

TREE SELECTION GUIDE FOR MID-ATLANTIC SILVOPASTURES

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## GENERAL AUDIENCE ABSTRACT

Silvopasture is a farming practice that intentionally combines trees, forages, and livestock grazing for the purpose of increasing overall productivity. Although silvopasture in the United States has historically been concentrated in the southeast, it holds great promise in the Mid-Atlantic region as well. However, lack of research and information specific to silvopasture in this region, has kept adoption rates low.

An important management decision for silvopasture establishment is tree selection. However, no comprehensive list or selection guide has been developed for silvopastures in the Mid-Atlantic region specifically. This project seeks to fill that void.

To create our guide, we used a variety of horticulture- and forestry-based information sources to research trees native to the Mid-Atlantic region. For each tree, we collected information relevant to silvopasture establishment, and used this information to select a diverse group of 20 trees that are highly suitable and productive for silvopastures in the Mid-Atlantic based on crown characteristics, rooting patterns, and growth rate. This information is presented in a quick-reference chart entitled a *Tree Selection Guide for Mid-Atlantic Silvopastures*. It includes a brief description of how to use the chart as well as guidance on source and availability of plant material.

## ACADEMIC ABSTRACT

Silvopasture is a farming practice that intentionally combines trees, forages, and livestock grazing for the purpose of increasing overall productivity. Although silvopasture in the United States has historically been concentrated in the southeast, it holds great promise in the Mid-Atlantic region as well. However, lack of research specific to silvopasture in this region, has kept adoption rates low. Landowners interested in silvopasture need information to encourage adoption and make sound establishment and management decisions.

An important management decision for silvopasture establishment is tree selection. First-time adopters (and technical service providers) need resources and information to help them choose the most suitable and most productive species for their site and operation goals. Plant and tree selection tools are widely available for horticulture applications. However, few exist for agroforestry-based systems, and no comprehensive list or selection guide has been developed for silvopasture establishment in the Mid-Atlantic region specifically. This project seeks to fill that void.

To begin this project, I used a variety of horticulture- and forestry-based information sources to research trees native to the Mid-Atlantic region. For each tree, I collected information identified as having the greatest relevance to silvopasture establishment including site preferences (pH, soil moisture, and hardiness zone), ability to tolerate site and weather extremes (heat/drought, flood, shade, and wind/ice), physical characteristics (crown features, root structure, growth rate, and mature height), potential utility (markets, fodder and coppice potential, rate of CO<sub>2</sub> sequestration, and other benefits), and maintenance needs (pest/disease issues). From this body of information, we selected a diverse group of 20 trees that are highly

suitable and productive for silvopasture in this region based on crown characteristics, rooting patterns, and growth rate; while offering Mid-Atlantic producers a range of choices for various site conditions and operation goals. This information is presented in a quick-reference chart entitled a *Tree Selection Guide for Mid-Atlantic Silvopastures*, which can be used in the field or office by landowners and technical service professionals. It includes a brief description of how to use the chart as well as guidance on source and availability of plant material.

Our hope is that this list of 20 trees will be expanded over time to include more species and perhaps become available as an online or phone-based selection tool.

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Thank you to the Virginia Tech Graduate School for selecting me for the George E. and Hester B. Aker Fellowship, and to the Aker family for creating the fellowship to assist students in need. Without the fellowship, I may not have been financially able to finish. I will be forever grateful and honored.

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the project portion of my degree, for never taking my picture off the graduate student poster or online (even though I haven't taken a class since 2014!), and for the inclusive and supportive environment. I felt very much like an oddball coming in as a non-traditional, older student, but I was appreciated and even celebrated by the Department and the Virginia Tech community. This was truly unexpected and very much appreciated. It built my confidence and helped me believe I made the right decision to go back to school and that I belonged.

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## CHAPTER 1

### INTRODUCTION

Silvopasture is one of five agroforestry practices. It is a farming application that intentionally integrates the management of trees, forages, and grazing livestock to increase overall farm productivity (Garrett, 2009). The benefits, if implemented and managed correctly, include diversifying farm income by adding tree products, increased protection and performance of livestock, improved marketability of meats (e.g. “agroforestry-raised beef”), and a host of conservation benefits.

As a landowner, long-time producer of pasture-raised beef, and niche-market farmer I was extremely interested in exploring whether silvopasture was a good fit for my farm. To learn more, I asked Dr. John Fike if he would agree to have me as an independent study student focusing on hardwood silvopasture. As we moved through the semester, I learned a great deal about forage selection, soil nutrient management, animal nutrition, tree establishment, and other aspects specific to hardwood silvopastures.

This inspired my husband and I to apply for a Natural Resources Conservation Service (NRCS) grant to establish silvopasture on our property. When we received the grant, my questions to Dr. Fike suddenly became more specific. One of my biggest questions was, how do I determine which tree species are best for my farm? I found extensive information about what qualities make a tree good for silvopasture (Fike et al., 2017; Fike, 2015; Univ. of MO, 2015; NRCS, 2005; Nowak et al., 2002). There is also excellent information on black locust, black walnut, and a handful of other species recommended for Mid-Atlantic silvopastures (Houx et al., 2013; DeBruyne et al., 2011; Bendfeldt et al., 2001). But I wanted to explore other species

and more diverse tree-products. I had used horticulture-based tree-selection tools in the past, but I was unable to find one specific to silvopasture. I brainstormed with our local forester and NRCS technical service providers, but they too had limited silvopasture-specific tree lists from which to pull. It was clear that this was a support resource that needed to be developed. And with a lack of information about silvopasture in this region being a major hurdle to adoption, creating a tool of this type would likely help other landowners as well (Frey et al., 2016).

Dr. Fike and I decided I would produce a silvopasture tree-selection guide as my independent study project. It would include a list of recommended species and key information about each species for selecting trees suitable for silvopastures in our region. The potential, need, and importance of such a guide became obvious quickly. The project expanded and has now become my master's project. It serves not only to satisfy the requirements of my degree, but also the needs of my family farm. I am excited to have had the opportunity to develop what I hope will be a very useful tool to landowners, extension agents, and technical service providers alike.

For the remainder of this report, we define "tree selection guide" as a list of recommended species and key information for selecting among that list, trees most suited to a given site and set of landowner goals.

## CHAPTER 2

### RESOURCE REVIEW

Anthony J. D' Angelo said "Don't recreate the wheel, just realign it." In this case, what we wanted to do was create a tree selection guide – much like the guides already out there – but make it silvopasture specific.

#### HORTICULTURE-SPECIFIC TREE SELECTION TOOLS

I knew from 18 years working in the green industry, there were excellent horticulture-specific tree selection tools available to the public – printed guides, online tools, and possibly even phone apps. These were the tools I wanted to use as the framework for our silvopasture tree selection guide. I did a search in 2014 and again in 2018, here is what I found:

##### Printed Guides (examples):

- University of Delaware, Cooperative Extension – Tree Selection Guide (See Figure 2.1)  
<http://udextension.s3.amazonaws.com/factsheet/wp-content/uploads/2012/06/TreesForDEChart.pdf>
- Casey Trees – Urban Tree Selection Guide  
<https://caseytrees.org/resources-list/urban-tree-selection-guide/>
- South Carolina Forestry Commission – Tree Selection Guide for South Carolina  
<https://www.state.sc.us/forest/refsel.htm>
- Ferguson Forest Centre, Forest Gene Conservation Association, and the Eastern Ontario Model Forest – Choosing the Right Tree: A Landowner's Guide to Putting Down Roots  
[http://www.northgrenville.ca/files/Choosing\\_the\\_Right\\_Tree.pdf](http://www.northgrenville.ca/files/Choosing_the_Right_Tree.pdf)

- Virginia Cooperative Extension – Selecting Landscape Plants: Shade Trees (Relf, 2009)

[https://pubs.ext.vt.edu/content/dam/pubs\\_ext\\_vt\\_edu/426/426-610/426-610\\_pdf.pdf](https://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/426/426-610/426-610_pdf.pdf)

**Online Selection Tools (examples):**

- University of Illinois Extension – Selecting Trees for Your Home (See Figure 2.2)

<https://extension.illinois.edu/treeselector/>

- Virginia Tech - Virginia Urban Street Tree Selector

<http://dendro.cnre.vt.edu/treeselector/> or

<http://dendro.cnre.vt.edu/dendrology/treeselectorsearch.htm?>

- Cornell University – Woody Plants Database

[http://woodyplants.cals.cornell.edu/plant/index?PlantSearch\[collection\]\[\]=1](http://woodyplants.cals.cornell.edu/plant/index?PlantSearch[collection][]=1)

- Arbor Day Foundation – Best Tree Finder: Tree Wizard

<https://www.arborday.org/shopping/trees/treewizard/intro.cfm>

- The Morton Arboretum – Search Trees and Plants

<http://www.mortonarb.org/trees-plants/search-trees/search-all-trees-and-plants>

- Cal Poly State University – SelecTree

<https://selectree.calpoly.edu/search-trees-by-characteristics>

**Phone Ap Selection Tools:** none found

All of these horticulture-specific tree selection tools are well organized and user friendly. However, they focus on characteristics most important when choosing trees for urban settings. Key information needed for selecting trees most suitable for silvopastures is missing.



# TREE SELECTION GUIDE

P=Piedmont and C=Coastal plain  
 U=upland and L=lowland  
 W=wet and D=dry  
 S=salt tolerant  
 N=no and Y=yes  
 X=flowering  
 C=good fall color  
 T=tolerant

LG. DECIDUOUS TREE	Height (ft)	Width (ft)	Native	Riparian	Soil Moisture	Salt tolerant	Use under power lines	Flowering tree	Fall color	Urban conditions	USDA hardiness zones	Notes	Botanical name
Red Maple	60	40-60	PC	L	WD		N		C	T	3 to 9	dense, rounded	<i>Acer rubrum</i>
Sugar Maple	60-75	40-50	P		W		N		C		3 to 7	upright-oval to rounded	<i>Acer saccharum</i>
River Birch	70	40-60	PC	L	WD		N		C	T	4 to 9	pyramidal	<i>Betula nigra</i>
European Hornbeam	40-60	30-40			WD		Y		C	T	4 to 8	pyramidal to oval-rounded	<i>Carpinus betulus 'Fastigiata'</i>
Hackberry	75-100	75-100	PC	UL	W	S	N		C	T	3 to 7	globular	<i>Celtis occidentalis</i>
Katsura	40-60	20-30			W		N		C		4 to 8	pyramidal	<i>Cercidiphyllum japonicum</i>
Yellowwood	30-50	40-55		L	W		Y	X	C		4 to 8	globular	<i>Cladrastis kentukea</i>
Turkish Filbert	40-50	20-25			D		N		C	T	4 to 7	broad pyramidal	<i>Corylus colurna</i>
American Beech	50-70	50-70	PC				N	X	C		4 to 9	wide-spreading crown	<i>Fagus grandifolia</i>
White Ash	50-80	50-80	PC	UL	W	S	N		C		4 to 9	irregular ovoid	<i>Fraxinus americana</i>
Green Ash	60	40-50	PC	UL	WD	S	N		C	T	2 to 9	pyramidal	<i>Fraxinus pennsylvanica</i>
Maidenhair Tree	50-80	30-40			WD	S	N		C	T	4 to 9	pyramidal (use male only)	<i>Ginkgo biloba</i>
Honey Locust	30-70	30-70			WD	S	N		C	T	4 to 9	open crown	<i>Gleditsia tricanthos inermis</i>
Kentucky Coffeetree	60-76	40-50			D	S	N		C	T	3 to 9	narrow obovate crown (males only)	<i>Gymnocladus dioica</i>
Black Walnut	50-75	50-60	PC	L	WD		N		C	T	4 to 9	irregular	<i>Juglans nigra</i>
American Sweetgum	60	40	PC	UL			N		C	T	5 to 9	pyramidal	<i>Liquidambar styraciflua</i>
Tulip Tree	80	30-50	P	U			N	X	C		4 to 9	upright-oval	<i>Liriodendron tulipifera</i>
Dawn Redwood	70-100	25			W		N		C	T	5 to 8	pyramidal, conical	<i>Metasequoia glyptostroboides</i>
Black Tupelo	30-50	25-35	PC	L	WD	S	N		C	T	4 to 9	irregular (difficult to transplant)	<i>Nyssa sylvatica</i>
American Sycamore	75-100	60-80	PC	L	WD		N			T	4 to 9	globular (susceptible to anthracnose)	<i>Platanus occidentalis</i>
London Plane	70-100		PC	L		S	N		C	T	4 to 9	(not susceptible to anthracnose)	<i>Platanus x acerifolia</i>
Sargent Cherry	40-50	40-50		UL	WD	S	Y	X	C	T	4 to 8		<i>Prunus sargentii</i>
Sawtooth Oak	35-45	35-45		UL	WD	S	N		C	T	5 to 9	oval rounded	<i>Quercus acutissima</i>
White Oak	75-100	75-100	PC	U	D	S	N		C		4 to 8	wide globular	<i>Quercus alba</i>
Swamp White Oak	50-60		P	UL	WD	S	N		C	T	4 to 7	rounded	<i>Quercus bicolor</i>
Scarlet Oak	50-75	50-75	PC	U	D	S	N		C	T	5 to 7	globular	<i>Quercus coccinea</i>
Shingle Oak	30-45	30-45	P	UL	WD	S	N		C	T	5 to 8	conical	<i>Quercus imbricaria</i>
Bur Oak	70-80	70-80	PC	UL	WD		N			T	3 to 8	broad crown (difficult to transplant)	<i>Quercus macrocarpa</i>
Swamp Chestnut Oak	80-100	80-100		L	W		N		C		5 to 8	pyramidal	<i>Quercus michauxii</i>
Pin Oak	60-70	25-40	PC	UL	WD	S	N			T	4 to 8	pyramidal	<i>Quercus palustris</i>
Willow Oak	50	40	PC	UL	WD	S	N		C	T	5 to 9	oblong (transplant only in spring)	<i>Quercus phellos</i>
Chesnut Oak	60-70	60-70	P		WD		N		C	T	4 to 8	pyramidal	<i>Quercus prinus</i>
Red Oak	60-75	40-50	PC	UL	WD	S	N		C	T	4 to 8		<i>Quercus rubra</i>
Shumard Oak	40-60	40-60	PC	U	D		N		C	T	5 to 9	pyramidal to spreading	<i>Quercus shumardii</i>
Japanese Pagodatree	45-70	50		UL	WD	S	N	X		T	4 to 7	broad-rounded	<i>Sophora japonica</i>
Bald Cypress	75-100	20-30	PC	L	WD	S	N			T	4 to 11		<i>Taxodium distichum</i>
American Linden	60-80	40-60	P	UL			N		C		3 to 8	ovoid	<i>Tilia americana</i>
Littleleaf Linden	60-70	40					N	X	C	T	3 to 7	dense-pyramidal (pollution tolerant)	<i>Tilia cordata</i>
Silver Linden	50-70	30-40					N	X	C	T	4 to 7	upright-oval	<i>Tilia tomentosa</i>
Chinese (Lace-bark) Elm	40-50	35-45					N		C	T	4 to 9	rounded	<i>Ulmus parvifolia</i>
Japanese Zelkova	50-80	50-80			WD		N		C	T	4 to 8	vase-shaped	<i>Zelkova serrata</i>

Figure 2.1. Example of a Print Guide: University Delaware, Cooperative Extension Tree

Selection Guide, page 1



[About this site](#)

**Search the Site**

<b>Text search:</b>	<input type="text"/>
<b>Hardiness Zone:</b>	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10 <input type="checkbox"/> 11 <input type="checkbox"/> 12 <a href="#">[Find Your Zone]</a>
<b>Size:</b>	<input type="checkbox"/> Small <input type="checkbox"/> Medium <input type="checkbox"/> Large
<b>Soil Conditions:</b>	<input type="checkbox"/> Dry <input type="checkbox"/> Moist, Well-Drained <input type="checkbox"/> Wet
<b>Foliage Color:</b>	<input type="checkbox"/> Green <input type="checkbox"/> Purple <input type="checkbox"/> Red <input type="checkbox"/> Silver/White <input type="checkbox"/> Variegated <input type="checkbox"/> Yellow
<b>Fall Foliage Color:</b>	<input type="checkbox"/> Brown <input type="checkbox"/> Green <input type="checkbox"/> Orange <input type="checkbox"/> Purple <input type="checkbox"/> Red <input type="checkbox"/> Yellow
<b>Exposure/Light Requirements:</b>	<input type="checkbox"/> Full Shade <input type="checkbox"/> Full Sun <input type="checkbox"/> Partial Sun/Shade
<b>Uses:</b>	<input type="checkbox"/> Massing <input type="checkbox"/> Patio <input type="checkbox"/> Screen <input type="checkbox"/> Shade <input type="checkbox"/> Specimen <input type="checkbox"/> Street <input type="checkbox"/> Wind Break
<b>Tolerance:</b>	<input type="checkbox"/> Alkaline Soil <input type="checkbox"/> Dry Sites <input type="checkbox"/> Salt <input type="checkbox"/> Soil Compaction <input type="checkbox"/> Wet Sites <input type="checkbox"/> Wind
<input type="button" value="Search"/> <input type="button" value="Start Over"/>	

**Figure 2.2.** Example of an Online Tree Selector: University of Illinois Extension, Selecting Trees for your Home

## **AGROFORESTRY- AND SILVOPASTURE-SPECIFIC TREE SELECTION TOOLS**

Although the green-industry has several tree-selection resources available, much of the information relates to tree problems and performance in an urban setting. What we want to create is something silvopasture specific. In 2014 and again this fall, I did a search for tree/plant-selection guides specific to agroforestry and silvopasture. Here is what I found:

### **Printed Guides:**

#### **Agroforestry-Specific (example):**

- University of Missouri Center for Agroforestry – Training Manual for Applied Agroforestry Practices, 2015 Edition (See Figure 2.3)

[http://www.centerforagroforestry.org/pubs/training/app2\\_2015.pdf](http://www.centerforagroforestry.org/pubs/training/app2_2015.pdf)

This is the closest to a silvopasture-specific tree selection guide that I found. It includes a plant selection guide for all agroforestry-related practices combined. Relevant characteristics for each plant species are listed, along with a notation regarding the type of agroforestry practice each species can be used for. *This resource helped to frame how we developed our initial guide.*

#### **Specific to Non-Timber Forest Products (NTFPs) (examples):**

- University of Nebraska, Lincoln – Edible Wood Landscapes for People and Wildlife, 2014 (Josiah and Lackey, 2014)

[https://nfs.unl.edu/sfp3\\_EdibleWoodyLandscapes.pdf](https://nfs.unl.edu/sfp3_EdibleWoodyLandscapes.pdf)

- University of Nebraska, Lincoln – Productive Conservation: Growing Specialty Forest Products in Agroforestry Plantings, 2014 (Josiah, 2014)

[https://nfs.unl.edu/sfp2\\_ProductiveConservation.pdf](https://nfs.unl.edu/sfp2_ProductiveConservation.pdf)

These publications include woody plant selection guides specific to NTPFs. The guides include species-specific information as well as a list of cultivars to consider. *These two resources helped to frame how we developed our initial guide and are the basis for one of the proposed products of this project (See Chapter 4. Field Testing and Products).*

**Windbreak-Specific (example):**

- Trees Forever – Recommended Tree Species for Windbreaks, 2011

<http://www.treesforever.org/servlet/servlet.FileDownload?file=00P6000000MC>

YxGEAX

**Silvopasture-Specific:**

There are many articles/resources that discuss tree selection for silvopasture installation. They describe what characteristics to consider, possible tree-products, spacing, arrangement options, establishment guidelines, and other important information (Fike, 2015; Univ. of MO, 2015; NRCS, 2005; Fike et al., 2004; Nowak et al., 2002). Some include short (2-6 species) tree lists (Garrett, 2009; NRCS, 2005; Nowak et al., 2002). However, I was not able to find an extensive list of recommended species (20 or more) and their associated attributes specific to silvopasture.

**Online Selection Tools:** none found

**Phone Ap Selection Tools:** none found

Trees and Shrubs for Agroforestry Practices in Missouri									
Common Name Scientific Name	Region	Agroforestry Application	Markets	Site	Soil Moisture	Growth Rate	Height	Light Preference	Notes
<b>Trees</b>									
American basswood <i>Tilia americana</i>	1 - 8	RB, FF	HV, LV, E	B-U	M	F	75-130'	● - ●	Missouri native Sprouting habit
American holly <i>Ilex opaca</i>	1, 3 - 7	WB	NT, W	B	W-M, X	S	40-50'	●	High tolerance to flooding Missouri native
American sycamore <i>Platanus occidentalis</i>	1 - 8	RB	LV, W	B	M-W	F	100'+	○ - ●	Coppice regeneration Missouri native Disease prone
Austrian pine <i>Pinus nigra</i>	1 - 6, 8	WB	O, NT	B	M, X	F-I	70-120'	○	Diseases: biliar fungus/blight
Baldcypress <i>Taxodium distichum</i>	1 - 8	WB	O, W	B-U	W-M	S-I	100'+	○ - ●	Missouri native
Black cherry <i>Prunus serotina</i>	2, 3, 5, 7, 8	RB	LV, HV		D-M	I	80-100'	○ - ●	Missouri native
Black locust <i>Robinia pseudoacacia</i>	1 - 8	RB, AC, SP, WB	LV	U	M-D	F	40-60'	○	On MDC noxious plant list Missouri native Nitrogen fixing
Black oak <i>Quercus velutina</i>	1 - 8	AC, WB	LV, W	U	D-M	I	50-60'	●	Missouri native
Black walnut <i>Juglans nigra</i>	1 - 8	RB, AC, SP, WB	HV, LV, F	B	M	I	70-90'+	○	Very site sensitive Missouri native Allelopathic (chemical growth inhibitor)
Black willow <i>Salix nigra</i>	1 - 8	RB	LV, E, W	B	M-W	V	30-60'	○	Missouri native
Blackgum <i>Nyssa sylvatica</i>	7, 8	RB	LV	B-U	W-D, X	I	50-100'	● - ●	Missouri native
Blue spruce <i>Picea pungens</i>	1 - 6, 8	WB	O, W	U	M-W, D	I	70-100'	● - ○	Disease & insect problems
Bur oak <i>Quercus macrocarpa</i>	2 - 8	RB, AC, SP, WB	LV, HV, W	B-U	M-D, X	S	70-80'	○ - ●	Commonly used in CRP Missouri native
Cherrybark oak <i>Quercus pagoda</i>	6 - 8	AC, RB	HV, W, O	B	M, X	I-F	100'+	● - ○	Excellent market Missouri native
Chinkapin oak <i>Quercus muhlenbergii</i>	1 - 5, 7, 8	WB	LV, HV, W	U	D-M	S	60-80'	●	Lumped with white oak for sale Missouri native
Common hackberry <i>Celtis occidentalis</i>	1 - 8	RB, WB	LV, NT	B-U	W-D	S-F	100'	● - ○	Can be hard to sell Missouri native
Eastern cottonwood <i>Populus deltoides</i>	1 - 8	RB, AC, SP, WB	W, LV	B	M-D	V	80-100'	○	Missouri native
Eastern redbud <i>Cercis canadensis</i>	1 - 8	WB	W, O, NT	U	M	I	<45'	● - ○	Easily transplanted Missouri native

Region: see UMCA Region map // Agroforestry Application: AC-alley cropping, SP-silvopasture, WB-windbreak, RB-riparian forest buffer, FF-forest farming, D-to add diversity // Markets: HV-high value wood products, LV-low value wood products, NT-non-lumber forest products, F-fruit, W-wildlife food or shelter, O-ornamental or Christmas trees, E-environmental // Site: B-bottomland, U-upland // Soil Moisture: W-wet, M-moist, D-dry, X-well-drained // Growth Rate: V-very fast, F-fast, I-intermediate, S-slow // Height: maximum range in feet under optimal site conditions // Light Preference: ○-full sun, ●-partial shade/sun, ●-full shade

Figure 2.3. Example of an Agroforestry Print Resource: University of Missouri Center for Agroforestry – Training Manual for Applied Agroforestry Practices, 2015 edition, page 1 of the plant selection guide

## CHAPTER 3. DEVELOPMENT PROCESS

Developing a silvopasture-related tree selection guide involved several steps. The goal was to create a tool that both landowners and technical service professionals could use in the field or office when choosing trees for a new silvopasture operation.

### DEFINING THE SCOPE

The first step was to define what we wanted the guide to be – what states or regions it would cover, the types of trees it would include, and which type of silvopasture it would target. We also needed to decide what information about the trees we would provide. These decisions guided the research process, as well as the creation of the final product.

**Region:** We decided our guide would be specific to the Mid-Atlantic region – including Pennsylvania, New Jersey, Delaware, Maryland, West Virginia, Virginia, and North Carolina. This allows it to be widely useful, but not overwhelmingly large.

**Tree Specifications:** We chose to focus on species native to North America in general and the Mid-Atlantic specifically. Native species exhibit fewer disease and pest problems and pose a lower risk of becoming invasive over time (Hightshoe, 1988). We define tree as any woody plant over 25 feet tall at maturity that is primarily single-stemmed. Both evergreen and deciduous trees were considered.



**Figure 3.1.** Mid-Atlantic Region, map based on USDA definition with the addition of North Carolina

**Silvopasture Establishment vs. Conversion:** Our tree selection tool targets producers who are establishing a silvopasture in an existing pasture. It includes information specific to choosing which species of trees to plant vs. which species to thin or cut. No consideration was given to thinning pressure, species performance from crop-tree release, or other factors associated with silvopasture conversion.

**Initial Information Categories:** We wanted to gather information of specific interest and importance in a silvopasture operation. For each species we wanted to know:

- What are its site preferences (e.g. hardiness zone, soil moisture level, and soil pH)?
- What timber and non-timber products does it offer? What is the value of these products?
- How fast does it grow?
- How much does it compete aboveground and belowground with forages?
- Is it tolerant to site extremes like drought, heat, or flooding?
- What other benefits does it offer such as conservation, farm products, or fodder?

(Inside Agroforestry, 2018; Fike et al., 2017 and 2015; Univ. of MO, 2015; Inside Agroforestry, 2008; Nowak et al., 2002)

We grouped this information into four categories – site preferences, tolerances, physical characteristics, and utility/maintenance. We also wanted to list suggested cultivars (Nowak et al., 2002) and any special considerations. (See Chapter 4 for details on each category.)

## **SELECTING INFORMATION SOURCES**

Information sources needed to be easy to use, thorough, reputable, and current.

Because not all tree species native to the Mid-Atlantic are included in every tree manual, and

not all manuals include all of the information I was looking for, I had to consult several sources. This also allowed me to cross reference information for more reliable results. The primary resources I used include:

- *Manual of Woody Landscape Plants – Their Identification, Ornamental Characteristics, Culture, Propagation and Uses, 6<sup>th</sup> Edition* by Michael A. Dirr (2009)
- *Native Trees, Shrubs, and Vines for Urban and Rural America – A Planting Design Manual for Environmental Designers* by Gary L. Hightshoe (1988)
- Virginia Tech Dendrology Factsheets  
<http://dendro.cnre.vt.edu/dendrology/factsheets.cfm>
- USDA Natural Resources Conservation Service Plants Database – Fact Sheets and Plant Guides <https://plants.usda.gov/java/factSheet>
- USDAFS Silvics of North America – Volume 1: Conifers and Volume 2: Hardwoods  
[https://www.srs.fs.usda.gov/pubs/misc/ag\\_654/table\\_of\\_contents.htm](https://www.srs.fs.usda.gov/pubs/misc/ag_654/table_of_contents.htm)

## COLLECTING INFORMATION

My goal was to look up/consider all Mid-Atlantic native trees over 25 feet tall at maturity. In total, I researched over 100 species. I used the Virginia Tech Dendrology Factsheets Search Tool (<http://dendro.cnre.vt.edu/dendrology/factsheets.cfm>) and *Native Trees, Shrubs, and Vines for Urban and Rural America* (Hightshoe, 1988) as starting points. I searched genus by genus. If a species was native to one or more of the Mid-Atlantic states and had a mature height of 25 feet or more, I put it in one of two categories: “Not Obviously Suitable for Silvopasture” or “Possibly Suitable for Silvopasture.” If the literature indicated a species was multi-stemmed, had a poor growth form, offered few to no well-known marketable

products, and/or had a slow growth rate, I listed it in the “Not Obviously Suitable for Silvopasture” category. I noted the reason why, and my research on that species stopped there. If a species was described as having a single trunk, good growth form, one or more marketable products, and/or a reasonable growth rate, I listed it as “Possibly Suitable for Silvopasture.” I used other information sources to populate a spreadsheet with information on the physical characteristics, site preferences, tolerances, and utility and maintenance issues associated with that species.

### **CHOOSING THE FIRST 20 TREES**

Once data collection was complete, it was time to narrow things down. Over 60 species were on the “Possibly Suitable for Silvopasture” list and less than 40 species were on the “Not Obviously Suitable for Silvopasture.” The goal was to narrow the list to 20 species with physical characteristics that would result in high performance in a silvopasture operation, while offering a range of choices for various site conditions and landowner goals. (See Chapter 3 for detailed information about selection criteria.)

To begin, I looked at which trees had favorable crown and root characteristics. Species with open, narrow crowns that leaf out late in the spring and lose their leaves early in fall result in less aboveground competition for forages. Species with deep rooting patterns (e.g. taproots) result in less belowground competition for forages which root closer to the soil surface. I also focused on trees with moderate to high growth rates as these species offer optimal productivity and returns for landowners. (Fike et al., 2017; Houx et al., 2013)

In addition to silvopasture-specific suitability, our first 20 trees also had to give Mid-Atlantic producers a range of choices for various site conditions, weather extremes, and operation goals. Specifically, I worked to ensure our first 20 trees offered

- choices for producers at all hardiness zones and various soil types in the Mid-Atlantic,
- a variety of uses – both marketable and other benefits, and
- plenty of options for droughty or flood prone areas.

For now, the list includes 20 species. I also created a “wish list” of 12 more species that could/should be considered for any future expansion of the list. I will use feedback from proposed field tests (see Chapter 4) to finalize and possibly expand the list before publication.

NOTE: These lists and the resulting tree-selection tool are adaptive. The species included may change as new research and markets emerge and regional challenges evolve.

Our top 20 trees include:

Sugar Maple	<i>Acer saccharum</i>		Bur Oak	<i>Quercus macrocarpa</i>
Paw Paw	<i>Asimina triloba</i>		Pitchlob Pine	<i>Pinus rigida x taeda</i>
Hardy Pecan	<i>Carya illinoensis</i>		Eastern White Pine	<i>Pinus strobus</i>
Persimmon	<i>Diospyros virginiana</i>		Loblolly Pine	<i>Pinus taeda</i>
Thornless Honey Locust	<i>Gleditsia triacanthos</i> <i>var. inermis</i>		White Oak	<i>Quercus alba</i>
Butternut	<i>Juglans cinerea</i>		Cherrybark Oak	<i>Quercus pagoda</i>
Black Walnut	<i>Juglans nigra</i>		Northern Red Oak	<i>Quercus rubra</i>
Yellow Poplar	<i>Liriodendron tulipifera</i>		Shumard Oak	<i>Quercus shumardii</i>
Red Mulberry	<i>Morus rubra</i>		Black Locust	<i>Robinia pseudoacacia</i>
Shortleaf Pine	<i>Pinus echinata</i>		Bald cypress	<i>Taxodium distichum</i>

Our 12 runners up, the “wish list,” include:

Black Maple	<i>Acer nigrum</i>		Poplar	<i>Populus sp.</i>
Yellow Birch	<i>Betula lutea or alleghaniensis</i>		Willow Oak	<i>Quercus phellos</i>
Red Alder	<i>Alnus rubra</i>		Apple	<i>Malus sp.</i>
Paper Birch	<i>Betula papyrifera</i>		Nuttall Oak	<i>Quercus nuttallii or texana</i>
Shellbark Hickory	<i>Carya laciniosa</i>		Willow	<i>Salix sp.</i>
Chinese Chestnut	<i>Castanea mollissima</i>		Basswood	<i>Tilia americana</i>

### CHOOSING THE FINAL INFORMATION CATEGORIES

During the research phase, I collected four categories of information – site preferences, tolerances, physical characteristics, and utility/maintenance. Each category contained specific information items that we initially thought were important. To create a user-friendly tree-selection guide with the most relevant information, we needed to narrow down this list.

Fortunately, I had been using the list to make choices for my own silvopasture. I noticed the items I paid attention to most and which information seemed less important. I also made a wish list of information that I could not easily find, but that would be useful during the selection process. This process was essentially an early field test for the guide.

Our final list of information categories and items includes:

Site Preferences	Tolerances	Physical Characteristics	Utility/Maintenance
Hardiness Zone	Heat/Drought Tolerance	Crown Width	Markets
Soil pH	Flood Tolerance	Crown Density	Other Benefits
Soil Moisture	Shade Tolerance	Crown Phenology	Fodder Potential
	Wind/Ice Tolerance	Root Structure	Coppice Potential
		Growth Rate	High CO2 Sequestration
		Mature Height	Pest/Disease Issues

NOTE: Tree selection is site specific. The two most important information categories are Site Preferences and Tolerances. For any species to survive and thrive it must be planted in the appropriate location and be able to withstand the extremes of that site. Once those criteria have been determined, a species' physical characteristics and utility/maintenance features can be evaluated and weighed against landowner goals.

Information "wish list" – items we think would be useful but did not research or could not easily find in the literature:

Site Preferences	Tolerances	Physical Characteristics	Utility/Maintenance
		Leaf Litter - Amount	
		Leaf Litter – Decomposition Rate	
		Harvest Age for Timber/Fruits/Nuts*	
		Nutritional Value of Leaves, Fruits, Nuts	

*\*Harvest age information for timber was available for forest grown trees but was not readily available for open grown situations.*

## CHAPTER 4: OUR GUIDE

Using the information collected, I created an initial tree selection guide for use at a landowner workshop in Culpepper, VA in February 2018. The guide, entitled *Tree Selection Guide for Mid-Atlantic Silvopastures – Our first 20 trees*, includes the tree selection chart, a summary of each information category, and information on availability and sources for plant material. (See Appendix A)

### UNDERSTANDING THE CHART – ITS INFORMATION CATEGORIES, ITEMS, AND CODING SYSTEM

Our final guide includes the following information categories and items:

Site Preferences	Tolerances	Physical Characteristics	Utility/Maintenance
Hardiness Zone	Heat/Drought Tolerance	Crown Width	Markets
Soil pH	Flood Tolerance	Crown Density	Other Benefits
Soil Moisture	Shade Tolerance	Crown Phenology	Fodder Potential
	Wind/Ice Tolerance	Root Structure	Coppice Potential
		Growth Rate	High CO2 Sequestration
		Mature Height	Pest/Disease Issues

This information is listed in a chart with codes that describe each species' value for that item.

We also include information on suggested cultivars and any special considerations. To understand the guide, you must understand what each information item describes and what each code means.

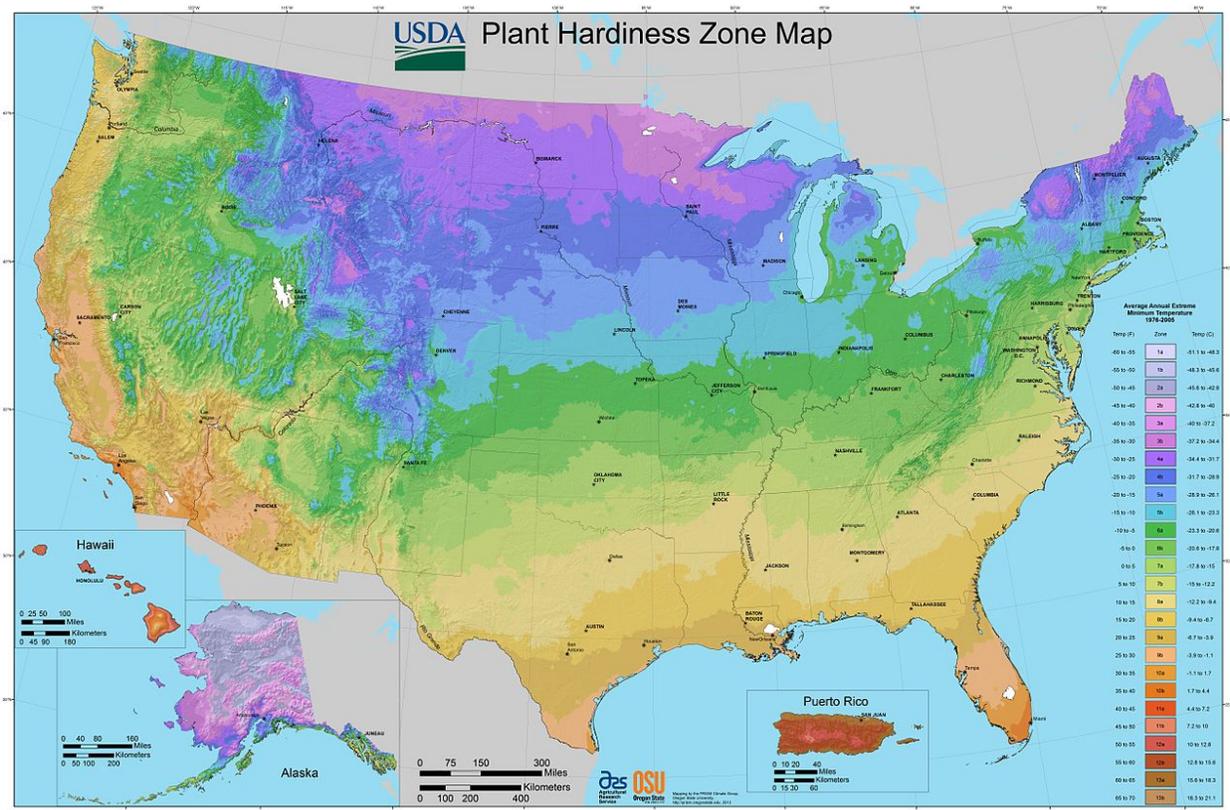
#### SITE PREFERENCES

Silvopasture producers strive to maximize productivity. They want trees that will grow as fast as possible, stay as healthy as possible, and reach their maximum size potential.

Choosing tree species well-suited to the conditions of a site is critical - “Right Tree, Right Site.”

Site preferences describe features of a location where trees will yield optimal growth and survivability. Three site preferences are included in this guide – hardiness zone, soil pH, and soil moisture.

**Hardiness Zone** - A geographical area where certain plants grow best based on the temperature extremes of that site. Knowing what zone you live in and choosing plants specific for that zone can mean the difference between success and failure of your tree crop. The USDA Plant Hardiness Map divides the country into 11 zones, with zone 1 being the coldest and zone 11 being the hottest. There is an average of 10 degrees between zones. The zones of the Mid-Atlantic Region range from 5a to 8b (see Figure 3.1). *NOTE: As the climate warms, the USDA plant hardiness zone map may change. This is an important consideration when dealing with tree crops as their life span/rotation can span two, three, or even four decades. Your zone may change while your trees mature. Plan accordingly.* (Inside Agroforestry, 2018)



**Figure 4.1.** USDA Plant Hardiness Zone Map

**Soil pH** – The pH of soil refers to how acidic or basic it is. Soil pH affects what nutrients are available to your trees as they grow. While plants can often survive in a range of pHs, they thrive and grow fastest at an optimal pH. This guide gives the optimal range for each species. Acidic soils have a pH range of 5.0-7.0. Alkaline soils have a pH of 7.0 or higher.

**Soil Moisture** – The amount of water regularly available in a soil dictates the growth and survival of most plant species. Four moisture designations are included in this guide. Designations are based on the amount of moisture held between soil particles after free water has drained away, expressed as inches of water per given depth of soil (Hightshoe, 1988). Many species are adaptable and will grow well at different moisture levels. All designations for a given species are listed.

**W** – Wet: grows well at more than 12 inches

**M** – Moist: grows well at 6-12 inches

**D** – Dry: grows well at 3-6 inches

**X** – Well-Drained: grows best when water is removed readily, but not rapidly; lingering wetness does not inhibit root growth

## **TOLERANCES**

Finding tree species that can survive site extremes is critical, especially as climate change threatens to increase the geographical range and duration of these extremes.

Four tolerance categories are included in our guide – heat/drought, flood, wind-ice, and shade. Species are designated as tolerant, moderately-tolerant, or not tolerant for each category.

### **Heat/Drought**

**T** – Tolerant: can withstand excessive heat or prolonged drought

**M** – Moderately Tolerant: moderate sensitivity/injury from excessive heat or prolonged drought

**N** – Not Tolerant: suffers early injury from excessive heat or drought

**Flood** – In this guide, tolerance to flooding conditions relates to the length of time a tree species can withstand standing water or a high water table without exhibiting injury or decline.

**T** – Tolerant: can survive flooding/high water table between 30-40% of the growing season

**M** – Moderately Tolerant: can survive occasional flooding/elevated water table between 20-30% of the growing season

**N** – Not Tolerant: exhibits decline/injury when exposed to elevated water table for more than 20% of the growing season

**Shade** – Shade tolerance is included for situations where a producer may want to plant trees near a forest edge, in the understory of an existing silvopasture (i.e. back planting to fill in gaps for rotations), or in a mixed silvopasture with trees that grow faster and taller than other species.

**T** – Tolerant: remains healthy and vigorous in deep to moderate shade

**M** – Moderately Tolerant: remains healthy and vigorous in moderate to light shade

**N** – Not Tolerant: experiences suppressed growth in any amount of shade; requires full sun for optimal growth and survival

**Wind-Ice** – While tolerance (or intolerance) to high winds and ice often go hand in hand, some species are more sensitive to ice than wind or vice versa. This guide indicates tolerance levels for wind and ice separately but in the same column.

**T** – Tolerant: branches rarely break; trees are steadfast even during strong storms

**M** – Moderately Tolerant: some branch damage; windthrow may occur during strong storms

**N** – Not Tolerant: branches break readily; tree susceptible to windthrow (being uprooting)

**A Note About Tolerances:** Within a given hardiness zone or state, it might be possible to limit tolerance designations to tolerant or not tolerant, without a “moderately-tolerant” category. However, because the Mid-Atlantic region spans seven states, covers four hardiness zones, and a range of site types, tolerances are not straightforward. For this reason, a mid-range designation is included.

## PHYSICAL CHARACTERISTICS

Physical characteristics relate to a tree's physiological suitability and overall productivity in a silvopasture system.

**Suitability:** One of the most important aspects of determining whether a tree is appropriate for use in a silvopasture operation is predicting how much it will compete with the forages that grow beneath it. Trees compete with forages aboveground in the form of shade pressure and belowground for available moisture and nutrients. The best silvopasture tree species produce the least amount of competition. (Fike et al., 2017; Houx et al., 2013)

**Productivity:** It is also important to gauge how quickly a given species grows, and how large it will become at maturity. Growth rate and mature height are critical in assessing a tree's productivity within a silvopasture system. (Fike, 2015; Garrett, 2009)

Six physical characteristics are included in this guide. Four relate to how much a tree species is likely to compete with forages – crown width, crown density, crown phenology, and root structure. Two characteristics, growth rate and mature height, relate to performance of the tree in terms of productivity within the system.

Tree species are given a score of 1, 2, or 3. Scores of 1 indicate high suitability and productivity in a silvopasture. Scores of 3 indicate low suitability. (Suitability scoring is described for each characteristic later in this chapter.)

A quick scan of a species' physical characteristic scores can tell you a lot. If it has many 1s and 2s indicate low shade pressure, low root competition, and fast growth rate. Scores of mostly 2s and 3s indicate you will need to manage forages for increased competition with canopies and/or roots and tree growth may be slow.

***A Note About Physical Characteristics*** – Less desirable physical characteristics may be offset by higher timber values, drought/food tolerance, fodder potential, or other characteristics. It may be worth the extra effort to manage for forage competition or slower growth because of other attributes. Each landowner has unique goals and site constraints. This guide strives to provide choices that span a diverse set of situations.

### **Aboveground Competition – SHADE**

This guide includes three categories related to tree crown – crown width, crown density, and crown phenology. Collectively, these describe how much shade pressure a given species produces.

**Crown Width** – The spread of tree’s canopy at maturity when grown in an open setting.

NOTE: Depending on the goals of a silvopasture, trees may be harvested before reaching their maximum width.

**1** – less than 35 feet

**2** – 35-50 feet

**3** – greater than 50 feet

**Crown Density** – The number, arrangement, and size of a tree’s leaves influence how much light penetrates a tree’s canopy.

**1** – open branching/light shade

**2** – moderate branching/shade

**3** – heavy branching/shade

**Crown Phenology** – Phenology refers to the time of year certain annual events occur in an animal’s or plant’s life cycle (Hightshoe, 1988). In terms of shade pressure from an open-

grown tree, crown phenology tells us when that species first leafs out in the spring and when it loses its leaves in the fall. Trees with late leaf out and early leaf drop produce the least amount of shade pressure on the forages growing beneath it.

**1** – late-spring leaf out/early-fall leaf drop

**2** – mid-spring leaf out/mid-fall leaf drop

**3** – early-spring leaf out/late-fall leaf drop

In the Mid-Atlantic region, depending on zone, trees with a crown phenology rating of 1 may only shade forages for four months of the year; whereas trees rated a 3 may shade forages for up to eight months of the year. Some species even hang on to a portion of their leaves through the winter, producing modest but still notable shade. This information is recorded in the “special considerations” section of the guide.

### **Belowground Competition – ROOTS**

**Root Structure** – The roots of most forage species occupy the top few inches of soil.

Tree species, however, have a range of rooting patterns from deep taproots to shallow, fibrous structures that expand widely from the base of the tree. Species with deeper, less spreading root systems offer less competition; while shallow rooting species may compete with forages for the same resources (Garrett, 2009).

Tree root structure is coded on a 1-3 scale, with a score of 1 for root structures yielding the lowest amount of competition and a score of 3 for roots with the highest amount of competition.

**1** – taproot

**2** – deep laterals/some shallow rooting

### 3 – shallow rooting

If you look at an individual tree species' scores for crown width, density, and phenology and root structure collectively, you will see that the more 1's they have, the less shade pressure and the more desirable they are from a shade pressure stand-point they are. Species with more 2s and 3s may require wider tree spacing, lower animal stocking rates, longer grazing rotations, or other management strategies to help forages stay healthy.

**Growth Rate** – How fast a tree grows changes with age. Young trees typically grow quickly in height and width, and slow with age (Hightshoe, 1988). Growth rate also depends on site index and can vary greatly from site to site. The values here relate to average vertical growth over time and assume an average to good site index.

1 – fast: 24 inches/year or more

2 – medium: between 12 and 24 inches/year

3 – slow: 12 inches/year or less

**Mature Height** – Mature height relates to vertical growth. It is given as a range because it depends heavily on the site conditions in which a tree is grown. Only woody plants with a mature height of 25 feet or more were considered for this guide.

***A Note About Crown Characteristics and Growth Rate:*** Because silvopasture species are open-grown, their crown characteristics more closely resemble urban or suburban trees versus those grown in a forested setting (Hightshoe, 1988). Silvopastural trees often grow faster than forest-grown trees as well. For this reason, I focused on horticulture references for information on crown characteristics and growth rate.

## UTILITY AND MAINTENANCE

An important quality of a good silvopasture tree is its overall value – in saleable products, non-market benefits, food for animals or farm owners, and costly inputs. Costs associated with maintenance that might offset this value must also be considered. (Garrett, 2009)

Five utility categories and one maintenance category are included in our guide – markets, other benefits, fodder potential, coppice potential, high rate of CO<sub>2</sub> sequestration, and pest/disease issues.

**Markets** – Diversification of income is a major goal of many silvopastures producers. Instead of earning income from livestock-related sales alone, silvopasture provides the option for a second income stream from tree-related products. Five of the most common tree-product markets are included in this guide:

**HV** – High value wood products: these species typically fetch higher board-foot pricing and are used for higher value products such as veneer, flooring, cabinets, and specialty furniture

**LV** – Low value wood products: these species fetch lower board-foot prices, and are used for lower value products such as plywood, pulpwood, and lumber

**FW** – Firewood: these species have a good BTU rating and long burn time.

**P** – Posts: species with very dense and/or rot resistant wood qualities can be sold for fence posts. Value of post sales can be significant in some areas.

**NT** – Non-timber forest products: these include edible products such as fruits and nuts, decorative products such as barks and branches for garlands, and medicinal

**Other Benefits** – Trees provide a host of other benefits that may not yield income directly but are an important part of the tree selection process. Six important conservation and aesthetic benefits provided by trees include:

**W** – Wildlife: these are trees that support or benefit greater than 25 different type of animals in the form of forage, browse, seed/fruit, cover, or nesting habitat

**B** – Bee Forage: tree species that provide food for native (and non-native) bee populations, sometimes during critical months where other food sources are limited

**FC** – Fall Color: species known to have vibrant shades of yellow, red, orange or crimson during the autumn months

**EC** – Erosion Control: trees with soil-stabilizing root systems that can withstand short-term, modest levels of moving water can be extremely useful along stream banks, on sloping land, and other areas of the farm where erosion may be a problem

**WB** – Windbreak: tree species that have steadfast rooting systems and branches that can withstand moderate to strong winds without breaking

**NF** – Nitrogen Fixation: of the species selected for this guide, only Black Locust has been proven to fix soil nitrogen. Because this is such a commonly asked question among sustainable agriculturists, we have chosen to list it here even though it appears next to only one tree on the list.

**Fodder Potential** – Fodder potential refers to the ability of a tree species to be used as a food for livestock or other animals on the farm. This can help cut feed costs and increase nutritional variety for animals. The leaves of some species, such as Black Locust, have a high nutritive value. Other species, like Red Mulberry, produce leaves with a high digestibility. Tree

fruits and nuts can be used to “finish” animals, potentially adding market value to the sale of the meat that they can market as “acorn-finished pork” or “apple-fed lamb” (Fike, 2015).

Whether a tree species leaves, fruits, or nuts are used as fodder is notated with the following codes. If the field is left blank, that species is not recommended for use as fodder.

**L** – Leaves

**F** – Fruit

**N** – Nuts

**Coppice Potential** – Coppicing is the practice of harvesting most or all branches from a woody plant, and then allowing it to resprout. Coppiced stems can be used as fodder or sold as biomass fuel or to other markets. Tree species that can be coppiced on specific rotations and retain a vigorous output are noted with a ●. Species that do not readily resprout or that decline after coppicing are left blank. (United States Department of Agriculture – PLANTS Database, n.d.)

**High Carbon Sequestration** – Carbon sequestration by plants is the removal of CO<sub>2</sub> from the air and storing it in another form. All trees have the ability to sequester carbon in their leaves, branches, and roots. However, according to the Natural Resources Conservation Service (NRCS), some species have a notably higher capacity to sequester carbon, particularly when grown in optimal conditions. In their *Conservation Practice Standard for Silvopasture Establishment* (2012), the NRCS provides guidelines for landowners wishing to install silvopastures on their property. They suggest “for optimal carbon sequestration [landowners should] select plants that have higher rates of sequestration.” Their list of recommended

species for that purpose is included in this guide. Tree species on that list are noted with a ●, all others are left blank.

**Pest/Disease Issues** – Despite our focus on natives, some tree species are more susceptible to disease and insect pressure than others. Tree species are given a score of 1, 2 or 3 depending on the number of problems, likelihood of attack, and severity of damage.

**1** – infrequent/minor damage from pests or disease

**2** – occasional/moderate damage from pests or disease

**3** – frequent and sometimes severe damage from pests or disease

## **CULTIVARS AND SPECIAL CONSIDERATIONS**

**Cultivars** that exhibit disease resistance, heat or drought tolerance, narrow/favorable crown shape, and superior fruit/nut quality are listed in this guide. There is some risk with including such a section. Cultivar availability can vary widely from year to year and state to state. This section may need to be reviewed and updated from time to time. However, for fruit and nut-producing trees in particular, use of suggested cultivars can make a marked difference in both yield and quality.

We also include a section called **Special Considerations** for any unique information about a species that would be useful and important when considering a tree for silvopasture.

## CHAPTER 5. FIELD TESTING AND FINAL PRODUCTS

### FIELD TESTING

To ensure what we have created is user friendly, contains the information people are looking for, and answers the right questions, we need to field test it.

I would like to identify upcoming silvopasture workshops targeting landowners and/or technical service providers as testing grounds for the current guide. Currently, I know of one workshop this fall that includes information on silvopasture: **October 11, 2018 - Livestock and Forage Field Day, Southern Piedmont Agricultural Research and Extension Center**. I would like to find one or two others.

### FINAL PRODUCTS

My goal for this project is to use the information collected and the guide I created for the Culpepper workshop to generate one or all of the following products:

1. A Virginia Cooperative Extension Fact Sheet on Selecting Trees for Use in Silvopastures. This could be a nice extension of the 2017 VCE Publication, "Creating Silvopastures: Some Considerations When Planting Trees in Pastures" (see Fike et al., 2017). It could be similar in format to the 2015 VCE Publication, "Selecting Landscape Plants: Shade Trees" (see Relf, 2009).
2. A publication similar to the 2014 University of Nebraska publications, "Edible Woody Landscapes for People and Wildlife" (see Josiah and Lackey, 2014) and "Productive Conservation: Growing Specialty Forest Crops in Agroforestry Plantings" (see Josiah, 2014).

3. An online tree selector tool. This could be modeled after Virginia Tech's Urban Street Tree Selector, or we can create our own design modeled after one of the selection tools referenced in Chapter 2 of this report.

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APPENDIX A: TREE SELECTION GUIDE FOR MID-ATLANTIC SILVOPASTURES

*(To be printed double-sided on 11x17 paper and folded in half with the chart on the inside.)*

## Availability/Sources

Finding a source for the species you want may seem like the last step of the tree selection process, but plant availability can often dictate which species you are able to plant. Time of year you want to plant, where you live, and the quantities and sizes of trees you wish to purchase can all affect which species are available to you. So where to start?

One of the best sources of plant material is your state’s local Department of Forestry. State nurseries often offer a large selection of hardwood and evergreen seedlings to landowners each spring. Many states post their availability and pricing online along with information about each species, planting tips, and other useful information. Department of Forestry trees are typically sold as bare root seedlings, requiring only minimal cold storage until planting.

But what if you want to plant a specific cultivar or larger plant material not offered by your state nursery? Wholesale tree nurseries throughout the mid-Atlantic region offer a wide-selection of cultivars and species in a range of sizes (from 1-year-old seedlings to 5-6 year-old saplings.) Larger nurseries sell in bundles of 10-100 plants – the larger the bundle, the lower the per-plant price. Smaller nurseries offer many hard-to-find cultivars. Large and small nurseries can typically ship plant material to any location with great success.

There are several ways to identify wholesale nurseries selling the species and/or cultivars you are looking for:

- [Contact your local extension agent!](#) These individuals often know growers personally or maintain lists of potential sources you can contact.
- [Contact your state or regional nursery and landscape association](#) for a list of reputable wholesale suppliers! The name of these associations is typically the name of your state followed by “nursery and landscape association” (e.g. Virginia Nursery and Landscape Association). NOTE: Tennessee is home to some of the largest and most affordable wholesale nurseries supplying trees to the mid-Atlantic. Visit the Middle Tennessee Nursery Association website for a list of some of these companies.
- [Do an online search](#) for the cultivar you are interested in! Many small nurseries maintain websites with extensive information about the plant varieties they grow. Email these growers, ask questions about what they offer, explain to them how you plan to use the trees, and develop a relationship. Growers are often your best source of information. They may suggest other cultivars you haven’t considered.
- [Visit websites for associations and/or research programs](#) focusing on the tree crops you are interested in! Examples include: the Northern Nut Growers Association, the North American Paw Paw Association, the Kentucky State University Paw Paw Page, and the North American Maple Syrup Council (to name a few).

**No matter who you purchase from, time of year is critical for availability!** Spring is when the largest variety of plant material is available. Forestry offices and wholesale nurseries often run out of or quit selling trees by late spring/early summer. It is best to start looking for a supplier and to place your order in January-March. Fall planting is an option, but you may have fewer suppliers to choose from.

*NOTE: If you are working within a cost share grant, you may have purchasing guidelines and/or suggested suppliers. Be sure to consult your grant administrator.*

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## **Selected Resources**

*Manual of Woody Landscape Plants – Their Identification, Ornamental Characteristics, Culture, Propagation and Uses.* Sixth Ed. 2009. Michael A. Dirr. Stipes Publishing, Champaign, Illinois  
*Native Trees, Shrubs, and Vines for Urban and Rural America – A Planting Design Manual for Environmental Designers.* 1988. Gary L. Hightshoe. John Wiley & Sons, Inc. New York.  
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*USDAFS Silvics of North America:* [https://www.na.fs.fed.us/spfo/pubs/silvics\\_manual/table\\_of\\_contents.htm](https://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm)  
*USDA Plant Database, Factsheets, and Plant Guides:* <https://plants.usda.gov/java/>  
*University of Florida, IFAS Extension, Environmental Database Information Source (EDIS):* <http://edis.ifas.ufl.edu/>  
*Natural Resources Conservation Service Plant Materials Program:*<https://www.nrcs.usda.gov/wps/portal/nrcs/pmreleases/plantmaterials/pmc/northeast/mipmc/cp/>

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## **Tree Selection Guide for Mid-Atlantic Silvopastures – *Our first 20 trees***

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Selecting the best tree species for your silvopasture can be an overwhelming task. With so many species to choose from and so many variables to consider, it can be hard to know where to start. This publication attempts to give you a starting point.

Over 80 tree species were considered for inclusion in this guide. The 20 species included were selected based on site conditions, physical characteristics most suitable for silvopasture systems (root structure, crown size and density, phenology, etc.), growth rate, timber and non-timber product value, and availability in the marketplace. In addition, this guide focuses on species native to North America that are less susceptible to extreme weather events like drought or wind/ice when possible. Cultivars that offer superior disease resistance, growth form, and/or product characteristics most suitable for use in a silvopasture system are listed.

**NOTE:** *Some species not included may be the best choice for your silvopasture. Please use this guide as a reference only.*

### Site Preferences

Understanding your site and selecting the trees that prefer those conditions is one of the most important factors in choosing species. Trees planted in their preferred environment are more resilient, longer-lived, and faster growing. Take time to become familiar with the moisture level of your soils as well as your soil pH. Your local university or extension office can help with soil testing. Be sure to test the soil of each unique area and in several locations throughout the field(s) you intend to plant.

### Tolerances

Familiarity with extreme conditions possible on your site is critical. Many regions experience regular drought or are prone to periodic flooding. Some sites are exposed to heavy winds and winter ice storms. Be sure to select trees that can withstand these conditions if they are a threat in the field(s) you plan to plant. Shade tolerance is important if you will be establishing species that grow slower or will be partially shaded by other trees in or adjacent to the silvopasture.

*NOTE: Black walnut and butternut produce the allelopathic chemical ‘juglone’ which can harm plants growing near them. Plant species can have some sensitivity to juglone. Check with your local forester or extension agent before interplanting trees with black walnut, butternut, or other juglone-emitting species.*

### Characteristics

Competition between tree growth and forage growth must be carefully managed in any silvopasture system. This is accomplished through tree selection and spacing. Some tree species have physical characteristics such as deep rooting habit, late leaf out and early leaf drop, and an open narrow crown that allow for optimal forage growth. This guide includes trees with both a light and moderate impact on forage growth. Planting tree species with impact on forage growth may require wider spacing of trees and/or fewer animals per acre.

### Utility/Maintenance/Special Considerations

A key benefit of silvopasture systems is diversifying your revenue stream. All of the tree species listed here have potential economic value as timber, pulp, non-timer products (fruit, nuts, etc.), or fodder. However, they may also have a cost associated in the form of pest/disease issues or maintenance requirements such as pruning. This guide gives utility and maintenance information and outlines special considerations for each species listed. Be sure to weigh these costs and benefits carefully when selecting your trees.

# TREE SELECTION GUIDE FOR MID-ATLANTIC SILVOPASTURES - *Our first 20 trees*

Common Name	Scientific Name	Cultivars	Site Preferences								Physical Characteristics							Utility/Maintenance					Special Considerations
			Native	Hardiness Zone	Soil pH	Soil Moisture	Heat/Drought	Flood	Shade	Wind/Ice	Root Structure	Crown Phenology	Crown Width	Crown Density	Growth Rate	Mature Height (ft)	Markets	Other Benefits	Fodder Product	Coppice Potential	High Rate of CO2 Sequestration	Pest/Disease Issues	
<b>EVERGREEN</b>																							
Shortleaf Pine	<i>Pinus echinata</i>	-	1	6-9	4.0-6.0	D-M,X	M	N	N	T-Wind, N-Ice	1	-	2	1	1	60-100	WP,NT	W,WB			●	2	Maintains tall, clear trunk w/o early pruning
Pitchlob Pine	<i>Pinus rigida x taeda</i>	-	2	4-7	Acidic	D-M,X	T		M		3	-	2	1.5	1	40-60	WP	EC,W					Combines the fast growth rate and drought resistance of loblolly pine, with the cold tolerance of pitch pine. A good choice for cooler zones in the Mid-Atlantic.
Eastern White	<i>Pinus strobus</i>	Fastigiata (narrow/columnar when young)	1	3-7	4.5-6.5	D-M	N	N	M	N	2	-	2	2	1	50-80	WP,NT	W				2.5	Can quickly reseed in open fields - bush hogging may be required if animals do not browse seedlings
Loblolly Pine	<i>Pinus taeda</i>		1	6-9	Acidic	M	M	N	N	N	3	-	1	1	1	60-90	WP,NT	EC,W			●	1.5	Grows well in red-clay soils; 'genetically superior' seedlings (increased growth rate - dbh and ht) may be available through your local forest service office
<b>DECIDUOUS</b>																							
Sugar Maple	<i>Acer saccharum</i>	Caddo, Commemoration, Legacy (heat and drought resistant); Temples Upright (narrow crown)	1	4-8	3.7-7.3	M-X	N	N	T	T	3	2	3	3	2.5	75-120	WP,FW,NT	FC,W				2	Maple syrup production at 10"dbh or greater; consult local extension office for varieties exhibiting high sugar content; use heat-tolerant cultivars for zones 7-8
Paw Paw	<i>Asimina triloba</i>	Many	1	5-8	4.7-7.2	M-X	N	N	T	N	2	1	1	1.5	2.5	15-40	NT	FC	F	●		1	Use superior fruiting varieties/cultivars for marketable fruit; trees can sucker and produce colonies; small container-grown plants transplant best
Hardy Pecan	<i>Carya illinoensis</i>	Many	2	5-9	6.5-7.5	M-X	M	M	N	T	1	2	3	1	2.5	70-100	WP,FW,NT		N			3	Select cultivars/varieties are recommended for marketable nuts and disease/pest resistance
Persimmon	<i>Diospyros virginiana</i>	Hicks, Meader, Pieper, Rnkwitz, Early Golden, John Rick, Killen, Miller, and Woolbright	1	4-9	4.7-7.5	D-M	M	M	T	T	1	2	1	1	2.5	35-60	WP,FW,NT	B,EC,W	F	●		1.5	Use cultivars or grafted trees (D. kaki (Asian) grafted onto D. virginiana) for marketable fruits; trees may sucker and form colonies
Thornless Honey Locust	<i>Gleditsia triacanthos var. inermis</i>	Millwood, Calhoun, Hershey (seed pods w/ high sugar content)	1	4-9	5-8	D-M	T	T	N	T-Wind, M-Ice	2.5	1	2	1	1	50-70	WP, FW	B,EC,FC,WB	F,L	●		2	If planting for fodder, use cultivars that produce seed pods with high sugar content, avoid cultivars from horticulture suppliers that are bred for little to no fruit production. Avoid clay soils.
Butternut	<i>Juglans cinerea</i>	Kenworthy, Mitchell	1	3-7	6.0-7.0	D-M,X	M	M	N	N	1.5	1	3	1	2	40-60	WP,NT		N	●		3	Develops a short trunk w/o early pruning; nuts are milder and sweeter than black walnut; loves limestone soils; susceptible to 1000 cankers disease
Black Walnut	<i>Juglans nigra</i>	Many	1	4-9	4.6-8.2	M,X	M	M	N	T	1.5	1	3	1	1	50-75	WP,NT		N	●	●	3	Maintains a tall, clear trunk often w/o early pruning; loves limestone soils; susceptible to 1000 cankers disease; extremely valuable wood, esp. mature veneer
Yellow Poplar	<i>Liriodendron tulipifera</i>		1	4-9	4.5-6.5	M-X	N	N	N	N	2.5	1.5	2	2	1	70-90	WP	B,FC		●		1.5	Tall, clear trunk often free of branches w/o early pruning
Red Mulberry	<i>Morus rubra</i>	Johnson, Weisman, Cooke, Wellington	1	5-9	5.0-7.0	M	T/M	M	M	N	2	1	2	3	1	40-70	NT,P	W	F,L	●	●	2	
White Oak	<i>Quercus alba</i>		1	3-9	4.5-6.8	D-M,X	M	N	M	Y	2	2	3	2	3	50-80	WP,FW,NT	W,FC	N,L*	●		2	Some leaves persist in winter
Bur Oak	<i>Quercus macrocarpa</i>	Urban Pinnacle (narrow/pyramidal)	1	3-8	4.6-7.5	D-M	T	M	M	T	2	2	3	1	3	70-80	WP,FW,NT	FC,W,WB	N,L*			1	Favors limestone soils in upland sites; very drought resistant
Cherrybark Oak	<i>Quercus pagoda</i>		1	6-9	4.5-6.0	M,X	N	N	N	N-wind, T-ice	2		3		1	80-100	WP, FW	W	N,L*			2	Some leaves persist in winter
Northern Red Oak	<i>Quercus rubra</i>		1	3-7	4.3-7.3	D-M,X	N/M	N	M	T-wind, N-ice	3	2	3	3	1.5	60-75	WP,FW	FC,W	N,L*	●		2	
Shumard Oak	<i>Quercus shumardii</i>		1	5-9	5-7.6	D-M,X	T	M	N	T?	2	2	3	1.5	1.5	40-60	WP,FW	FC,W	N,L*			2	
Black Locust	<i>Robinia pseudoacacia</i>	Appalachia, Allegheny, Algonquin	1	4-8	5.1-7.7	D-M	T	N	N	N	3	1	1	1	1	30-50	WP,FW,P	B,EC,NF	L	●	●	3	Rot resistant wood. High protein forage, however toxicity can develop if animals consumer too much.
Baldcypress	<i>Taxodium distichum</i>	Shawnee Brave (pyramidal), Fastigiata (narrow/upright)	1	4-11	4.5-6.5	D-M	N/T	T	M	T	3	2	1	1	2	50-70	P	EC,FC		●	●	1.5	Cypress knees do not form on drier sites

**Native:** 1-native to mid-Atlantic, 2-native to North America, 3-not-native to North America; **Site:** U-upland, B-bottomland; **Moisture:** D-dry, M-moist, X-well-drained; **Tolerances:** T-tolerant; M-moderately-tolerant, N-not-tolerant; **Root Structure:** 1-taproot, 2-deep laterals/some shallow, 3-shallow rooting; **Phelology:** 1-late spring leaf out/early fall leaf drop, 2-mid-spring leaf out/mid-fall leaf drop, 3-early spring leaf out/late fall leaf drop; **Crown Width:** 1-less than 35 ft, 2-35-50 ft, 3-greater than 50 ft; **Crown Density:** 1-open branching/light shade; 2-moderate branching/shade; 3-heavy branching/shade; **Growth Rate:** 1-Fast, 2-Moderate, 3-Slow; **Markets:** WP-wood products, NT-non-timber forest products, FW-firewood, P-posts; **Other Benefits:** W-wildlife (>25 wildlife users), B-bee

forage, FC-fall color, EC-erosion control, WB-windbreak; **Fodder Product:** F-fruit, N-nuts, L-leaves; **Coppice Potential:** Y-yes, N-no; **Pests/Disease Issues:** 1-few, 2-some, 3-many

*\*Heavy consumption of oak leaves and acorns can be toxic to some livestock*