for feed in the area. A second connecting silvopasture parcel of 11 acres was established in the 1990s and a third 13-acre tract after 2004. In this final tract, the stumps were grubbed for convenience.

**Table 1.2—Silvopasture establishment activities on farm 1**

Activity <sup>a</sup>	Years to establishment <sup>b</sup>	Labor	Material	Material amount	Equipment	Equipment amount
Commercial thin (row + low)	10	Thinned by timber sale	—	—	—	—
Fence infrastructure	7	Contract	2-strand hot	—	—	—
Mark trees	5	—	—	—	—	—
Second commercial thin (5 years later) (low)	5	Thinned by timber sale	—	—	—	—
Third commercial thin (1 year later, no marking) (row)	4	Thinned by timber sale	—	—	—	—
Grub (contract \$350 per acre)	3	3.5 hours per acre	—	—	Track hoe excavator/loader	3.5 hours per acre
Clear debris, fill gullies	3	6 hours per acre	—	—	—	—
Bushhog	3	0.3 hours per acre	—	—	Tractor, bushhog	—
Fertilizer	3	—	Turkey litter	2 tons per acre	Spreader	—
Disk	3	—	—	—	—	—
Lime	2	—	—	3 tons per acre	—	—
Fertilizer	2	—	Turkey litter	2 tons per acre	Spreader	—
Disk	2	—	—	—	—	—
Fertilizer	0	—	Potash	\$50 per acre	—	—
Seed (broadcast and cultipack)	0	—	Bluegrass, ryegrass, ladino	100 pounds per acre	—	—
Harrow	0	—	—	—	Reciprocating harrow	—
Water infrastructure	0	—	—	—	—	—

<sup>a</sup>Activities listed with no information with regards to labor, material, or equipment are/were undertaken, but the producer did not/could not provide additional detailed data.

<sup>b</sup>Number represents number of years that this activity took place before the silvopasture was considered “established,” i.e., ready to introduce livestock.

### Silvopasture Management

Typical periodic and annual management activities are given in table 1.3. The producer breaks the herd into smaller units and grazes the land accordingly. Initial entry requires the adequate development of forage after sowing. Established sites typically would be grazed about once every 30 to 42 days. Often this would be 90 pairs on 5- to 12-acre paddocks for up to 2 days. A new silvopasture establishment was grazed sparingly with calves in the first season, and 11 heifers with calves had been on the land in the subsequent spring. Rotations were sometime based on pasture availability, and sometimes based on infrastructure and where animals were on the farm at a point in time.

Insemination for breeding cows is with a bull, but heifers are artificially inseminated. Calves are birthed within a 60-day window. Expenses such as fly tags are avoided by rotating cattle through paddocks every 2 days and encouraging predatory birds such as swallows, which helps break intestinal parasite and insect cycles. Mortality across the herds is <1 percent.

The producer may conduct another thin of the timber, and stretch the timber rotation to 45 years or so before clearcut, to reach full sawtimber potential.

### Product Marketing

Weaned fall calves are sold in August at a special sale of the local Cattlemen’s Association; spring calves are sold between December and February. Timber is sold to a logger that does a relatively good job of not leaving large debris or stumps, who in turn sells to traditional timber markets for products such as pulpwood, sawlogs, posts, and shavings. This producer is managing the stands to achieve future large sawlogs. He plans to thin the stand again in order to maximize that product class. The producer also sells hunting rights for the land.

### Potential Effects of Scale on Establishment, Management, and Marketing

This producer has other timberland that can be thinned or otherwise managed at the same time as the silvopasture, which facilitates scale limitations on timber harvest. He would like to do more silvopasture but is limited by time and establishment costs. This potentially could imply a difficulty with large-scale establishment, if there are limitations of the time of the manager with the best skills to supervise the silvopasture establishment process. Since the time of the interview, the producer has informed us that he has hired help, who he hopes will be able to assist with additional

**Table 1.3—Typical periodic and annual silvopasture management activities on farm 1**

Activity <sup>a</sup>	Year(s)	Labor	Material	Material amount	Equipment	Equipment amount
Fertilizer	Annual	—	Turkey litter	1 ton per acre	—	—
Clipping	Annual	—	—	—	—	—
Commercial thin	Periodic	Thinned by timber sale	—	—	—	—
Maintenance of fence/water	Annual	—	—	—	—	—
Grazing	Annual	—	—	—	—	—
Minerals	Annual	—	Minerals	—	—	—
Supplemental feed	Annual	—	Hay	—	—	—
Livestock health	Annual	—	Vaccinations (no fly tag)	—	—	—
Insemination	Annual	—	—	—	—	—
Pregnancy check	Annual	—	—	—	—	—
Weaning	Annual	—	—	—	—	—
Culling	Annual	—	—	—	—	—

<sup>a</sup>Activities listed with no information with regards to labor, material, or equipment are/were undertaken, but the producer did not/could not provide additional detailed data.

silvopasture establishment and management. Also, the producer has occasionally leveraged Federal cost-share assistance from programs such as the NRCS Environmental Quality Incentives Program. These programs might be difficult to obtain for very large- (or very small-) scale parcels.

### **Farmer's View of Silvopasture Performance**

The producer views silvopasture very favorably and would likely do more in the future since he has timber stands that can potentially be converted to silvopasture. However, given the investment in time and materials, the degree of adoption is uncertain. The producer had used Federal cost-share assistance to protect surface water and also to help establish about 12 acres of silvopasture. The producer does appreciate the aesthetics of silvopasture and thinks it improves the marketability of a rental house he owns.

### **Case Conclusions**

This producer is generally satisfied with silvopasture implementation on his farm and indicates he would not change what he had done. Questions of scale seem less of an issue in terms of marketing products because the producer has other timber that could be harvested and marketed with silvopasture trees. From a livestock standpoint, the silvopastures are blended into the operation's normal functions; indeed, they provide benefit against weather extremes by providing forage during the hottest months. He is interested in creating more silvopasture but notes that he has to move slowly on implementation because he had many other things to do. Since the time of the interview, this producer has hired additional help who he hopes can assist with additional silvopasture establishment and management.

## FARM 2: VIRGINIA'S SOUTHERN PIEDMONT

### Farm Context

This farm is located in the central southern Piedmont region of Virginia. The landscape is typified by rolling hills and is on the edge of the native range of loblolly pine. In this area, average farms are relatively larger in terms of acreage, with median size about 100 acres and mean size about 290 acres; however, farms in this area only generate modest incomes with gross revenues of about \$40,000 on average (NASS 2014). The revenues are approximately evenly split between crops and livestock, poultry, and their products (NASS 2014). Most of the livestock in the county are cattle, with about 60 head per cattle farm and sales of about 20 head per cattle farm each year (NASS 2014).

### Farm Description

This producer primarily manages a cow-calf operation. Table 2.1 describes the allocation of land uses within the farm. Silvopasture occupies approximately 10 percent of the total pasture area on the farm and 5 percent of the total farm.

### Silvopasture Purpose

This producer indicates that he arrived at the idea of using silvopasture by observing animal behavior. Cattle seemed to congregate in one area, often around individual trees, which were scattered sparsely in traditional paddocks. This would lead to poor forage conditions in those areas. By spreading trees throughout the pasture, the producer hypothesized that the impact could be spread out. Reading articles, discussing with a local forester and a NRCS forage specialist, and attending short courses solidified this idea in the producer's mind.

### Silvopasture Description

The two sites on this farm comprise 30 acres of pine silvopasture and 25 acres of hardwood silvopasture. A representative photograph of the pine silvopasture is presented in figure 2. Strips of trees were harvested from the pine stand, leaving 2- or 3-row sets of trees. Fifty-foot-wide alleys between tree rows provide sufficient forage of tall fescue and a clover mix consisting of ladino (*T. repens*) and red (*T. pratense*) clovers. The understory within the tree rows had received little management at the time of our visit.

**Table 2.1—Allocation of land uses in farm 2**

	Silvo- pasture	Woodland	Open pasture	Hay and row crops	Infrastructure and residential	Other	Total
Area (acres) <sup>a</sup>	55	225	520	400	25	—	1,200

— = No land area, or an insignificant land area attributed to this land use.

<sup>a</sup> Areas of individual land uses may not add up to the total farm area because of rounding/approximations by the producer.



Figure 2—Photograph of representative silvopasture site on farm 2.

Relatively little forage was present directly under the trees within rows, but other woody and non-woody vegetation was present. Since that time the producer has used various burn and fertility treatments to test forage establishment methods within the tree rows. In the hardwood site, the forage base is predominantly fescue, and trees have had epicormic sprouting since the original thin. Livestock on this farm are predominantly Black Angus, with some Hereford x Angus cattle.

### Integration of Silvopasture into the Broader Farm

Silvopasture is part of the broader forage and livestock management system on the farm. Although the producer does foresee a future timber clearcut harvest of the silvopasture trees, silvopasture is managed principally as a livestock and forage management tool, rather than with a focus on timber. Having silvopasture in combination with other pastures on the farms allows the producer to graze almost year-round with little need to purchase hay.

### Silvopasture Establishment

A detailed list of silvopasture establishment activities is given in table 2.2. The producer purchased a piece of land that had about 30 acres of pine plantation and 25 acres of hardwoods. These were thinned in 2013 when the pine plantation was 14 years old. The thinning was conducted by clearing alleys and then removing select trees from within rows, which were individually marked by the producer and a consulting forester.

Next, a track loader was used to push and collect debris, with remaining rocks and branches picked up by hand. The highest stumps that would cause issues for equipment were removed with the track loader, but smaller and lower stumps were left behind. A heavy disk was used to chop up any residual small debris and break up the soil. Lime and 10-20-20 fertilizer were applied. To accomplish acceptable seed-to-soil contact, the silvopasture alleys were dragged before and after seeding using a large cedar tree trunk pulled behind a tractor.

**Table 2.2—Silvopasture establishment activities on farm 2**

Activity <sup>a</sup>	Years to establishment <sup>b</sup>	Labor	Material	Material amount	Equipment	Equipment amount
Mark trees	2	0.5 hours per acre	—	—	—	—
Commercial thin	2	Thinned by timber sale	—	—	—	—
Clear debris	2	1.75 hours per acre	—	—	Track loader	1.5 hours per acre
Disk	2	0.6 hours per acre	—	—	Tractor, disk	0.6 hours per acre
Lime	2	0.6 hours per acre (including fertilizer)	Lime	2 tons per acre	Tractor	0.6 hours per acre (including fertilizer)
Fertilizer	2	—	10-20-20 fertilizer	320 pounds per acre	—	—
Drag, seed, and drag again	1	0.6 hours per acre	Tall fescue seed Clover seed	25 pounds per acre 4 pounds per acre	Tractor, drag tree trunk	0.6 hours per acre
Water infrastructure	0	—	Ball drinkers, water line	One per 18 acres	—	—
Fence infrastructure	0	—	5-strand high-tensile fence 2-strand fence	—	—	—

<sup>a</sup> Activities listed with no information with regards to labor, material, or equipment are/were undertaken, but the producer did not/could not provide additional detailed data.

<sup>b</sup> Number represents number of years that this activity took place before the silvopasture was considered “established,” i.e., ready to introduce livestock.

### Silvopasture Management

Typical periodic and annual management activities are given in table 2.3. This silvopasture, *per se*, does not involve much additional management that is different from the producer’s usual management of pasture and livestock. Table 2.3 does not include detailed information such as labor hours or quantities of materials for those activities which are common to cow-calf operations. The additional activities mentioned include additional fertilizer applied the first 3 years after establishment and yearly clipping to cut back woody species that might seed into the pasture.

The silvopasture site (pine and hardwood) is divided into six paddocks of about 8–10 acres each. A herd of 22–23 cow-calf pairs utilizes individual paddocks within the silvopasture approximately half the year and other open-pasture paddocks half the year. Rotation between paddocks is determined by the height of the grass and the weather, with the producer electing to utilize the silvopasture sites during the hottest periods for shade.

Eventually, the site will be clearcut harvested for timber. However, the producer indicates that he would prefer to wait longer until the trees are older than would be used in a conventional pine plantation timber rotation. The reason is to extend the length as a silvopasture under the current trees. If trees are clearcut, the area will either have to be transitioned to open pasture or replanted with trees. If the former, the producer will lose the shade benefit. If the latter, it will be a few years until usable again and several years until full shade benefits are realized. So, it makes sense to delay this decision point.

### Product Marketing

The producer uses the best livestock genetics he can afford for this herd. He markets several products. Primarily, he markets weaned calves, which are born January–February and weaned in August. The producer has a target of 2.5–3 pounds per day weight gain for growing calves. The producer will also keep some calves for backgrounding or for sale as heifers for breeding. A few additional heifers and steers are marketed for slaughter.

**Table 2.3—Typical periodic and annual silvopasture management activities on farm 2**

Activity <sup>a</sup>	Year(s)	Labor	Material	Material amount	Equipment	Equipment amount
Fertilizer	First 3 years after establishment (mid-to late February)	0.4 hours per acre	Biosolids or poultry litter Ash	0.5 tons per acre 0.4 tons per acre	Tractor	0.4 hours per acre
Overseed	First 3 years after establishment	—	Clover seed	—	—	—
Clipping	Annual	0.1 hours per acre	—	—	Tractor, batwing bushhog	0.1 hours per acre
Herbicide	Periodic	—	—	—	—	—
Maintenance of fence/water	Annual	—	—	—	—	—
Grazing	Annual	—	—	—	—	—
Minerals	Annual	—	Minerals	—	—	—
Supplemental feed	Annual	—	Hay	—	—	—
Livestock health	Annual	—	Vaccinations Wormers	—	—	—
Insemination	Annual	—	—	—	—	—
Pregnancy check	Annual	—	—	—	—	—
Weaning	Annual	—	—	—	—	—
Culling	Annual	—	—	—	—	—

<sup>a</sup> Activities listed with no information with regards to labor, material, or equipment are/were undertaken, but the producer did not/could not provide additional detailed data.

### Potential Effects of Scale on Establishment, Management, and Marketing

Of the four silvopasture case studies we examined, this farm was intermediate both in terms of silvopasture area and total farm area. At 55 acres, the total silvopasture size seems to be sufficient on its own to achieve economically viable commercial timber thinning and future clearcut.

Still, this farm's silvopasture is limited to a 55-acre parcel. For establishment, part of the benefit of a larger silvopasture scale or having silvopasture replicated numerous times on the property might be to have a learning curve and improve efficiency over time. However, this particular producer does not think that was much of an issue, as he said that he probably would not do things very differently if he had to do it again. The producer indicates that the forester who marked the trees for the commercial thin did so free of charge as a learning experience. One would presume he would not do so for larger, more time-consuming tracts. So there may even be some advantages of operating at small scale, although the consulting forester's fees would probably not have been large.

The management and marketing of the system largely goes hand in hand with the rest of the farm operation. Therefore, although the silvopasture was only a small portion of the overall farm, it did not present specific difficulties in terms of scale size. The producer's farm was of sufficient scale to market a variety of livestock products, including freezer beef, truckloads of backgrounded heifers, and both open and bred heifers. The producer has also begun leasing the farm to a hunting club, which suggests wildlife management may become more important to the operation over time and raises the question of the role of silvopasture management in such context.

### Farmer's View of Silvopasture Performance

The producer thinks relatively highly of silvopasture. He wishes there were more research available to scientifically demonstrate the benefits and most appropriate management

techniques. He rates it a "B+," which indicates a few continuing questions but overall satisfaction with the performance of the system. Indeed, he rates B+ as a high mark for most any agricultural endeavor. Although the producer indicates he would not likely plant trees into an existing pasture at scale, in conversations subsequent to this interview he indicated he has considered using a tree spade to plant a few trees for shade in some open pastures. The main benefit this producer sees from silvopasture is that forages continue to grow to an extent in the hot and cold months, allowing almost year-round grazing when combined with the open pastures. Thus, there is very little need for supplemental hay in either the hottest or coldest months. Such supplemental feeding would have been much more common prior to implementing silvopasture. While the producer feels total forage production is probably lower in the silvopasture, he notes that growth patterns are a bit different from those in open pastures, creating a better balance between supply and demand over the year. Thus, having both open pasture and silvopasture on the farm makes sense from a production standpoint. Also, the cattle visually appear more comfortable where there is shade. If he had to do it over again, he is not convinced he would have done anything differently. The producer and his wife also suggested that the aesthetics of silvopasture are nice, although probably not a deciding factor.

### Case Conclusions

The producer seems generally satisfied with his approach and outcome to silvopasture implementation. Interestingly, he had a vision and approach to the practice that didn't match what he had seen at some other farms. Thus, he implemented his own innovation. Shade is a concern for the producer, and he views silvopastures both as a way to expand annual returns and meet animal welfare needs. Large farm size and system diversity have provided some access to equipment and labor that may not be available for smaller producers and have also provided opportunity to lease the land for hunting, which may make silvopasture more valuable in the future.

## FARM 3: NORTHEASTERN PIEDMONT OF NORTH CAROLINA

### Farm Context

This farm is located on the eastern edge of the Piedmont physiographic region in North Carolina and has a gently rolling landform. Farms in this region are intermediate in size with a median of about 80 acres and mean of about 250 acres (NASS 2014). Average farm incomes in the region are moderate, averaging about \$100,000 in gross revenues, of which about 45 percent is derived from livestock, poultry, and their products (NASS 2014). Most of the livestock in the county are cattle. Average cattle farms in the region own approximately 75 head and sell approximately 23 of these during the year (NASS 2014).

### Farm Description

The producer primarily manages a cow-calf operation and has significant revenue also from timber sales. Table 3.1 describes the allocation of land uses within the farm. Silvopasture occupies only a very small portion (<1 percent) of the total pasture area on the farm.

### Silvopasture Purpose

This producer was already well-established in both the cattle and timber businesses when he sought to experiment with silvopasture to see if it would be possible to produce both from the same acreage at the same time. Something akin to silvopastures was within the producer’s memory; his family had utilized spaces under widespread oak trees for cattle to graze at least as far back as when he was a child, and probably further. However, it was likely not an intentionally planned or managed system. The producer also had read magazine articles about silvopasture in the deep South (possibly Louisiana) as far back as the 1970s or 1980s. University faculty assisted with the planning and implementation of silvopasture on this farm.

### Silvopasture Description

The silvopasture on this farm was located on two separate sites that sum to approximately 10 acres total. A representative photograph of the silvopasture is given in figure 3. The tree component is second generation loblolly pines that are approximately 20 years old. The trees were thinned to double rows, with alleys between the double row

**Table 3.1—Allocation of land uses in farm 3**

	Silvo-pasture	Woodland	Open pasture	Hay and row crops	Infrastructure and residential	Other	Total
Area (acres) <sup>a</sup>	10	2,500	1,250	400	20	—	4,200

— = No land area, or an insignificant land area attributed to this land use.

<sup>a</sup> Areas of individual land uses may not add up to the total farm area because of rounding/approximations by the producer.



Figure 3—Photograph of representative silvopasture site on farm 3.

tree sets equivalent to the spacing of two or three rows. The site is unique in that the forage planted between and within tree rows consists of native warm-season grasses: big bluestem (*Andropogon gerardii*) and switchgrass. This decision seems to have been driven by consultation with university and NRCS personnel who assisted with implementing the project. Fescue has also entered the system naturally over time. The cattle are a cross of Angus, Hereford, Simmental, and some Brahma.

### Integration of Silvopasture into the Broader Farm

This silvopasture system is only a very small part of the broader farm operation. The silvopasture parcels themselves are also only a part of larger paddocks that contain open pasture. The producer also practices “forest grazing” in stands that are grown under conventional forestry practices. No forage is planted in those stands, but the cattle are allowed to graze to reduce undergrowth, kill undesirable species, and leave manure. In terms of the tree component of silvopasture at this particular scale, the silvopasture is fairly easy to manage because commercial thinning or a clearcut can be combined and sold with other nearby parcels.

### Silvopasture Establishment

A detailed list of silvopasture establishment activities is given in table 3.2. The producer thinned two existing 5-acre stands of loblolly pine in approximately 2008. These stands were

the same age as other nearby stands on the property, totaling 100 acres. Thus, thinning of those combined stands could take place commercially without much difficulty. The thinning of the stand for silvopasture involved removing sets of tree rows. Typically two to three rows were removed for alleys, and two tree rows were left in each set of trees. This means that about 40–50 percent of the original stand remained. After a year, the producer sheared the stumps, disked the soil, and then established native warm-season grasses in the understory.

### Silvopasture Management

Typical periodic and annual management activities are given in table 3.3. The silvopasture stands are part of mixed paddocks with open pasture, so most livestock management activities are no different for the silvopasture than for other pastures. The producer brings cattle into the silvopasture paddock when forage gets 8–10 inches tall and moves them to another paddock when it has been grazed down. Since these are warm-season grasses, there is less forage available in late fall, so September or October is usually the end of the grazing season for these paddocks. The producer will periodically put down lime and oversee the silvopasture with cool-season annual grasses in certain areas.

One silvopasture parcel of 5 acres is in a paddock of 30 acres total. The paddock may be occupied by a herd of 25 head up to 75 percent of the year. The other 5-acre silvopasture is in a 105-acre paddock with 75 head. The producer estimates that

**Table 3.2—Silvopasture establishment activities on farm 3**

Activity <sup>a</sup>	Years to establishment <sup>b</sup>	Labor	Material	Material amount	Equipment	Equipment amount
Commercial thin	2	Thinned by timber sale	—	—	—	—
Shear stumps	1	1.5 hours per acre	—	—	Bulldozer	1.5 hours per acre
Harrow and disk	1	—	—	—	Tractor, new-ground harrow, disk	—
Lime	1	—	Lime	1 ton per acre	Tractor	—
Fertilizer	1	—	—	—	—	—
Seed	1	—	Seed	10 pounds per acre	Tractor, cultipacker	—
Water infrastructure	0	—	Existing water	—	—	—
Fence infrastructure	0	—	5-strand high-tensile fence 2-strand fence	—	—	—

<sup>a</sup>Activities listed with no information with regards to labor, material, or equipment are/were undertaken, but the producer did not/could not provide additional detailed data.

<sup>b</sup>Number represents number of years that this activity took place before the silvopasture was considered “established,” i.e., ready to introduce livestock.

**Table 3.3—Typical periodic and annual silvopasture management activities on farm 3**

Activity <sup>a</sup>	Year(s)	Labor	Material	Material amount	Equipment	Equipment amount
Lime and fertilizer	Periodic	—	Lime	—	—	—
Overseed	Periodic	—	Cool-season annual seed (rye, wheat)	—	—	—
Maintenance of fence/water	Annual	—	—	—	—	—
Grazing	Annual	—	—	—	—	—
Minerals	Annual	—	Minerals	—	—	—
Supplemental feed	Annual	—	Hay, silage, other as available <sup>b</sup>	—	—	—
Livestock health	Annual	—	Vaccinations, fly control program	—	—	—
Weigh	Annual	—	—	—	—	—
Insemination	Annual	—	—	—	—	—
Pregnancy check	Annual	—	—	—	—	—
Weaning	Annual	—	—	—	—	—
Culling	Annual	—	—	—	—	—

<sup>a</sup>Activities listed with no information with regards to labor, material, or equipment are/were undertaken, but the producer did not/could not provide additional detailed data.

<sup>b</sup>Byproducts from peanut, distiller/brewer's grain, cotton gin, and steep water.

while livestock are on that paddock, they may be physically in the silvopasture about 20 percent of the time, although this is highly variable (perhaps all day on the hottest days). The herds calve in fall (November). The producer has a target of 1.75 pounds per day weight gain.

### Product Marketing

The producer has several marketing streams. Calves are raised until they reach 1,000 pounds and then sent to a feedlot with retained ownership for 120 days. Cows are sold with their sixth calf. The producer also sells approximately 120 bred heifers each year. Hunting rights on the farm are also leased, which includes the silvopasture.

### Potential Effects of Scale on Establishment, Management, and Marketing

Of the producers we interviewed and observed, this producer had the largest overall farm operation but the smallest silvopasture at 10 acres total. The silvopastures as management units do not stand alone, and their size is insufficient to be economical in terms of forest or livestock management. However, as a small part of a much larger system, the silvopasture can be combined with other forest

stands for forestry management and other pastures for livestock management. Hunting also includes both the silvopasture and other parts of the farm.

The one aspect of the system that is more or less distinct in terms of management from the rest of the farm is the forage, which comprises largely native warm-season grasses, rather than fescue, which makes up most of the forage on the rest of the farm. This small venture into silvopasture with warm-season grasses was facilitated by NRCS and North Carolina State University.

### Farmer's View of Silvopasture Performance

The farmer's view of silvopasture is not necessarily totally negative but not positive enough to warrant further expansion or continuance of the practice beyond this experiment. The cattle do not prefer the warm-season grasses in the silvopasture. The producer did agree that cattle are more comfortable in shaded areas during hot and humid weather. However, this benefit did not overcome the challenges. In his opinion, it is probably better to grow just trees or just grass on any particular plot at any particular time. The economics just do not seem to add up for this producer.

The producer observes that, when weather is not too hot, cattle spend most of their time on open pastures. He believes this is in part because the forage in the silvopasture—particularly the switchgrass—is less palatable than other forages.

The producer did say that silvopasture could be utilized to expand pasture acreage from timberland slowly over time on a timber stand with small-diameter trees that are not yet ready for sawtimber. The conversion to silvopasture, therefore, is concurrent with a commercial thin, with the long-term strategy of eventually becoming open pasture. Part of the reason that this producer would not continue further silvopasture is that he considers present markets to be favorable towards clearcutting small-diameter stands for

pulpwood, rather than waiting for sawtimber. Thus, thinning timber is not part of the general management regime at present, eliminating the role for silvopasture.

### **Case Conclusions**

Among the cases studied, this producer is the least likely to continue silvopasture in the future. This producer has the largest farm overall, but the smallest silvopasture acreage. He is also the only producer with native warm-season forages in the silvopasture, with other producers using fescue and other cool-season species. This may affect the producer's view of silvopasture, as he noted that the livestock did not seem to prefer this forage. Also, the relatively high pulpwood and low sawtimber prices at present affect his economic calculus for silvopasture.

## FARM 4: SOUTHEAST NORTH CAROLINA

### Farm Context

This farm is located in the Coastal Plain physiographic region. Landform is relatively flat, with some depressions and wetter areas. Farms in this region on average are relatively small in terms of land area with a median size of about 50 acres and mean of about 170 acres (NASS 2014). However, nearby farms have high average gross revenues of almost \$500,000, of which about 80 percent is livestock, poultry, and their products (NASS 2014). These data are skewed by the large chicken farms nearby—14 nearby farms have nearly 10,000,000 broilers (NASS 2014). Cattle farms in the area average about 25 head and sell about 9 head per year (NASS 2014).

### Farm Description

This producer primarily manages a cow-calf operation. Table 4.1 describes the allocation of land uses within the farm. Silvopasture occupies approximately 40 percent of the total pasture area and total farm area.

### Silvopasture Purpose

The farm first belonged to this producer's father, who grew row crops. As the father approached retirement, he began "retiring" some erodible soils from production with support payments from U.S. Department of Agriculture's Conservation Reserve Program funding for pine plantation practices. Later, the current producer decided to take over the farm from his father. At that time, he began to look for ways to generate short-term income from the pine plantations. The producer spoke to foresters to get ideas about how to implement his vision of incorporating livestock into the pine plantations but received mostly negative responses from them, based on their views that the land should be managed for timber only and not include cattle.

The producer had had some experience clearing out brush from the understory of pine stands and planting grass around his house for aesthetic purposes, and he believed that the same process could be successful at generating forage for

livestock under the pines. Based on that experience, he believed the pine acreage could be utilized to supplement his pasture base and generate annual income.

The producer wants to make a reasonable income from the farm and build up the soil for the next generation of land managers, regardless of whether the land ends up as pasture or pine in the future.

### Silvopasture Description

Silvopasture occupies 160 acres across several paddocks/stands on the farm. A representative photograph of the silvopasture is presented in figure 4. The tree component is loblolly pine established in plantation configuration. The pine stands may undergo several thinnings until they are ultimately left in single rows with 40-foot alleys and substantial within-row thinning, potentially leaving average spacings of 40 feet by 40 feet or something similar. The forage is novel-endophyte (NE+) fescue (primarily Jesup MaxQ®). The producer's site is marginal for fescue due to heat, and having trees was considered the only way to make the environment suitable for that cool-season species. The producer is thinking of converting some of these to annual ryegrass (*Lolium multiflorum*) and crabgrass (*Digitaria* spp.) because they do better after prescribed burning and avoid damage in summer months when silvopasture use is emphasized. The livestock utilized in the system are Angus and Gelbvieh cross cattle.

### Integration of Silvopasture into the Broader Farm

Silvopasture is a large part of the farm, occupying a full 40 percent of the grazing acreage. Although the silvopasture started as a way to expand acreage and annual income through grazing acreage—while still being able to allow trees to grow for the long term without clearcutting prematurely—it is clear that this component of the system is now well-integrated into the producer's overall operation. Cattle rotate through silvopastures, apparently as they would any other paddock, but with the producer tending to stock silvopasture paddocks more frequently and open pasture less frequently during the summer.

Table 4.1—Allocation of land uses in farm 4

	Silvo-pasture	Woodland	Open pasture	Hay and row crops	Infrastructure and residential	Other	Total
Area (acres) <sup>a</sup>	160	—	240	—	3	23	400

— = No land area, or an insignificant land area attributed to this land use.

<sup>a</sup> Areas of individual land uses may not add up to the total farm area because of rounding/approximations by the producer.



Figure 4—Photograph of representative silvopasture site on farm 4.

### Silvopasture Establishment

A detailed list of silvopasture establishment activities is given in table 4.2. The trees are from thinned stands of traditionally spaced (10 feet by 10 feet) loblolly pine plantation at about age 15. The producer first has the pines thinned to double-row sets with 30-foot alleys; ultimately the pines will be left in single rows with 40-foot alleys. Thinning occurs within rows as well. Because the trees were already in 10-foot spacings, this producer was able to use equipment that fit the space and did not need to remove stumps to facilitate farm operations.

### Silvopasture Management

Typical periodic and annual management activities are given in table 4.3. The silvopastures are divided into 5-acre paddocks. A herd of 25 cows will graze for 1 week, followed by 30- to 60-day rest periods.

Since the interview, some of the stands have undergone additional thinning to support greater forage production. Eventually, the site will be clearcut harvested for timber. The producer does not see any purpose in letting trees grow old and die without taking advantage of their economic potential. However, the producer would allow a longer timber rotation than the conventional pine plantation rotation. The perceived value of shade for his cattle coupled with a desire to avoid disruption to the overall system drive this decision.

### Product Marketing

Of the calves born, the producer markets a large portion at 10 months old, after they have been weaned 60 days. The

producer markets calves through an alliance that forms truckload lots. Fifty percent of the heifers are retained. Once mature, about 75 percent of those are bred, and 25 percent are sold locally for beef. Each year, four or five of the best males are kept and raised to sexual maturity; these bulls are rented to other local producers. After that, they are sold for beef, locally. Timber is sold through traditional markets.

### Potential Effects of Scale on Establishment, Management, and Marketing

The producer was able to spread the stand thinnings into two separate operations in different years, which may not have been possible with a smaller site. This producer tries to market quality and not to put too much pressure on the land, even if he has to reduce quantity. The producer is able to sell some beef locally, mostly marketed by word of mouth in town. He indicated that this is one of the most lucrative opportunities because he can sell at retail prices, which would not be possible at very large scales.

### Farmer's View of Silvopasture Performance

The farmer's view is positive overall. For now, he believes, the benefits are worth the amount of work it takes, and the process itself is rewarding. He sees it mostly as a way to take advantage of pine plantation acreage for short-term cattle income. In addition, the aesthetics are pleasing for his family, but he perceives the aesthetics would be particularly beneficial if he ever decided to sell or lease residential lots. He enjoys turkey hunting on the farm. This pine acreage was mostly determined and planted prior to his taking over the farm (or in some cases, purchasing or renting new property).

Table 4.2—Silvopasture establishment activities on farm 4

Activity <sup>a</sup>	Years to establishment <sup>b</sup>	Labor	Material	Material amount	Equipment	Equipment amount
Commercial thin	11	Thinned by timber sale	—	—	—	—
Mark trees	1	—	—	—	—	—
Second commercial thin (5–8 years later)	1	Thinned by timber sale	—	—	—	—
Clear debris	1	\$50–60 per acre	—	—	—	—
Spray	1	—	—	\$25–30 per acre	Tractor, 300-gallon boomless sprayer	—
Burn	1	—	—	—	—	—
Disk	1	—	—	—	Tractor, offset disk harrow	—
Lime	1	—	Lime	2 tons per acre = \$10 per acre	—	\$40 per acre
Fertilizer	1	—	Poultry litter	—	Spreader	\$30 per acre
Seed (broadcast and cultipack)	1	—	Fescue	\$50 per acre	Tractor, cultipacker	—
Water infrastructure	0	—	Frost-free waterer, fabric, clay, crush/run, and concrete	\$300 per waterer (one per two paddocks)	—	—
Fence infrastructure	0	—	—	—	3-strand high-tensile fence, single-strand high-tensile internal fence	—
Mark trees	Planned <sup>c</sup>	—	—	—	—	—
Third commercial thin	Planned <sup>c</sup>	Thinned by timber sale	—	—	—	—

<sup>a</sup> Activities listed with no information with regards to labor, material, or equipment are/were undertaken, but the producer did not/could not provide additional detailed data.

<sup>b</sup> Number represents number of years that this activity took place before the silvopasture was considered “established,” i.e., ready to introduce livestock.

<sup>c</sup> Planned to occur perhaps 5–6 years post-establishment.

Still, the farmer’s view is not so positive that he is ready to start planting trees into his open pastures, and he noted that it would be very difficult to convince any cattleman to do that. If he had more pine stands, he would definitely be open to more silvopasture, with the main barrier being the labor involved. Incorporating longleaf pine (*P. palustris*) particularly seemed to intrigue the producer, given the opportunity to produce and sell both cattle and pine straw.

The jury is still out on the overall profitability. He thinks that once the current silvopasture timber is mature and needs to be clearcut, it will probably either become open pasture or be replanted to traditional pine plantation, not likely silvopasture. He noted at least once that forage does grow slower under silvopasture shade than in open. In the producer’s view,

while there are some benefits from silvopasture in terms of managing heat stress on livestock, this could be managed in other ways—through livestock genetics and novel-endophyte (NE+) fescue.

### Case Conclusions

This producer had the largest acreage and largest percent of his farm dedicated to silvopasture. Still, the establishment and management of the system was similar to that of the other producers. Although he has a large amount of acreage dedicated to the practice now, and it is well-integrated into his current operation; for him, the jury is still out on the final economic viability.

**Table 4.3—Typical periodic and annual silvopasture management activities on farm 4**

<b>Activity<sup>a</sup></b>	<b>Year(s)</b>	<b>Labor</b>	<b>Material</b>	<b>Material amount</b>	<b>Equipment</b>	<b>Equipment amount</b>
Herbicide	1–2 years after establishment	—	—	—	Boomless sprayer	—
Overseed	1–2 years after establishment	—	Clover seed	2–3 pounds per acre	—	—
Lime and fertilizer	2–3 years after establishment	—	Lime N	2 tons per acre 50 units per acre	—	—
Fertilizer	Periodic	—	Poultry litter, potash	—	—	—
Herbicide	Periodic	—	—	—	—	—
Maintenance of fence/water	Annual	—	—	—	—	—
Grazing	Annual	—	—	—	—	—
Minerals	Annual	—	Mineral	1.5 bag per head = \$30	—	—
Supplemental feed	Annual	—	Hay	2 bales per head = \$50	—	—
Livestock health	Annual	—	Long-range wormer Vaccinations	\$14–15 per head	—	—
Weigh	Annual	—	—	—	—	—
Insemination	Annual	—	—	—	—	—
Pregnancy check	3 times per year	—	—	\$4 per head	—	—
Weaning	Annual	—	—	\$100	—	—
Culling	Annual	—	—	—	—	—

<sup>a</sup> Activities listed with no information with regards to labor, material, or equipment are/were undertaken, but the producer did not/could not provide additional detailed data.

## DISCUSSION AND CONCLUSIONS

Three of the four producers in our case studies said they would continue with silvopasture operations and consider expanding silvopasture in the future, which is a relatively positive result in terms of their perceptions of the system. The study set is perhaps biased in that all the producers started with large acreages with trees that were suitable for thinning. In fact, each of our case study producers had total farm acreages larger than average (both as measured by mean and by median) in their respective counties. All case studies presented here had hundreds of acres of land (and attendant resources) that likely facilitated implementation. Although the sample set is biased in terms of farm size, the actual silvopasture system size (and percent of forage-livestock land base) varied substantially among these farms.

We entered this project with the aim of looking at how silvopasture system size affects implementation. Small silvopasture scale has not seemed to affect silvopasture management much in these four cases, although implementation at small scale would likely be manageable for any of these farms given their large operating size and resource base. One producer did reckon that the availability of larger forest stands for harvest would be more economical. Although the range of silvopasture scale was from 10 to 160 acres among our cases, all the farms had substantial woodlands. When combining woodlands and silvopasture acreage, the scale ranged from 160 to 2,500 acres. This means that the producers can combine timber harvest from small silvopasture parcels with other timber stands to achieve economic scale size.

Although information from the current case studies suggests small silvopasture scale is not a problem for implementation, on these medium to large scale farms, there was some evidence that large-scale implementation of silvopasture may actually present challenges, at least in the short run. Larger size might limit some of the more labor-intensive parts of the establishment (e.g., clearing debris from thinning), either due to cost or time incurred. This may in part reflect limited labor availability. Also, at least one of the producers markets beef locally, which brings higher returns (with retail, rather than wholesale, prices), but would be difficult to do at a large scale.

All four producers either lease hunting rights to their land or hunt themselves. This is not necessarily viewed as a primary output of silvopasture, but is potentially important. Husak and Grado (2002) found that hunting leases were a significant contributor to silvopasture profitability in

Mississippi. Hunters often will pay more to hunt on farms and ranches with more tree cover such as in silvopasture settings (Shrestha and Alavalapati 2004), but also seem likely to appreciate the open understory of silvopasture. Hunting leases in themselves have interesting scale-related issues, as Shrestha and Alavalapati (2004) found decreasing lease price per acre above 1,000 acres but increasing price per acre as ranch size increased for ranches under 1,000 acres, suggesting some optimal size to maximize revenue per acre. Hussain and others (2007) found no effect of size on lease price per acre, but perhaps this is because they did not include the possibility of a curvilinear effect.

Taken all together, silvopasture scale size is not apparently a major issue, as long as farms have substantial land base and resources in other systems to complement it. One of the questions that bears pursuing is what small silvopasture scale means for small- to medium-sized farms, and how their owners might manage the system differently.

Of the three producers in our cases that would consider establishing more silvopasture in the future, each indicated that they were most likely to do so only by thinning established trees. Only one producer in our four case studies indicated he would consider introducing trees into pasture but not by the conventional method. One of the four producers has considered using a tree spade to “thin” trees from his pine stand and move them into open pastures. This presumably would shorten or eliminate the amount of time needed until livestock could be allowed into the pasture since these trees could be protected individually. Whether enough trees could be economically moved to create a silvopasture (as opposed to scattered, living shade) remains a question. Along with recognizing his animal needs, this willingness likely reflects his satisfaction with existing silvopasture and availability of the resource (tree spade) to do so. For future research, it would be interesting to see how or if such an endeavor would affect future thoughts on tree planting.

At least three of four producers said that they would extend the silvopasture timber rotation, growing trees for longer periods than a traditional timber rotation, but each seemed to have different outlooks on tree stands. One producer had reasonably sized logs that would be ready for market in a few years, but expressed that, given the requirements to create the silvopasture, it may be better to leave the trees in place as long as possible for the benefit of the cattle. A second producer seemed more willing to follow markets where they would lead—meaning that harvest would occur whenever

it made financial sense. He seemed to display less concern about the needs of cattle, likely because he could use other wooded lands to help mitigate heat stress.

Several of the producers met resistance from foresters when thinking about establishing silvopasture. It would be useful to interview foresters and loggers to better understand their perceptions and rationales.

Stumps can be a major expense in conversion from timber stands to silvopasture. One of the three producers was able to work around the stumps because they were from a pine plantation planted at regular 10- by 10-foot spacings, so he was able to utilize equipment that fit that space. The other three producers either had irregular tree spacings to work with or could not make their equipment fit, so they had to find a way to reduce or eliminate at least some of the stumps. This expense can be mitigated if the logger is contracted to cut stumps fairly close (within about 4 inches) to the ground so the producer can focus only on grubbing or shearing the largest remaining stumps.

Silvopasture implementers generally were satisfied, and the practice seems viable for producers in the Southeast based on these case studies. Scale for most operations generally was small, particularly relative to farm size. The role of aesthetics is not easily quantified, but it was mentioned as part of the rationale for implementing silvopastures for at least two of the operations and may play a role in those operations' capacity to lease hunting rights. However, that too is scale-dependent. All producers had approached silvopasture from thinning given their available resources. More work is needed to determine how the effects of silvopasture scale change with farm size, available markets, resources, and labor.

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## APPENDIX: PROCEDURE AND QUESTIONS FOR INTERVIEWS WITH CASE STUDY MANAGERS

### DETERMINING SCALE CHARACTERISTICS OF SILVOPASTURE IN THE U.S. SOUTH

This document includes procedures and questions for conducting interviews with managers of silvopasture system parcels in North Carolina or Virginia that are selected to be case studies.

We will consolidate a list of known practitioners in North Carolina and Virginia based on key informant interviews and other contacts, and then conduct in-depth interviews with three to five practitioners on the implementation practices and costs of silvopasture. These practitioners should be selected to represent diverse scales. To the extent possible they should have very different sizes of operations in terms of acreage, livestock number, capital invested, etc. We will observe the parcels to note similarities and differences in implementation.

These interviews are one component of a larger research project. They will feed into our growing knowledge of silvopasture economics, in particular, how scale of operation affects establishment, management, costs, and revenues of silvopasture. We will utilize the data from the case studies to create spreadsheet models of costs and returns over time. We will use capital budgeting techniques to estimate indicators of economic profitability of the different case studies and compare these to the scale and implementation techniques of each.

#### Procedure:

We will contact potential interviewees to describe the project, obtain consent for their participation as a case study, and arrange a time to interview them and observe the site (which may be done at the same time or separately). Potential case studies (developed from previous interviews with key informants) are kept in a separate file.

Interviews will be recorded on paper and possibly use voice recordings. Interview recordings (paper or voice) will be deleted after 5 years. In addition, at any point, if the interviewee requests for us to do so, we will destroy all recordings and notes.

Occasionally there may be a need to convey the interview contents to collaborators at the U.S. Department of Agriculture Forest Service (the granting agency) and research assistants. This will be done via password-secured

email accounts. Each email will contain a reminder to the collaborator/assistant that the content is confidential and not to be shared outside of the research group.

#### Interview script/discussion topics:

1. To get started, I'd like to ask you about your background.
  - a. How old are you?
  - b. What is your highest level of education?
  - c. [if applicable] What was your field of study?
2. Now, to really get started, please describe the land you manage. How much land do you manage, and how many acres are dedicated to various uses, including: forest/woodland; open pasture; silvopasture; row crops (corn, soy, cotton, etc.); vegetables/flowers/other crops; conservation set-asides; residential/family use; other.
3. How did you first learn about silvopasture? Where do you first see it?
4. Where did you get the conception (formal/informal learning)?
5. When you were first thinking about establishing silvopasture, what was your motivation or the idea behind it?
6. In what year did you first establish silvopasture on the land you manage? Where was the site? How many acres?
  - a. Have you established silvopasture on other sites since that first site?
  - b. [if yes] When, where, and what acreage?
7. Please describe the components of your various silvopasture sites:
  - a. What is/are the tree species?
  - b. What is/are the livestock species (and breed if applicable)?
  - c. What is/are the forage species (and type if applicable)?

8. What is/are the establishment method(s) you have used? Planting trees into existing pasture or bare land OR thinning a stand of trees and establishing forage?
9. [if more than one silvopasture site] Think of the single site that is most representative of how you personally would normally establish and manage a silvopasture. Let's call that "site S." The following questions are only about site S:
  - a. [if necessary] How many acres is site S?
  - b. [if necessary] What was on site S before silvopasture? What was the establishment method used on site S?
  - c. [if necessary] What are the tree, forage, and livestock species used on site S?
10. Think back about all the activities you conducted when you established site S. Please tell me what you did, when you did it, how much it cost. Please include your own time spent, as well as materials, hired labor, and type and hours of equipment use.
14. Consider all the management activities for livestock, whether while they are on silvopasture or otherwise. Please tell me what you do, how much it costs. Please include your own time spent, as well as materials, hired labor, and type and hours of equipment use.
15. Consider all the products you hope to sell from livestock on your farm, such as the livestock that spends some time on site S. From a typical head or pair such as a cow-calf pair, describe and estimate the revenue streams you derive in a typical year. Please tell me what you sell, how much it is sold for, net of any marketing or transportation costs.
16. Describe costs or losses from disease, mortality, etc.
17. Consider all the products you hope to sell from trees on site S. From a typical head or pair such as a cow-calf pair, describe and estimate the revenue streams you derive in a typical year. Some of these activities you may have not carried out but are planned for the future. Describe and estimate the revenue streams. Please tell me what you sell, how much it is sold for, net of any marketing or transportation costs.

SEE TABLE A.1.

11. Think back about all the management activities you conduct on an annual basis. This includes management of the site itself and plants; I will ask about livestock management later. Please tell me what you do, how much it costs. Please include your own time spent, as well as materials, hired labor, and type and hours of equipment use.

SEE TABLE A.2.

12. Consider all the management activities you conduct on less frequent than annual basis. This includes management of the site itself and plants; I will ask about livestock management later. Some of these activities you may have not carried out but are planned for the future. Please tell me what you do, how much it costs. Please include your own time spent, as well as materials, hired labor, and type and hours of equipment use.

SEE TABLE A.3.

13. What percent of time is site S occupied with livestock? How many head are present on site S when it is occupied?

18. Describe any products or beneficial activities such as recreation that you and your family obtain for personal use from site S.
19. How would you rate the success of the silvopasture for you, financially, biologically, other?
20. Would you consider doing more silvopasture?
21. What are the barriers to you doing more silvopasture?
22. Have you received any cost share or other financial incentives to implement silvopastures, and how would that affect your decisions to implement silvopastures?
23. If you had to do over again, what would you do differently?

That was the last question. Is there anything else you would like to tell us about your view of silvopasture?

Do you have any questions for me?

**Thank you very much for your time.**





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Silvopasture, the intentional combination and integrated management of trees, forage, and livestock on the same area of land, has drawn interest in the Southeastern United States because of potential environmental, economic, and animal welfare benefits. However, it is as yet not widely adopted in the region. Therefore, aspiring adopters do not have peer models to observe, and technical service providers and researchers do not have a firm grasp of practical issues adopters may face or their views of challenges, benefits, and adaptations for implementation. In particular, very little is known about how the scale of operation may affect establishment and management. The goal of this research was to observe and document four case studies of early adopters of silvopasture in the States of North Carolina and Virginia to help potential future adopters, technical service providers, and researchers understand practical issues related to establishment and management of the practice. Each of the four case study producers was a cow-calf farmer who had established silvopasture by thinning trees and then planting forages in the understory. There were many similarities in how the producers managed their silvopasture and whole farm, yet there were differences in how they viewed and ultimately addressed the practical implementation (such as stump removal, grazing rotation, etc.) and system outputs (marketing of beef products, production of sawtimber versus pulpwood, etc.) of silvopasture. Three of the four producers were generally satisfied and had a positive view of the system, and the fourth indicated he likely would not continue silvopasture in the future. Among this limited sample, scale did not seem to affect establishment and management of silvopasture specifically to a great degree, because small-scale silvopasture could be managed concurrently with operations on nearby conventional forest stands and pastures. Still, scale issues seemed to come into play at the whole-farm level.

**Keywords:** Adoption, agroforestry, cattle, farm management, forage, scale, silvopasture.



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