# Trees and Livestock Together: Silvopasture Research and Application for Virginia Farms

***Gregory E. Frey*** *(USDA Forest Service, Southern Research Station);* ***John H. Fike*** *(Virginia Tech);* ***Adam K. Downing*** *(Virginia Cooperative Extension-Virginia Tech);* ***Marcus M. Comer*** *(Virginia Cooperative Extension-Virginia State University);* ***Timothy A. Mize*** *(Virginia Cooperative Extension-Virginia Tech);* ***Christopher D. Teutsch*** *(Virginia Tech Southern Piedmont Agricultural Research and Extension Center)*

## Abstract

Silvopasture is the intentional combination of trees, forage, and livestock on a parcel of land to optimize multiple outputs and has been shown to have benefits for production in various parts of the world. There is strong interest in silvopasture in the Southern United States, likely driven by multiple motivations. However, silvopasture practices have not been adopted or studied widely in Virginia or surrounding states, and lack of familiarity and information is a key hurdle to adoption. Potential adopters need research in order to make sound establishment and management decisions, but researchers typically need a reasonable pool of adopters to justify the expense of research studies. Still, a team of scientists in Virginia and neighboring states has pooled resources to move forward with research on establishment methods, biophysical interactions, economics, and perceptions of stakeholders. One small research site began in western Virginia in 1995, but since 2012, the effort has expanded to include new research and extension sites in other parts of the state, outreach and support to farmers interested in establishing parcels on their land, and training and surveying of technical service providers. We will present preliminary results and practical considerations gleaned from these early activities.

## Introduction

Silvopasture combines trees, livestock, and forage on a single parcel of land. Silvopasture can be distinguished from similar uses because it involves planning and management of all three system components, instead of leaving one or more of these unmanaged. For example, simply “turning livestock into the woods” is neither planned nor managed, and can lead to negative impacts such as transport of pasture nutrients into the forest, tree damage, and soil degradation (Brantly 2014). Likewise, having sparse trees in a pasture can cause concentration of nutrients and parasites in the loafing areas around the trees. “Forest grazing” can be managed to limit and control livestock-forest interactions, but only involves managing the livestock component; trees and forages are not directly manipulated (Brantly 2014). This limits growth of a healthy forage layer that could act as a buffer to prevent damage to tree roots.

In addition to avoiding the pitfalls of sparse trees in a pasture, turning livestock into the woods, and forest grazing, well-planned and -managed silvopasture in environments similar to Virginia can potentially increase forage production relative to traditional pasture in some situations (Buergler *et al.* 2005) and alter forage nutritive value in both beneficial and detrimental ways

(Buergler *et al.* 2006). Shading and shelter from trees provides relief from heat or cold for livestock (McDaniel & Roark 1956), leading to potential overall economic benefits (Clason 1998; Frey *et al.* 2012). There is strong interest in silvopasture in the US South (Workman, Bannister, & Nair 2003), possibly driven by multiple motivations. First, concerns about water quality have led to livestock exclusion from streams, so there is a search for alternatives to streamside areas to reduce heat stress on livestock. Second, producers perceive hotter summers[1]. Third, producers have increased interest in local sustainable agricultural systems. However, silvopasture practices have not been adopted or studied widely in Virginia. Potential adopters need information in order to make sound establishment and management decisions.

A team of scientists and practitioners in Virginia has pooled resources to move forward with research on biophysical interactions, economics, and perceptions. This paper summarizes some early efforts to gain insights about establishment and management of silvopasture.

**Current Research in Virginia**

Five silvopasture research sites have been established so far (others under consideration). Thus far, these sites have utilized cattle, or have not been open to livestock yet, but there is potential to utilize small ruminants at these or other sites in the future:

- Kentland Farm (Blacksburg, VA) – planted hardwood (black walnut [*Juglans nigra*])
- Shenandoah Valley Agricultural Research and Extension Center (Steele's Tavern, VA) – thinned hardwood (black walnut and other species)
- Southern Piedmont AREC (Blackstone, VA) – thinned pine (loblolly [*Pinus taeda*]) and hardwood (oak [*Quercus* spp.]); planted loblolly pine with variable alley spacing; forage testing under shade structures
- Catawba Sustainability Center (Catawba, VA) – planted hardwoods (walnut, oak, and American chestnut [*Castanea dentata*] based system with trainer trees)
- Clermont Farm (Berryville, VA) – planted hardwoods (walnut, oak, and American chestnut based system with trainer trees)

We conducted an electronic survey targeting all Agriculture and Natural Resource Extension Agents in Maryland, West Virginia, Virginia, North Carolina, South Carolina, and Georgia. 138 agents responded to questions about: environmental attitudes and concern, the economic viability of silvopasture systems, the social aspects of adopting and managing a silvopasture practice, the knowledge level of agents on technical comprehension of silvopasture, and agent demographics.

[1] Data from the National Oceanic and Atmospheric Administration (http://www.ncdc.noaa.gov/cdo-web/search) show that average highs, lows, and monthly temperatures for July at Richmond International Airport were all 1.5 to 2.2 F higher for the period 2010-2015 than for 1981-2010 (data summary available from authors).

Mixed-method interviews of 20 researchers and technical service providers were conducted in 2013-14 about silvopasture characteristics and potential economies of scale. We also are planning observation and case study documentation of silvopastures on private land.

**A Silvopasture Typology for Virginia**

Virginia lies in the overlapping area of the Southeast, Mid-Atlantic, and Appalachian regions, leading to wide varieties of agro-ecological conditions and farmer types. This poses opportunities and challenges, as there are numerous decision points and underlying (often difficult to alter) characteristics which deeply affect establishment and management methods, and the potential type and magnitude of benefits and costs of the system. Our survey and interviews, along with our own observations from establishing the research sites, led us to identify eleven characteristics that differentiate silvopasture systems:

- Primary Activity, Prior to Silvopasture (Forest/Timber or Livestock)
- Reason for Owning Land/Farm (Lifestyle/Income or Investment)
- Scale (Smaller or Larger scale)
- Tree Type (Hardwood, Mixed, or Pine)
- Tree Regeneration (Naturally-regenerated or Planted)
- Forage Type (Tall fescue [*Festuca arundinacea*], Alternative forage, or Mix)
- Livestock Type (Small ruminants, Cattle, or Other)
- Establishment Method (Thinned forest, or Trees planted into pasture)
- Tree Arrangement (Scattered trees or Rows and alleys)
- Motivation (Focus on livestock or Tree product important)
- Tree product (Nuts, fruits, etc., or Timber)

It is reasonable to group silvopasture systems by establishment method, tree type, and motivation as these three factors have the largest impact on the establishment and management activities undertaken:

*Thin pine or hardwood stand; focus on livestock*

Often undertaken in small scales, timber is not a principal output of this system. Trees are retained primarily for shade. Other potential drivers may include erosion control and other benefits.

*Thin pine stand; balance livestock with timber production*

Thinning is viewed as an important tool in pine management for timber; thinning to introduce silvopasture is more intense. The compromise toward greater timber production supports greater long-term returns at the expense of annual animal output.

*Plant pines or high-value hardwoods into a pasture and limit access to livestock; balance livestock with timber production*

Planting trees into pasture offers flexibility in design and implementation in terms of configuration and species selection.

**Lessons Learned**

As noted previously, we have interviewed and surveyed researchers and technical service providers. Furthermore, our observations from our own work to establish silvopasture research sites and conversations with individual producers has provided insights. The following are some preliminary results and observations from our work, and lessons learned that may help future practitioners. In some cases, these "lessons learned" are preliminary or anecdotal – they have not been comprehensively vetted through a scientific process, so they may be incomplete or applicable only to certain sub-populations, but still we believe they are helpful at this stage.

*Perceptions of landowners*

1. Many landowners and service providers know very little about silvopasture. Landowners do not know enough typically to form a positive or negative opinion about silvopasture. Service providers often have negative opinions – perhaps based on their previous experiences with "turning livestock into the woods" or similar not-silvopasture, practices.
2. The time scale for timber management is hard to fathom for producers whose business is based on annual production.
3. Producers perceive lost production by adding trees to pasture as a negative. Many of these producers are not managing any woodlands of any size, so thinning is not an option.
4. Some producers who are also forest landowners are eager to experiment and may try thinning small forest parcels. Care for and management of the trees often has been secondary for these landowners, but some do seem to place more emphasis on tree management after watching their initial silvopastures develop. As a group, those who thin stands generally appear to have been in agriculture longer, and many of them have histories with both agriculture and forestry, compared with those who plant trees into pasture. This method may be effective to learn by trial and error and to increase livestock production, but may provide limited numbers of potential adopters because many landowners do not own forestland.
5. In our experience, producers who have planted hardwood trees into pastures generally are younger and express a desire to do something different than traditional livestock production. They may also have fewer acres to work with, so "two-story" agriculture is a means of increasing the productivity of their land base (as opposed to thinning, which is seen as a means to expand the land base). We have less experience in Virginia with those who plant pines to create silvopastures than with those who plant hardwoods, but this

group may be somewhere in between the "thinners" and hardwood planters in terms of available resources and motivations.

6. Landowners are not likely to convert all their pasture operation to silvopasture. Silvopasture is generally seen as one component of a broader rotational system.

*Establishment from thinned stands*

1. Challenges with these systems include managing tree selection and quality for short or long-term returns. On small land areas with low total timber volume, particularly with low-quality trees, the timber values may be unattractive to loggers, particularly if the best trees are being left for silvopasture.
2. It is possible to over-thin. Timber value can be affected by the thinning, as heavy thinning may be more financially rewarding in the short term but this must be weighed against the effects on the remaining trees, which can be stressed by too heavy tree removal. Risks include epicormic sprouting of hardwoods[2] and bending due to the loss of support from surrounding trees. However, it may not be a big issue for producers whose goal is to create sheltered sites for livestock, and in some markets there is not a large discount for the resulting lower timber quality. Over-thinning is less of a risk for pine stands in terms of timber quality but wind-throw or shearing does occur on these over-thinned stands, particularly on sites that receive heavy winds, are not suited to good tree root development, or both. Knowing the site and its potential for such conditions is important when making thinning decisions.
3. Tree stumps remaining after harvest can limit the use of equipment commonly employed for lime and fertilizer application, forage establishment, clipping, and hay making. Ideally remaining stumps should be at the soil level to facilitate equipment use.
4. Logging residues can pose a dilemma. If left whole, tops and branches impede equipment and livestock. If chipped and left as mulch, the decomposition process of this high-carbon wood can immobilize nitrogen, temporarily leaving less nitrogen available for forage growth. Chipping and removing results in a loss of future soil organic carbon. Options to manage this include prescribed burning and soil fertility amendments.
5. Furthermore, soil fertility and pH can be quite low to begin with in forested areas. This can limit forage establishment and productivity. Soil tests should be undertaken to determine optimal amounts of soil inputs. Developing a vigorous, productive forage stand under pines can be economically challenging unless resources such as poultry litter or biosolids are readily available as soil amendments.

[2] Epicormic sprouts are from previously dormant buds underneath the bark, usually lower on the trunk than the active buds. Epicormic sprouting is an indicator of poor health since it usually occurs in response to a shock such as injury or disease, and reduces the value of the tree for timber by introducing knots. It does not occur in all tree species; in the US South it is more common in hardwood species.

6. Sustainability and replacement of the current stand of trees needs to be considered. After the thinning, remaining trees may experience mortality from the shock. For species that resprout from the stump (some hardwood species), one option to mitigate these concerns may be to protect from livestock some of the re-sprouts or seeds that germinate to become the next stand. However, not all sprouts can be left or the tree stocking will be too high.
7. Thinning existing pine stands perhaps provides some of the greatest flexibility and ease both in terms of stand uniformity and for configuring the remaining trees to meet desired infrastructural/logistic or aesthetic needs.
8. The use of controlled grazing is an essential part of silvopasture management and should be considered a key part of the silvopasture establishment plan.

*Planting trees into pasture*

1. Hardwoods can be difficult to establish from seedlings under optimal conditions, but particular challenges occur where trees face competition from the existing forage base. Pines are potentially less challenging. Still, killing the sod around the seedling tree with a chemical or mechanical treatment is important for the seedling's survival and productive growth. In some cases irrigation may be necessary.
2. High levels of vegetative cover also can provide shelter for small rodents which damage tree roots. Using tree tubes or other protection can add expense to hardwood tree establishment but may be essential in sites where heavy predation from rodents or deer is an issue. Tree tubes are not considered necessary or economical for pine plantings, but depending on species these also can be heavily predated by deer. Three dimensional fencing can be an effective and relatively cost efficient way of keeping deer off trees.
3. Trees must be protected until they can sustain livestock damage. In some cases, an entire paddock might be fenced off, and livestock excluded for a number of years. However, most producers are not enthusiastic about losing an entire paddock for multiple years, so options to protect trees as individuals or small groups should be identified. For example, trees in linear rows can be fenced for a period to create alleys with forages that are still available.

*Forage growth in shade*

1. Managing tree cover can be a long-term issue in silvopastures. Moderate levels of shade (40% full sun) can benefit animals and forages alike, but as shade levels increase above about 50 or 60% full sun, forage productivity likely will decline. This may or may not be an issue as the animal welfare benefits provided by shade and shelter can compensate for forage production losses. Whether it is economical to thin (or prune) trees at strategic

times to maintain light to the forage understory will need to be assessed on a site by site basis.

2. Forage species selection can be important in offsetting the effects of shade as well. A mix of forage species may be effective, and legumes may help manage some fertility issues. Orchardgrass (*Dactylis glomerata*) may be more tolerant to a low light environment, but use of shade tolerant species must be considered in terms of the whole farm, e.g., if the silvopasture site is to be grazed in winter, fescue for stockpiling may be preferred.

**References**

Brantly, S. (2014). Forest grazing, silvopasture, and turning livestock into the woods. AF Note - 46. 4 pp. Lincoln, NE: USDA National Agroforestry Center. Retrieved from: http://nac.unl.edu/documents/agroforestrynotes/an46si09.pdf.

Buergler, A. L., Fike, J. H., Burger, J. A., Feldhake, C. R., McKenna, J. A., & Teutsch, C. D. (2005). Botanical composition and forage production in an emulated silvopasture. *Agronomy Journal, 97*(4), 1141-1147. DOI: 10.2134/agronj2004.0308

Buergler, A. L., Fike, J. H., Burger, J. A., Feldhake, C. M., McKenna, J. R., & Teutsch, C. D. (2006). Forage nutritive value in an emulated silvopasture. *Agronomy Journal, 98*(5), 1265-1273.

Clason, T. R. (1998). Silvopastoral practices sustain timber and forage production in commercial loblolly pine plantations of northwest Louisiana, USA. *Agroforestry Systems, 44*(2-3), 293-303. DOI: 10.1023/a:1006267114962

Frey, G. E., Fassola, H. E., Pachas, A. N., Colcombet, L., Lacorte, S. M., Renkow, M., Peréz, O., & Cubbage, F. W. (2012). A within-farm efficiency comparison of silvopasture systems with conventional pasture and forestry in northeast Argentina. *Land Economics, 88*(4), 639-657. DOI: 10.3368/le.88.4.639

McDaniel, A. H., & Roark, C. B. (1956). Performance and grazing habits of Hereford and Aberdeen-Angus cows and calves on improved pastures as related to types of shade. *Journal of Animal Science, 15*(1), 59-63.

Workman, S. W., Bannister, M. E., & Nair, P. K. R. (2003). Agroforestry potential in the southeastern United States: perceptions of landowners and extension professionals. *Agroforestry Systems*, 59(1), 73-83. DOI: 10.1023/A:1026193204801