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Creating Silvopastures: Some Considerations When Thinning Existing Timber Stands

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Silvopastures intentionally integrate trees, forage, and livestock production in a rotational grazing system. These systems have the potential to improve animal comfort, increase farm resource use efficiency, boost income, and mitigate environmental costs. A broader discussion of silvopasture may be found in "Defining Silvopastures: Integrating Tree Production With Forage-Livestock Systems for Economic, Environmental, and Aesthetic Outcomes; CSES-146P" available at https://www.pubs.ext.vt.edu/CSES/CSES-146/CSES-146.html), and information on tree selection and planting to establish silvopastures is available in the publications "Creating Silvopastures: Some Considerations When Planting Trees in Pastures", available at https://www.pubs.ext.vt.edu/CSES/CSES-185P/CSES-185.html and Tree Selection Guide for Mid-Atlantic Silvopastures at https://www.pubs.ext.vt.edu/SPES/spes-476/spes-476.html.

From a theoretical standpoint, silvopastures are designed and managed to capture the beneficial interactions among each of the system's components. The added biodiversity and buffering (e.g., reduced temperatures and water runoff) provided by integrating trees and forages can also increase system resilience to extreme weather events and a changing climate. For the growing number of folks interested in silvopastures, the benefits of these systems seem clear, but the path to creating silvopastures may be less certain.

The quickest way to create a silvopasture is to thin an existing tree stand and then establish forages (fig. 1). Producers might prefer this way because it more quickly increases their forage/grazing capacity and shortens the investment time, but several issues should be considered before taking this approach. Soils and slope, tree stand composition and age, returns and costs for thinning the trees and clearing residues, and the method of establishing forages are all important variables when considering whether to thin existing stands.

Figure 1. Thinning stands is considered by many to be the quickest way to functional silvopastures, but many questions need consideration before jumping in. (Photo by Adam Downing.)

Build a Team, Make Goals, Assess Resources, and Plan, Plan, Plan

Given that few producers (or professional consultants) have experience across both forage-livestock systems and forestry, the first recommendation for getting started should be to build a team. Extension agents, foresters, and technical service providers (from the Natural Resources Conservation Service or soil and water districts) working together can assist in considering goals, site suitability, implementation strategies, and best management over short- and long-term time horizons. Silvopasture development involves significant investment, requires a long-term view, and is not changed rapidly once set in place, so careful preparation is essential. Having a team working together to help to get it right on the front end can minimize mistakes and improve outcomes.

It is worth noting that some natural resource professionals who are unfamiliar with these integrated systems may be resistant or reluctant to support their adoption. They might view creating silvopastures by thinning woodlots as detrimental to both the environment and the health and productivity of the forest. This view is likely due to the fact that (1) this thinning involves reducing rather than increasing tree density/cover, (2) unmanaged livestock often damage trees, and (3) in some stands, thinning will lead to decreased biodiversity or loss of some nontimber forest species. These concerns have a valid basis given historical mismanagement. The resource professional's perspective and expertise is valuable and their support is best obtained by including them in the process early and assuring them of your commitment to long-term, engaged, and active management. Seek their input to help make short-, medium-, and long-term management plans that safeguard the health and vigor of the remaining trees.

Site Suitability

On many farms, the back woods **are** the back woods because they are often on marginal land. Attempting silvopastures on such sites is a poor decision if the ground cannot be readily managed, is highly erodible, or will not support adequate forage production. Unfortunately, too many farms currently allow cattle unmanaged access to woodlots, resulting in severe damage to soils and vegetation and creating opportunities for non-native invaders. In some cases, developing silvopastures from abused woodlots can provide a functional way to advance responsible, productive land management through timber stand improvements, invasive species removal, and soil revegetation. Of course, this will require a great step up in management, including time and labor.

Harvest Decisions

Deciding which trees to harvest can be a challenge, especially in hardwood stands. Tree species, form, size, age, local markets, value, and timber quality all play a role in the current and future returns to the system. These factors also affect their suitability when managed with forages and livestock. Along with these considerations, thinning decisions should account for farm layout and infrastructure associated with rotational grazing system needs — which don't always match the preferred harvest plan.

Knowing how much timber to remove (and when) can be perplexing, yet sound thinning decisions are essential both for tree development and for light management for forage productivity. Silvicultural principles such as relative density and stocking should be considered to ensure the thinning achieves the most productive and healthy outcome. Removals based on basal area and trees per acre using forestry stocking charts, as well as the silvics of the species present in the stand, can help identify a reasonable balance point for getting adequate light to the forages without compromising the long-term productivity and health of the tree stand. Thinning factors will differ from stand to stand based on characteristics such as average tree diameter, species composition, topography and environmental sensitivities, site productivity, and operational considerations. For instance, small-diameter trees that are overtopped or in an intermediate crown position below dominant the canopy can be thinned to a much greater extent without risk of windthrow and top breakage.

However, heavy thinning that leads to large gaps in the canopy could be too stressful if those trees remaining after harvest are tall, thin, and top-heavy or prone to epicormic sprouting (fig. 2). Such trees would be susceptible to damage from high winds or ice or develop poor form and quality (e.g., knotty wood) unacceptable in some timber markets. In some cases, multiple thinnings over time could be best for the tree stand, but this approach must be balanced against greater costs, slower conversion, and the potential for more damage to soil and remaining trees from harvest operations. In any case, forestry professionals should assist this process.

Figure 2. Opening up stands for adequate light is essential for forage production, but excess thinning can stress trees. Root compaction (which can occur from harvest operations or poorly managed livestock), increased heat, and fungi or other pathogens can be sources of stress. Epicormic branches (which reduce timber value) and crown dieback can occur due to thinning shock or from partially or completely shaded trees suddenly being exposed to more light and heat. Oak trees in the left picture initially flourished after thinning but then suffered in response to environmental stresses. Black locusts in the top right picture were crowded; after heavy thinning, this young tree drooped under the weight of its crown. In some cases this can break the water column in the tree, resulting in death. The bottom right photo shows direct damage to a tree root that occurred during harvest. (Photos by John Fike and Adam Downing.)

Some Economic Considerations

Working with a professional forester is likely to improve the functioning of the final system and also benefit you financially. Consulting foresters are well-suited to not only provide input into thinning but also to assist in marketing the timber. In general, timber sales involving a consulting forester have greater economic return (due to competitive bidding) and have stronger contracts to ensure minimal damage to the site and protect landowner interests.

Producers looking to support conversion to silvopastures by selling the harvested timber could be disappointed if their woodlots suffer from past high-grading (i.e., “taking the best and leaving the rest”). This all-too-common practice (fig. 3) has been used to maximize short-term timber returns, but it often leaves low-value and low-vigor trees and does not fit with a long-term strategy of improving the timber stand. Such sites will have even less economic value if they have been subjected to unmanaged livestock access. Stands such as this, regardless of future use goals, could benefit from a “start-over” type of strategy, such as clearcutting and planting.

Figure 3. In a true thinning, some desirable trees are left to maintain timber stand quality. In this photo, however, only valuable trees have been marked for harvest (yellow marks in red circles). Such high-grading practices leave behind less desirable individuals and species groups that are slower-growing and lower-quality. (Photo by Adam Downing.)

This section highlights a few of the relevant terms that can help foresters and agricultural producers better communicate. Forestry and agricultural terms often sound very similar but they can have very different meanings.

Some Forestry Terms for Agricultural Producers

basal area – The average amount of area that the tree trunks occupy on a unit of land, usually measured at 4.5 feet off the ground. For example, a BA of 70 square feet would mean that the cross-sectional area of the tree stems on the site occupy 70 square feet of area. However, markedly different tree stands can have the same BA. For example, a forest stand with an average of 100 eleven-inch diameter trees per acre would have a BA of 70; however, the same BA is possible with only 33 trees per acre if the trees average about 20 inches in diameter. The BA gives some idea of site occupancy and can be used in combination with stocking measurements to guide thinning decisions.

board foot – A unit of volume equal to a board that is 1 inch thick, 12 inches long, and 12 inches wide, or 144 cubic inches.

epicormic branches – New sprouts formed from latent (inactive) buds that are under the bark of a tree. In a forest stand these buds typically are inactive because they are shaded. After thinning, these buds can become active as the newly exposed tree trunks heat up due to light exposure. In some cases, epicormic branching also may be a sign of stress, especially if trees are shocked by overthinning. Although some epicormic branching occurs naturally, these branches increase knots in the wood and lower its quality and value if too large. In some cases pruning can be an option to maintain timber value.

release – Removal of competing vegetation (herbaceous or woody) in a newly regenerated forest stand to “release” them from undesirable competition. The most common application of release treatments is in pine plantings after a couple years of growth to give them a competitive edge over faster growing vegetation that is starting to overtop the desired regeneration. In this case, release is usually accomplished with an aerial herbicide application.

rotation – The length of time between timber harvests. Rotation lengths are longer for slow-growing hardwood trees. Midrotation is a term often used to describe a thinning harvest that reduces competition and allows the remaining trees to grow faster.

stocking and stand density – Criteria used to describe the amount or degree to which a site’s resources for growth (light, water, and nutrients) are used by trees. Stocking uses several metrics (e.g., number of trees per acre, average tree diameter) to determine the status of the tree stand with regard to what is optimum. Stand density is a quantitative measure of tree stocking. Stand density can be measured in basal area, tree volume, or tree numbers per unit area, and it essentially describes how crowded the trees are on an area. Relative stand density is the quantitative measure of density in relation to some base condition, such as an open grown tree or a fully stocked forest.

thinning – Removal of specified trees to reduce stand density to reallocate growing space (and thus increase growth rates) of the desired trees.

Some Agricultural Terms for Foresters

browse – Vegetative growth (leaves, small twigs) on shrubby plants and trees consumed by livestock.

forage – Grasses, legumes, and other forbs that livestock graze.

rotational grazing = rotational stocking – A method for managing grazing livestock and the pasture resource in which livestock are moved from one area of a farm to another based on available forage or browse. Rotational management allows for rest and recovery of forage stands and is especially important to minimize potential for damage to trees in silvopasture systems.

stocking density – The number of animals on an area of property at a point in time (e.g., 20 cows on a 2-acre pasture is a stocking density of 10 cows/acre).

stocking rate – The number of animals on the entire pasture area of a grazing system over a specified period of time (e.g., 20 cows on 60 acres of pasture over a year's time is a stocking rate of 0.33 cows/acre per year).

Stumps, Timber Harvest, Residue Management, and Forage Establishment

Residual tree stumps can be problematic to work around. Setting stump height limits and penalties for those trees not meeting this standard can be useful, although setting strict limits for timber harvest could reduce the price received for the harvested timber. If future management will not include large machinery, strict limits on stumps or harvest residues might not be necessary.

In sparse tree stands, removing residue might not be justifiable or necessary (fig. 4). However, residue management typically will be needed postharvest to create better conditions for forage establishment and management and and may be able to be performed by the logger with negotiations on of payment. Residue can include tree branches and treetops that were not removed as part of the logging job. Cleanup could be as simple as pushing the remaining wood into piles and burning or removing these materials by mulching. Forest mulching is also a good way to deal with residue and even remove standing small-diameter junk wood without causing excessive soil disturbance, although it can affect germination and growth of the forage to be established (see "Options for Clearing Land: Pasture Establishment for Horses," Virginia Cooperative Extension publication 465-341 [http://pubs.ext.vt.edu/465/465-341/465-341.html], for more on forest mulching). Removing scrubby underbrush **before** the actual harvest can be helpful if costs are not prohibitive. Some producers successfully use small ruminants as "brush cutters" for this purpose as well as for cleaning up stump sprouts after thinning.

Figure 4. With thin tree stands, it may be more cost-effective to let downed trees decompose in place rather than mulching or burning these residues (top). Goats (bottom, inset) can be an effective (and profitable) way to remove the tops of downed trees and stump sprout regrowth, and to clear understory vegetation. (Top photo courtesy of Greg Frey, U.S. Forest Service; bottom photos courtesy of Chris Fields-Johnson, The Davey Institute.)

In most cases, reducing residues and heavy duff layers (mechanically or with fire) will be essential for successful forage establishment (figs. 5-7). High seeding rates could be needed because litter and mulch layers reduce seed contact with mineral soil, greatly decreasing germination and establishment. This is especially true when broadcasting seed, which might be the only suitable method of seeding forages into thinned tree stands. High levels of carbon-rich, low-nitrogen woody debris and residues left from logging can lead to a "tie up" of nitrogen and other nutrients by soil microbes, limiting forage growth. Some producers have success confining and feeding hay to livestock on sites where they wish to establish forages. This takes advantage of browsing, "treading action," and additions of fertility in feces and urine but may be less useful (or require more time) when converting large land areas. Producers should also consider the time of seeding to minimize leaf fall effects on young seedlings. (e.g., on sites with stands of oaks or other trees with heavy leaves, seeding after leaf drop could be advantageous to avoid smothering emerging seedlings provided that adequate seed-soil contact is maintained. In all cases, creating a sound forage stand is essential both to the grazing system and to ensure future erosion risks are minimized.

Figure 5. Mulching is a good way to clean up a site quickly and with minimum disturbance (as compared with bulldozing), but the benefits must be weighed against generally greater expense. (Photos by John Fike.)

Figure 6. Mulching and burning (including an old homestead, bottom) were needed to clean up this demonstration site. "Leave" trees were first marked before thinning operations, and the residual materials were mulched or piled and burned. In this instance, the large piles of residuals represented a cost to pile up and burn, and some of its nutrients were lost; in some cases, the fire also was too close to trees and caused damage to the tree stand. A preharvest mulching that removed the invasive understory could have facilitated harvest and reduced the residual cleanup, while the chips would have protected soils during harvest operations. (Photos by Adam Downing.)

Figure 7. Fire can be an effective tool for residue removal, which is important for preparing soil seeding. (Photo courtesy of Chris Fields-Johnson, The Davey Institute.)

Soil Fertility

Soil sampling is a critical first step in understanding forage production potential and input needs for silvopasture created in woodlots or forest stands. Many forest soils have low pH and fertility. Achieving adequate pH and nutrient levels (primarily phosphorus and potassium) suitable for good forage production might be difficult logistically, economically, or both. When such amendments are needed, low-cost organic nutrient sources such as biosolids or poultry litter are likely to be among the most cost-effective options if the site can accommodate spreading equipment. If available, applying lime-stabilized biosolids is an effective way to increase soil pH while also supplying phosphorus and nitrogen to the soil. If waste wood remains after thinning, this can be burned and the residual ash spread on-site because the ashes can be a useful source of potassium and other minerals.

Forage Species and Grazing Management

Several forage species can be effectively established and managed in silvopastures. Most cool-season forage grasses are reasonably shade-tolerant, and orchardgrass, as the name implies, is one of the best. In southern pine silvopastures, both introduced (e.g., bahiagrass and bermudagrass) and native grasses (such as switchgrass, Indiangrass, and bluestems) are considered suitable species, but more light (greater thinning) may be needed to sustain these grasses. Legumes are generally less-tolerant of shaded environments than grasses. However, there is a broad range in adaptation among grass and legume species and varieties, although there has been little effort to compare and select for shade tolerance in forages. The pattern of forest thinning can further play a role in the suitability of forages for the site and their ease of management in grazing systems (fig 8).

Figure 8. Loblolly pines in the photo on the left were thinned across the whole stand. Strips of trees were cleared to leave wide alleys in the photo on the right. These approaches have different requirements for thinning, cleaning up the forest floor, preparing the seedbed, and subsequent animal management. Cool season forages such as fescue and orchardgrass can work well in either of these scenarios, as shown here. For growing warm-season forages, alleys are likely a better environment given the greater heat and and light intensity. (Left photo, courtesy of Greg Frey, U.S. Forest Service; right photo, courtesy of Miller Adams, Virginia Department of Forestry.)

Whatever the forage, rotational grazing management is essential for silvopastures. The greater the amount of shading, the longer the rest period needed for forage plants to recover. Similarly, less intense grazing than is typical for open pastures can help maintain stands growing in deeper shade (fig 9). That is, in these more light-limited environments, forages should not be grazed as close to the ground as would be acceptable in open pastures. This will also help protect trees from potential damage associated with compaction and nutrient loading, as often happens when livestock have unmanaged access to forests and wood lots.

Figure 9. Rotational grazing is an important part of silvopasture management. It is essential to manage the frequency and intensity of grazing, both to help protect and maintain the forage base and the tree stand. In heavily shaded silvopastures, grasses might grow more slowly due to lower light levels. In such cases, having animals graze when pastures are taller and have more leaf area or removing animals from pastures sooner (i.e., with more postgraze residual leaf area) or simply grazing less frequently than is typical in open pastures will be facilitated by rotational grazing. (Photo courtesy of Brett Chedzoy, Cornell University Extension.)

The Take Home

Silvopastures have great potential for improving economic, environmental, and animal welfare outcomes, but their appropriate use will require long-term commitment and a willingness to manage complexity. This is a different paradigm for many who have been trained that livestock and forests cannot be managed together. However, a growing cohort of producers and resource professionals see the potential benefits of these systems. Those producers who are well-positioned to intentionally and intensively manage their unique forest, forage, and livestock resources will be best able to implement silvopastures, but given the complexity and skill sets required, it is highly advisable that producers develop a team of professionals to implement these systems.

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