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**A Framework for Successful Planning and Implementation of Silvopasture Projects**

*The Silvopastoralist's Quiz…*

I am willing and able to:

- Intensively manage both *livestock* and *timber* on my property in a way that is not detrimental to either resource over the long-term?
- Accept significant and continual visual changes in my woods and pastures?
- Invest in sufficient grazing infrastructure to allow full rest and recovery of each silvopasture paddock?
- Adapt management to changing conditions in plant composition (overstory and understory), site carrying capacity for different numbers and types of livestock, weather, and other dynamic factors?

These are just a few of the questions that require an unequivocal "YES" response to move forward with silvopasturing as a management system on your land, or the land that you manage for others.

Mistakes in agriculture can often be corrected quickly: a reseeded field; a herd liquidation; or the sale of a piece of equipment that didn't meet expectations. Mistakes in forest ecosystems, by comparison, can take many decades to correct. Also, a future desired condition might require action(s) now in a particular sequence. Therefore, it is important to carefully consider all aspects of a silvopasture project ***before*** initiation to avoid mistakes that are both costly and enduring.

The following list of questions can be used to help initially gather data to be used in the planning process. This is not meant to be an exhaustive list of all considerations that one should take into account, and responding to the questions may require detailed thought and diligence.

1. **Why?** Describe the purpose or goals of the proposed silvopasture project

2. **Where?** Describe the location, physical boundaries and why this site was chosen. Include a detailed drawing that shows size, shape, adjacent stands, access, water sources, gates, hazards, etc.

3. **What?** Describe the proposed actions and desired end conditions

4. **When?** Schedule when work will commence and be completed for major project phases.

5. **Who?** List activities to be done in-house and those that will be contracted. Do you have the time and ability to perform the tasks listed as in-house and what is the opportunity cost?

6. **Will it pay?** Prepare a budget for the project and compare to the estimated benefits. Know what it will cost going into the project to do things right, and make sure that it is a sound investment.

7. **What did I forget?** List potential pitfalls and contingency plans. Are the assumptions realistic?

## Creating Quality Silvopastures in Forested Areas

Silvopastures are only as good as the ***quality*** and ***quantity*** of food that is available for livestock. Consequently, dense forest stands with barren understories do not make quality silvopastures! There are three keys to establishing quality food (primarily forages and browse) in silvopastures:

1. ***Reduce stand density to allow adequate sunlight*** *(i.e. solar energy) to reach the ground level (practice = Thinning; science = Silviculture)*

2. ***Meet the germination requirements of the desired forage species*** *(practice = Forage Establishment; science = Agronomy)*

3. ***Manage the trees, forage and livestock to encourage the growth of desirable vegetation once established*** *(practice = Management Intensive Grazing; science = Forage and Animal Sciences)*

## Key Number 1 – Reducing Stand Density

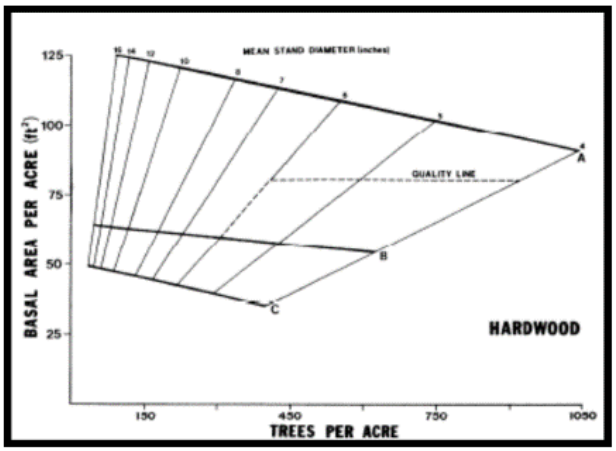
There are two thinning methods that silvopasture practitioners can utilize in even-aged stand to enhance the value of their best timber and increase solar energy at the ground level to grow quality forages: “Crop Tree Management” (CTM) and “Basal Area Thinning” (BAT). “Even-aged” implies that most trees in the stand are approximately the same age, despite a possible wide range of diameters. This is typical of second-growth forests on former agricultural land. Most forests in the Northeast are second-growth, even-aged forests.

CTM was developed and introduced by the US Forest Service in the early 1980’s as a method of promoting the growth and vigor of the “best” individual trees. The “best” trees are those available and that contribute to the management objectives. CTM recommends that trees are culled when

they directly compete with the crowns of the best 50 – 75 upper canopy trees per acre. Lower canopy trees that do not directly compete with the crowns of Crop Trees can be retained to save time and thinning expenses since their removal does not (significantly) benefit Crop Trees. The concept is similar to a gardener with limited time only weeding around the tomato plants, while leaving weeds in between rows that do not directly compete with the tomatoes. CTM requires the manager to identify the "best" trees in the stand, and then release their crows on at least 2 or 3 sides (quadrants). However, all non-Crop Trees in silvopastures are intercepting valuable sunlight from reaching the ground. *Therefore, thinning in silvopastures should consider trees and shrubs in every strata and location - even if they do not directly compete with the growth of Crop Trees in the upper canopy.* Some lower strata trees and shrubs may be retained for other purposes, but most should be removed to maximize sunlight levels at the ground when CTM is applied to silvopastures.

Basal Area Thinning, by contrast, focuses on reducing overall competition in the stand by reducing stocking. One measurement used to measure forest stocking (~ density) is "basal area". BA is the surface area of all tree stems per acre at "diameter breast height" (4.5' above ground) and is an easy-to-measure indicator but less accurate indicator of the "porosity" of the stand. For best results in silvopasture thinnings, the stand should be "thinned from below" until the desired residual stocking (BA) is reached. These lower, sub-canopy trees in even-aged stands generally have less potential to grow and appreciate in value, and have a more significant shading effect on the ground per unit of basal area. Simple instruments used to measure BA are the angle gauge and prism.

Although relatively little research has been done to date to evaluate forage growth under different forest stocking levels in northeastern silvopastures, studies at the Center for Agroforesty at the University of Missouri and the Ag Research Service Station in Beaver, WV suggest that acceptable growth of a number of cool season grasses and forbs will occur at around 60 sq. ft./acre of basal area. This stocking level coincides approximately with the "B-line" of a stocking chart for northern hardwoods.




Stocking chart for northern hardwoods is based on trees in the main crown canopy. The A line is average maximum stocking. <u>The B line is recommended minimum stocking for adequate growth response per acre.</u> The C line defines the point at which the stand become understocked (until new trees become part of the stand). The quality line defines the stocking measure in young stands for maintaining quality stem development

Since both forage and timber production are primary objectives in silvopastures, more frequent thinning will be necessary to maintain stocking at around the B-line. Allowing stocking to significantly surpass the B-line may still be acceptable for good tree growth, but be detrimental for forages as the tree crowns quickly close after thinning and reduce sunlight at the ground level. Thinning below the B-line may increase forage production (depending on sward composition and management) but decrease timber production on a per acre basis. It is currently believed that maintaining stocking levels in silvopastures at around the B-line through lighter and more frequent thinnings will optimize combined timber and forage production. Plan for future harvests to balance operability (sufficient volume and value for a commercial timber harvest) and sustained forage development.

***Methods for estimating sunlight penetration to the ground surface:***

Stocking, expressed as basal area per acre, is a readily measurable stand characteristic that provides managers an indication of stand "porosity" for sunlight penetration to the ground surface. Actual porosity, however, can vary greatly at a given stocking level across stand types. For example, a stand composed of shade-tolerant, deep-crowned, dense-foliage species like hemlock, sugar maple and beech will be less porous than a stand of shade-intolerant species at the same stocking level. Therefore, Relative Density – a measure of tree crowding compared to a reference level – is a better indicator of stand porosity since it considers the density contributions of individual trees. Relative Density is calculated from tree diameters and species, so it is arduous to determine in the field while making tree removal decisions. Relative Density is also calculated using average contributions per tree, which may not reflect the actual conditions and contributions.

An alternative approach to estimating sunlight penetration is "canopy openness". A traditional tool for measuring canopy openness is the spherical densiometer, a mirror (convex or concave) that reflects an image of the forest canopy above it onto a grid etched in the mirror that allows the observer to estimate canopy openness (or closure) immediately in the field. However, good daylight conditions and the presence of summer canopy foliage are necessary for accurate estimates, as well as an unobstructed view of the upper forest canopy. This approach can help determining pre- and post-harvest stand porosity, but is impractical for gauging adequate stocking or density reduction during marking operations. ForestConnect webinars on the history and application of relative density are available at www.youtube.com/ForestConnect (Dr. Stout on June 21, 2023 and Dr. Nyland on November 15, 2023).

Terrestrial LiDAR systems (TLS) are new technology that will enable rapid and accurate assessment of stand biomass density and expected sunlight penetration to make real time management decisions in the field. For some of the latest advances with TLS for this application, visit Cornell's Xu Lab page: http://xiangtaoxu.eeb.cornell.edu

***Thinning tips:***

- Lighter and more frequent thinnings are preferable when operationally feasible to reduce the risk of epicormic branching, thinning shock, windthrow and other negative response.

- Mark trees ahead of time – not when walking through the woods with a chainsaw. Retain trees that are: desirable species; good quality; well-spaced; healthy; and, fast-growing (larger diameter).
- Use directional felling techniques to safely get trees on the ground, minimize damage to residual trees and increase productivity.
- Girdling vs. felling will increase productivity and "stockpile" dead standing trees that can later be salvaged for firewood (but extreme care should be taken when cutting dead standing trees!)
- Heavy-duty mowing machines or mist-blown herbicide treatments may be cost-effective to remove invasive shrub species and dense, small-diameter brush and trees.

***Caveats:***

- Timber harvesting is physically-demanding and time-consuming work that requires skill and adherence to technique for safe and efficient execution. Silvopasture creation at significant scales will best be accomplished through commercial timber harvests executed by professional logging contractors and overseen by foresters.
- Slash (logging debris) and woody understory vegetation removal are crucial for ensuing forage establishment and management and should be integrated into the commercial timber harvest operation to the extent possible.

**Key Number 2 – Meet Germination Requirements**

Woods that are adjacent to fields and pastures will normally have sufficient seed banks of forbs and grasses to provide adequate volunteer forage establishment once sufficient sunlight reaches the ground level. However, in areas where there may be an insufficient seed bank - or where it may be desirable to augment with commercial forage mixes - care should be taken to use species and varieties that have reputed tolerance to modest shade. Seed germination and establishment will also depend on numerous factors such as: soil contact, soil moisture, seed quality, soil pH and fertility, pests, sunlight levels, temperature, and disturbances such as grazing during vulnerable stages of early growth. Scarification of the duff layer may be necessary to achieve acceptable germination.

The conditions that establish forage species will also allow invasive shrubs species to establish or expand. Be alert to even low abundance of these species. Identify animal-based, chemical or mechanical tactics that prevent their dominance.

**Key Number 3 – Manage the System to Encourage the Growth of Desirable Vegetation**

Silvopastures should be managed with "Management Intensive Grazing" (MIG) principles. Longer than normal rest periods may be needed to allow plants in the understory to fully recover since they are generally growing in lower sunlight levels. Woody plants are generally more sensitive to the

timing, frequency and intensity (level of defoliation) of grazing than grasses and forbs, so care should be used if preserving woody plants in the understory is a goal.

Silvopastures should be developed at a rate that is synchronized with herd growth to avoid thinning a site and then having it become overgrown with undesirable vegetation due to insufficient grazing pressure.

**Living Fence Posts**

Treated posts cost about $10/post and upwards of twice that amount after handling and installation costs are included. Furthermore, installation on rugged terrain and in shallow soils can prove challenging.

Low quality trees growing around the perimeter of pasture areas offer an effective, economical and environmentally-friendly alternative to pressure treated posts. Identify and mark potential post trees before beginning any cutting or spraying. The following characteristics can be used to help identify suitable living post trees:

- At least 2" in diameter (greater, if under side strain)
- Low economic value (present and future)
- Likely to live at least 10, and preferably 20+ years
- Properly positioned and spaced along desired fence route

Wire that requires tensioning should never be fastened directly to live trees since tree growth will eventually crimp the wire at the point of attachment. To prevent this, a durable batten should first be attached to the tree with two heavy gauge, rust-resistant nails. Use fender washers between the nail head and batten as shown in the adjacent image to allow batten to be pushed outward as the tree grows. Wires can then be attached to the batten, using insulators if needed for electrified fences.

**Living Barns**

Coniferous silvopastures can also be created and managed for the dual purpose of protecting cold-tolerant livestock from extreme winter weather. For examples, visit: https://onpasture.com/2015/03/02/living-barns