

Silvopasture

Wisconsin Guidance Document 381



DEFINITION

Silvopasture is the intentionally planned combination of trees/shrubs, forage, and livestock in an integrated system. Ideally, establishment of trees in a pasture provides shade and/or wind protection for livestock, and better growing conditions for carefully selected forage species. The livestock graze the forage and reduce competition between forage and trees for water and nutrients, improving tree growth and cycling nutrients. As the trees mature, they must be managed through thinning and/or pruning to maintain proper light conditions for forage species. The livestock provides annual income while the trees/shrubs provide annual or periodic future income.

PURPOSE

- Provide forage, shade, and/or shelter for livestock
- Improve the productivity and health of trees/shrubs and forages
- Improve water quality
- Reduce erosion
- Enhance wildlife habitat
- Improve biological diversity
- Improve soil quality
- Increase carbon sequestration and storage
- Provide for beneficial organisms and pollinators

WHERE USED

At this time silvopasture is allowed in existing pastures or cropland where a landowner would like to establish tree cover. It is not being considered for use in existing woodlands.

RESOURCE MANAGEMENT SYSTEM

Silvopasture must be integrated in a NRCS-approved grazing plan (NRCS offers cost-share on grazing plans). The grazing plan must include silvopasture considerations such as configuration and placement of trees and potential fence placement for tree protection during establishment. It should also include considerations for proper forage species in a setting with partial sunlight. If planting of forage is necessary, this should be accomplished prior to tree planting. The plan may also need to address exclusion of livestock during the tree establishment period if protection measures are not planned. Other grazing practices that may be used with silvopasture include 512-Pasture and Hay Planting and 528-Prescribed Grazing. Forest management practices may include 660-Tree Pruning. Other resource concerns (e.g., gully erosion or non-native invasive plants) also need to be addressed during the planning process.

WILDLIFE

Silvopasture can be used to approximate savanna habitat conditions. Species that benefit from this habitat include turkey, quail, and several migratory songbird species. Savanna habitats are much rarer now compared to before European settlement.

PLANNING CONSIDERATIONS

See 612-Tree/Shrub Establishment for general tree planting guidance documents. See 512-Pasture and Hay Planting for standards and guidance for forage planting. What follows is guidance specific to Silvopasture tree plantings, including agroforestry considerations.

Forage Establishment: It is important to establish forages that are suitable for partial shade, site soil and weather conditions, and desired livestock. If adequate forage is not available, there can be excessive damage to trees by hungry livestock.

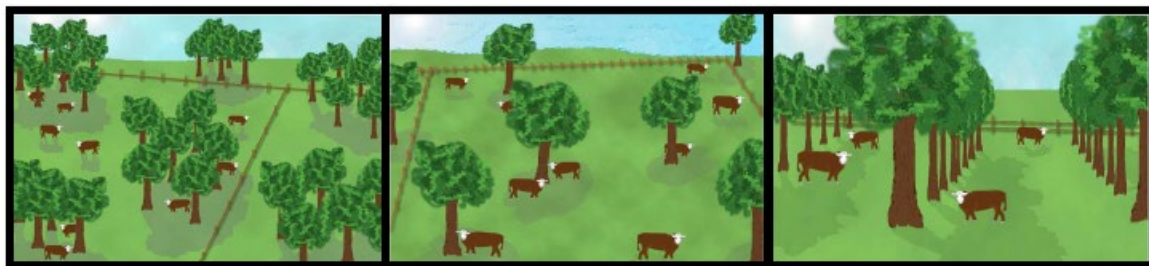
Each forage species has a different growth period and responds differently to grazing pressure. Forage mix should be planned carefully to account for these factors. Desirable forages in a silvopasture system will be shade tolerant (typically cool-season forage) with heading dates that match grazing schedules and have a legume component. The forages should be persistent over time and respond well to grazing. If new forage species need to be established in a pasture, it is important to do this before trees are established. The site will be easier to prepare and seed without needing to work around trees and avoids potential damage to tree roots. Control non-native invasive plants as part of site preparation. Forages should then be established in a similar manner to typical pasture establishment. Note that many tree species do not respond well to fertilization, so consider effects to trees if fertilization is planned.

Tree/Shrub Establishment: The process of tree establishment begins with planning the configuration of trees, tree species to plant, and number and stock size of each species. This planning should begin well before the planned planting date, as it is best to order seedlings in the fall of the year prior to planting. Common configurations include rows, groups/clusters, or blocks.

Group/cluster planting

Block/Single tree planting

Row planting



Important factors for each configuration include adequate space for equipment to travel, enough light for forage (at least 50% sunlight for cool season species, up to 75% sunlight for native prairie species), and purpose of tree plantings (e.g., bole quality for timber, light considerations for fruit/nut production). Rows are common configurations and can be established as single-row, double-row, or multiple-row plantings. In a single-row planting trees are typically spaced 8 to 12' apart within the row, with 20-50' between rows (alley width). This configuration can be useful to allow crown expansion for good

production from nut trees. Double-row configurations have 8-12' spacing both between trees within the row and between the two rows of the set (trees should be staggered in each row so that they are not growing directly next to each other), with 20-50' between row sets (alley width). This configuration allows for a greater number of trees to be planted, providing more shade and wind relief. The multiple-row configuration is like double-row except it has three or more rows within a set. This configuration can be used to encourage timber quality, with the outside rows (typically pine species) "training" the middle row(s) to grow upward and self-prune lower branches. Group/cluster planting allows the shade effects from the trees to be more concentrated, resulting in a mosaic of openings for forage production. Trees may also be more easily protected during establishment with this method if fencing is used. Block plantings are low levels of trees evenly distributed throughout the site. This configuration allows for an even distribution of shade and forage.

If using a row configuration, orientation of the rows should be determined by objectives. If mid-summer heat stress is a concern, rows should be oriented to provide shade from the southwest (NW-SE row layout). If winter wind is the concern rows should be oriented to block north and west winds (NE-SW row layout)

Planting rates are typically from 100 to 400 trees per acre, as calculated using the acreage of the entire pasture area to be planted. Plantings may be as low as 30 trees per acre (10% of stocking level of a wildlife planting). Lower density plantings can maximize tree growth and forage production and reduce the need for early non-commercial thinning; if timber production is a goal trees at low density will require pruning to develop timber quality. Planting rate should be adjusted based on estimated mortality and desired final tree stocking level. Below is a table from the USDA National Agroforestry Center showing planting rates for row configuration plantings.

Alley Width	Single-Row Set			Double-Row Set			Triple-Row Set					
	Row Spacing	Tree-to-tree-in-row spac-			Row Spacing	Tree-to-tree-in-row spac-			Row Spacing	Tree-to-tree-in-row spac-		
		6 foot	8 foot	10 foot		6 foot	8 foot	10 foot		6 foot	8 foot	10 foot
15 feet	Row spacing	6 foot	363	290	6 foot	691	518	414	6 foot	807	607	484
		8 foot			8 foot	631	473	378	8 foot	703	528	422
		10 foot			10 foot	580	435	348	10 foot	622	468	374
		12 foot			12 foot	537	403	322	12 foot	558	418	335
20 feet	and alley width are	6 foot	272	218	6 foot	558	418	335	6 foot	680	512	409
		8 foot			8 foot	518	388	311	8 foot	605	455	363
		10 foot			10 foot	484	363	290	10 foot	545	409	327
		12 foot			12 foot	454	340	272	12 foot	495	372	297
30 feet	the same for single-	6 foot	182	145	6 foot	403	303	242	6 foot	512	390	311
		8 foot			8 foot	382	287	229	8 foot	473	356	284
		10 foot			10 foot	363	272	218	10 foot	435	328	262
		12 foot			12 foot	345	259	207	12 foot	403	303	242
40 feet	row sets.	6 foot	136	109	6 foot	315	237	189	6 foot	419	315	252
		8 foot			8 foot	303	227	182	8 foot	389	292	234
		10 foot			10 foot	290	218	174	10 foot	363	273	218
		12 foot			12 foot	279	209	167	12 foot	340	256	204

Bold figures are outside of recommended planting rates for silvopasture
 *Field shape and planting design may cause some variation in trees-per-acre.

It is important to match the tree/shrub species to site conditions and landowner objectives. Some objectives may include shade and wind relief, timber production, fruit/nut production, and forage. Tree species suitable for shade and wind relief depend on the seasonality of pasture use. If wind relief is needed outside of the growing season, conifer trees are most appropriate. Pine species should be favored in this case, as spruce and fir species are shallow-rooted and more likely to be damaged by livestock. Within the growing season, light penetration to forage species is important. Generally, shade intolerant (e.g., aspen, paper birch, black walnut) or mid-tolerant (e.g., most oaks, most hickories, most pines) tree species have less dense crowns and allow more light to the ground. Shade-tolerant species (e.g., sugar maple) generally have dense crowns and cast more shade. Tree species capable of producing valuable sawtimber include black walnut, northern red oak, white oak, sugar maple, red pine, and white pine. Tree/shrub species suitable for nut/fruit production can be found in the Agroforestry Species List on the Wisconsin Field Office Technical Guide (Section III>Planning Tools>Forestry). Tree species that may provide forage opportunities include aspen (leaves), honeylocust (seed pods), and oak/hickory/walnut (nuts/acorns). It is important to note that black walnut produces a chemical called juglone that can affect some forage species. If black walnut is to be planted ensure that forage is not affected by the juglone chemical.

Planning will also need to be done to determine size of the tree stock available. Larger tree stock will result in faster establishment.

The implementation of tree establishment begins with good site preparation. Tree seedlings do not compete well with grass competition. Tillage or herbicides will eliminate this competition from planting areas. Tillage should be 2 to 4' wide for each row of trees. Existing pastures with compacted soil should also be sub-soiled to allow tree roots to establish further into the soil. Otherwise, tree roots will spread shallowly when dealing with compacted soil, making the trees more vulnerable to being blown over by wind and subjected to increased competition with grass roots. When working on slopes that are 6% or steeper, do site preparation on the contour to minimize soil erosion. The photo below shows good site preparation for a row planting of trees.



Degraded pasture land (Photo: NAC)

The 612 Tree/Shrub Establishment-Planting Guide guidance document has a timeline for nurseery plantings and should be consulted for implementing the planting. Important considerations will be either protecting the trees from livestock or excluding livestock from the area while trees are establishing. This generally takes five years for the leader to grow above browse height and may take longer for boles to be strong enough to resist physical damage (e.g., from use as livestock scratching post). Trampling and rubbing by livestock is the most common reason for tree death in silvopasture

systems. Trees are especially susceptible to bark damage in the spring as the sap begins to run and rapid growth occurs. Type of livestock needs to be considered when choosing protection methods. Larger livestock will require sturdier protection measures or electric fencing.

Deer or rabbit browse will also be important considerations. Generally, wire cages with at least three supporting T-posts or rebar will be best for individual tree protection. For protection over an entire area, electric fence capable of excluding livestock may be sufficient unless deer populations are high. In this case mesh or wire fencing would be better, or a combination of individual tree protection and electric fencing. If shrubs are planted and are not for forage purposes, long-term protection may be needed depending on palatability to livestock. The 612 Tree/Shrub Establishment-Protection guidance document has more information on protection measures for deer and rabbits.

If livestock are excluded from the area while trees establish, the forage may be hayed, taking care not to damage tree seedlings with haying equipment. This can also reduce habitat for rodents that may cause tree damage.

Post-planting competition control is also important, especially with grass competition. Tree seedling's roots do not compete well with grass roots until the trees are established and can find space below the grass rooting zone. Grass competition should be controlled for the first three to five years following planting, in a 3' circle or 3'x3' square around each tree. The 612 Tree/Shrub Establishment-Planting Guide guidance document has more information on methods for competition control.

Tree Management: As trees grow and mature, they will cast more shade on the ground, impacting forage quality. Trees should be periodically thinned to maintain at least 50% light levels on the ground for cool season species and up to 75% light on the ground for warm season native prairie plants. Tree pruning will also increase the amount of light on the ground and can be used to improve tree quality for timber production objectives. A forester should be consulted to plan and oversee implementation of these practices.

Livestock/Grazing Considerations: As with any sustainable grazing system, it is important to prevent overgrazing and soil compaction in the silvopasture system. This is done by setting up a system of paddocks to rotate livestock between different areas. Fencing, gates, and watering are important considerations for paddock configuration. Grazing plans and Prescribed Grazing (528) practices should be used to plan paddocks in detail. Continuous grazing during the entire growing season in silvopasture is not recommended.

It is recommended that grazing period in any one paddock should be less than 3 days. Cool season forages should not be grazed shorter than 3 inches in height and should be at least 6 inches in height at the end of the growing season. Warm season grasses should not be grazed shorter than 8 inches in height and should be at least 10 inches in height at the end of the growing season. Regrowth periods may range from 20 to 45 days depending on forage species, site conditions, and weather conditions. Forage species are affected differently by grazing. The table below from University of Minnesota Extension shows recommended grazing rotation for some common cool season species.

Recommended Grazing Height and Recovery Periods			
Forage Height	Target Height (Inches)		Usual Days Rest for Recovery of Leaf Area
	Begin Grazing	End Grazing	
Alfalfa	10-16	3-4	15-30
Clover, white and sub	6-8	3-4	7-15
Tall Fescue	4-8	3-4	15-30
Orchardgrass	8-12	3-4	15-30
Ryegrass	6-12	3-4	7-15
Small grains	8-12	3-4	7-15

REFERENCES

- Robinson, J.L. and T. Clason. 2000. *From a pasture to a silvopasture system*. USDA National Agroforestry Center. AF Note-22. <https://www.fs.usda.gov/nac/assets/documents/agroforestrynotes/an22s04.pdf>. Accessed May 2021.
- USDA National Agroforestry Center. 2008. *Silvopasture: An agroforestry practice*. <https://www.fs.usda.gov/nac/assets/documents/workingtrees/brochures/wts.pdf>. Accessed May 2021.
- University of Missouri Agroforestry Center. 2018. *Training manual for applied agroforestry practices*. Gold, M., Hemmelgarn, H., Ormsby-Mori, G., and Todd, C., Eds. <https://centerforagroforestry.org/landowners/resources/training-manual-for-applied-agroforestry-practices/>. Accessed May 2021.
- Zamora, D.; Wyatt, G.; Buttler, M.; Ford, M.; Magner, J.; Reichenbach, M.; Burkett, E.; Current, D.; Walter, D. (2017). *Silvopasture: Establishment and Management Principles for Minnesota*. Retrieved from the University of Minnesota Digital Conservancy, <https://hdl.handle.net/11299/214976>. Accessed May 2021.

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