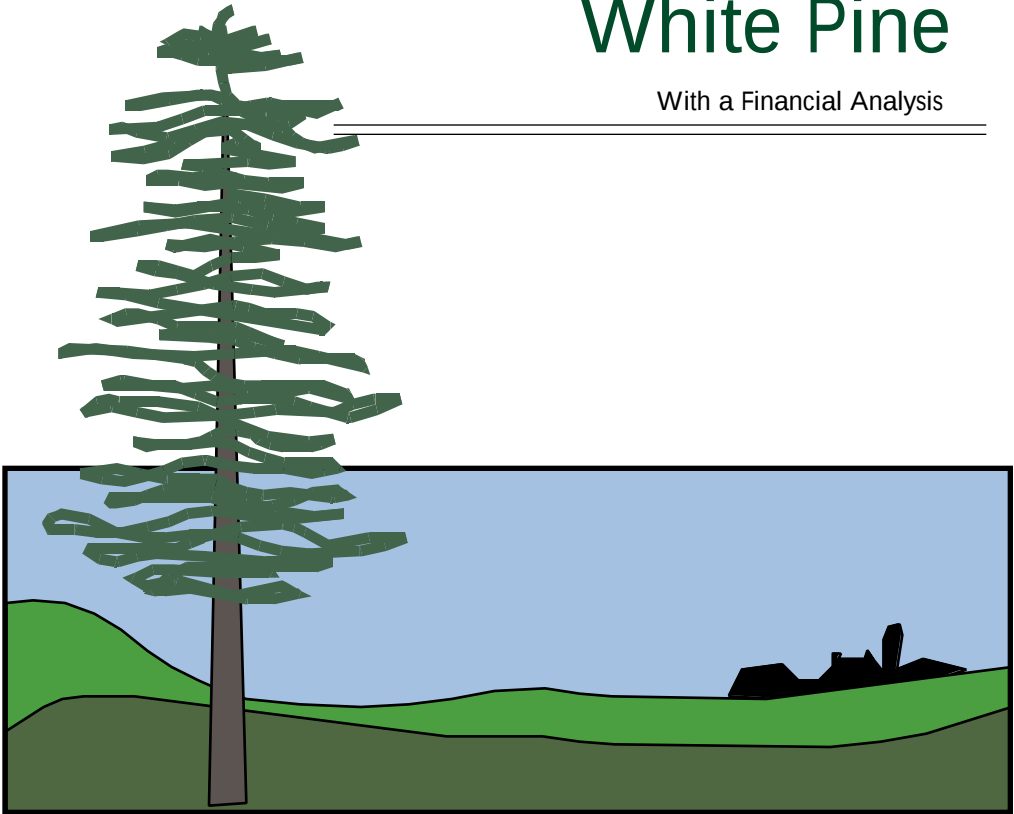


Tree Crops For Marginal Farmland

White Pine

With a Financial Analysis



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Acknowledgements

This publication is a 2000 revision of the text and financial analysis of The University of Tennessee Agricultural Extension Service Publication PB1462 (1992) of the same title. The authors acknowledge the original authors of this publication: Russell L. Hatcher and Larry A. Johnson, formerly with The University of Tennessee; George M. Hopper, The University of Tennessee; and James E. Johnson and James E. Pease, Virginia Tech University.

The Cooperative Extension Service of the United States Department of Agriculture provided funds for the original development of the *Tree Crops for Marginal Farmland* project.

Tree Crops for Marginal Farmland

Many producers would like to increase farm income and decrease income variability. A growing number of farmers are investigating new and diversified sources of income. A resource which has not been tapped to its full potential is marginal farmland, specifically its use for growing tree crops. More than 30 million acres of woodland and idle pasture and cropland exist on Southeast farms, and much of this land could be producing valuable tree crops.

The Tree Crops for Marginal Farmland Project seeks to provide farmers with basic information about growing and marketing tree crops. Tree crops have many advantages for farmers with marginal or unused land. The cost of inputs is relatively low, and economic returns may be quite competitive with alternatives. Marginal lands converted from annual rowcrop and pasture production to tree crops can reduce soil erosion, improve water quality, reduce total pesticide and fertilizer applications, and produce more profitable returns for the landowner.

Five introductory guides are available in this series, and each has an accompanying videotape. They provide information on a specific tree crop, which can be grown on small or medium-sized tracts of marginal or unused farmland. All these crops are common to areas of the southeastern United States, but their economic potential should be evaluated. The tree crops chosen for this series are:

- White Pine for Timber
- Black Walnut for Timber and Nuts
- Loblolly Pine for Timber
- Royal Paulownia for Timber
- White and Virginia Pine for Christmas Trees

Your decision to grow a tree crop should be made only after careful consideration of the growing time, expense requirements, market conditions, expected returns and your personal objectives. These guides will help you make your decision. In addition, you should seek information from representatives of organizations such as your state Forestry Service, your local Agricultural Extension office and private consultants.

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How to Use This Guide

This guide describes the most effective practices used to grow white pine (*Pinus strobus*) trees in the southern United States and the cost of those practices. A financial analysis is included that uses typical costs and expected returns to evaluate a representative investment.

To use this guide to best advantage, read it straight through. Take special note of the cultural practices described and their estimated costs. Think about potential markets for the harvest. Read how to evaluate your potential investment, and think about the other benefits of tree crops. Next, read the case study, “What Happened to Greg,” to get a better idea of how these investments can be evaluated. To conduct a financial analysis of your own situation, carefully estimate all the production costs, then take your estimates to your local Extension agent or farm management agent for assistance.

White Pine: Description and Uses

White pine has flexible, blue-green needles that are grouped in fascicles of five. Each year, branches originate from the terminal growing tip (whorled pattern) giving the tree a distinctive appearance of layers of branches. The distance between successive whorls represents one year of growth. In forested settings, white pine grows rapidly on good sites, exceeding 100 feet in height and averaging 2 to 3 feet in diameter. The trunk is usually straight with a pyramidal crown. White pine is capable of attaining ages of 200 years.

White pine was extensively used in construction when old-growth white pine forests were abundant. Today, the use of white pine as construction lumber is rare. It is now chiefly a specialty wood in the furniture industry. Siding and decorative trim, knotty pine paneling, cabinets and other interior wood products are its more common uses. The ease of finishing and repairing makes white pine wood useful for furniture stock. Young white pines are also used in the manufacture of log homes. The ability of white pine to adapt to a wide range of sites and its rapid growth rate makes young trees desirable as Christmas trees or as ornamental landscape trees. The increasing use of white pine for pallets, pulp and chips for engineered wood panels encourages harvesting of smaller, lower-quality trees.

White pine has several characteristics that make it a good tree crop on marginal land, especially in the South. It requires a relatively small amount of labor and management, it is ideal for coarse sandy soils, it has few natural enemies and it is one of the fastest growing trees in the United States. Essentially, you can plant the trees, and after the plantation is established, watch them grow.



White pine plantations are well-suited to abandoned or marginal farmland.



Distinctive appearance of white pine growing on an old field site.

Production Management

Site Selection

The southernmost limit of the white pine range is the Cumberland Plateau and Mountains and the Southern Appalachians. Diameter and height of white pine increase faster in the southern portion of its range than in any other area. Forested areas in Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Virginia and West Virginia include about 35 million acres of white pine.

White pine is found between elevations of 1000 to 4000 feet, but grows best at 2000 to 3000 feet. For optimum growth, plantations should be located on north- or east-facing slopes or on stream terraces. Most of the growth occurs early in the growing season (May and June) when temperatures are cooler and rainfall is abundant.

White pine is adaptable to many soil types. On coarse, sandy soils, white pine will outgrow most other trees. However, as the productivity of the soil increases, the competitiveness of white pine decreases because other trees grow faster than white pine on the better sites. Poorly drained and heavy clay soils are not suitable for white pine.

Site Preparation

Site preparation depends on the location of the site and existing vegetation. If competition from existing trees or other vegetation is minimal, site preparation may not be necessary. Otherwise, reduce competition with herbicide application, prescribed burning or mechanical means such as mowing or disking. Subsoiling may be necessary on compacted old fields or pastures. Proper site preparation allows easier planting of seedlings and decreases competition from other vegetation during the first few years. Make sure to follow Best Management Practices (BMPs) to minimize soil erosion during site preparation activities. Herbicide applications are recommended over mechanical methods because herbaceous plants (primarily grass) compete for soil moisture with the pine seedling roots.

Tree Planting

On most sites, you should plant 2- or 3-year-old seedlings. White pine seedlings grow slowly in height initially, so most seedlings sold by nurseries are 2 years old. Seedlings can be planted by machine, but most are planted by hand. Plant at 10-foot by 10-foot (435 trees per acre) or 12-foot by 12-foot (302 trees per acre) spacing to produce the best board-foot yields.

Plant between December and March. On prepared sites void of ground cover, freezing might be a problem, so delay planting until after the first of February. Seedlings are sometimes uprooted by freezing and thawing on prepared land.

Contractors are usually available to perform the work necessary for plantation establishment. Contact your county forester or Extension agent for information about these vendors.

Pine seedlings are easily planted by hand (a) or by machine (b) in old fields.

(a)



(b)



Cultural Practices: Thinning And Pruning

White pine requires a relatively small amount of labor and management compared to other tree crops. Generally, the higher the quality of your trees, the higher will be the price you'll receive. High quality trees are often a direct result of proper management.

Improvement in stand quality is obtained by thinning at the appropriate time. The decision of when to have a partial cut depends on the density of trees planted. If fewer than 400 trees per acre were planted, a rotation of 30 to 40 years with no thinning should produce the logs most demanded by the furniture market. On the other hand, if the number of trees planted per acre exceeded 400 trees, a thinning is often warranted. The decision to harvest is made easier if the trees removed can be sold as small logs, especially for log homes. Smaller, low-quality material can be sold for pulpwood where those markets for paper and engineered wood panels (oriented strand board) are available.

Pruning is another practice to improve the quality of your white pine stand. White pine self-prunes as it competes for space, but dead branches often persist for several years as short stubs. Artificial pruning of side branches eliminates this undesirable characteristic. If you decide to prune, only prune those trees that will remain until final harvest. Prune after the first thinning and to a height of 17 feet on trees no larger than 7 inches in diameter. This helps to ensure that pruning wounds are adequately covered by clear wood before final harvest.

Pest Control

Protecting white pines against insects and diseases in the northeastern United States requires intensive management. However, in the southern part of its range, pests are not a severe problem. With proper management and site selection, white pine can usually be grown with only limited pest management.

Like all trees, white pine has insect and disease enemies. The most important are the white pine weevil and root declines. Other threats are various root rots, white pine adelgid and white pine blister rust. If you grow white pine, become familiar with pine pests. Most problems can be avoided rather easily. Contact your county forester or Extension agent for more information.

Although not a biological pest, fire can cause major injuries to white pine trees. The thin bark of white pine makes it the least tolerant of fire of any of the native pines. Fire breaks or lanes should be installed with white pine plantations.

Calendar of Silvicultural Practices

Common silvicultural practices for white pine and the approximate time to perform them are listed here. Not all the practices are necessary to establish and maintain a healthy stand of trees for every situation.

Calendar of Silvicultural Practices for White Pine	
WHAT	WHEN
Prescribed burning	Spring or fall before planting
Site preparation and subsoiling (if needed)	Fall before planting
Buy seedlings	At planting
Plant seedlings	December to March
Weed control	First 3 years after planting in early spring
Protect from fire	Continuously
Protect from livestock grazing	Continuously
Fertilize	After first thinning
Prune	Early spring after first thinning
Pest control	Early spring
Harvesting —thinning	Once between ages 25 to 35
—final	Between ages 30 to 40



Young white pine makes rapid growth. Note the wide growth.

Financial Analysis

Production Costs

The cost of planting and managing white pine varies from site to site. Some landowners may have the necessary labor and equipment to perform most silvicultural practices. Others may find it necessary to contract the work. Remember that all costs quoted here are our estimates based on 2000 prices and will likely vary from your actual cost.

Site Preparation

The site where trees are to be planted usually requires preparation. Control of competing vegetation is essential for growth of white pine. Generally, a herbicide application is recommended to control herbaceous competition because grass is one of the fiercest competitors for soil moisture. Mowing and disking helps, but is not as effective as herbicides. Site preparation costs up to \$40 per acre, depending on treatment used.

Tree Planting

Establishment cost is a combination of the cost of seedlings and the cost of putting them in the ground. White pine seedlings cost, on average, about \$90 per thousand trees, and contract-planting costs about \$35 per acre. The additional growing season required for two-year white pine seedlings increases their cost compared to one-year loblolly or shortleaf pine seedlings. There is little difference in cost between

machine planting and hand planting. The time required for hand planting depends on the number of trees planted per acre and the terrain. If you plant the trees, figure on between 10 to 20 hours per acre. You will need to purchase a dibble, spade, auger or other suitable tool.

If drought or other adverse conditions occur, 25 percent of the seedlings may die. Additional planting costs will be incurred, assuming you want to replace the dead trees.

Thinning and Pruning

Grass and woody plants compete with white pine and must be controlled if white pine growth is reduced. If you have a backpack sprayer, the necessary chemicals, and protective gear, count on spending 5 to 10 hours per acre for this task. Herbicide and labor for a pine release treatment is approximately \$70 per acre.

If greater than 400 trees were initially planted, a thinning would be needed at mid-rotation, at approximately age 25. Thinning reduces the number of trees per acre and gives the remaining trees more space to grow and expand to attain larger size. An advantage of thinning is that it can provide an intermediate income. Generally, the trees that are left to grow after thinning command a premium price at final harvest because of their larger size. The primary disadvantage of thinning is that markets are sometimes not available for the smaller, thinned trees. Thinning of small, unmarketable trees is an expense or cost and therefore is not recommended.

Pruning requires only a pruning saw, but takes about 10 to 15 hours per acre. Typically, this chore costs about \$1 per tree.

Other Costs

Management practices such as prescribed burning and harvesting are often contracted due to liability exposure and large capital investments. Assume a harvest expense of 5 percent of the total payment received for the trees for a consulting forester to administer the sale and harvest operation.

Markets and Returns

Several factors affect the price received for trees. The most important are location, quality, size and accessibility. Most white pine is sold to sawmills. The price paid for standing trees is the stumpage price, while that for logs hauled to the mill is the delivered price. Typically, sawmills perform primary manufacturing by sawing logs into boards, dimension lumber and cants. These products are sold to furniture manufacturers or millwork firms. Other white pine timber is used by log home manufacturers and carpenters for constructing and finishing houses. Although markets are spotty, some of the smaller, less valuable white pine trees are chipped for engineered wood panels and paper. These markets can add considerable income to the overall sale price. Otherwise, this material is lost income that is left in the woods. You may want to investigate all potential markets for white pine to obtain the best price for your trees.

Typical prices associated with white pine as it progresses from a tree to a piece of furniture or part of someone’s house are listed in Table 1.

Table 1. Typical White Pine Prices	
Stumpage price	14 cents per board foot
Delivered price	30 cents per board foot
Manufactured price	65 cents per board foot

Since the major buyers of white pine are sawmills, trees are purchased by “thousand board-feet,” or “MBF.” Typically, the total volume of MBF in a stand of trees is estimated and a potential buyer will make a stumpage offer based on this estimate. Expected revenue will depend on the volume estimate and bid price.

Evaluating Your Investment

Tree crops are different from most agricultural crops because of the long growing time needed to return profits. Many factors, such as inflation and interest rates, will have very important effects on profitability. For example, inflation may result in future returns that appear large in today’s dollars, but have low future purchasing power. Also, since interest rates are closely related to inflation, interest cost incurred or interest income foregone will vary with inflation rates. Inflation is an important concern when considering investments that do not generate returns for many years.

Deciding whether white pine production is a good investment will require careful consideration of production costs, expected returns and how much your time is worth. After all, trees take much longer to grow than traditional crops, and your money will be invested for many years.

Returns must be discounted, because a dollar to be received tomorrow is not worth the same as a dollar received today. Whether a bird in the hand today is worth more than two (or even three) in the bush tomorrow depends upon your time preference for money and your evaluation of risk. In investment analysis, you should choose the discount rate to reflect your preference for dollars today rather than dollars in the future. With an annual discount rate of 10 percent, you should be just as pleased to receive one dollar today as one dollar and ten cents next year.



Mature white pine plantations are high yielding.

Three measures to analyze an investment are:

- Present Net Worth (PNW) is similar to the term “profit.” The effects of inflation on expected returns over costs are accounted for, and returns are discounted to the present. An investment with PNW greater than zero is profitable.
- Annual Equivalent Value (AEV) is the Present Net Worth expressed as a constant annual return throughout the investment period. The AEV can be used to compare a tree-crop enterprise with field-crop returns on the same site.
- Internal Rate of Return (IRR) is the rate at which discounted revenues just equal discounted costs. An investment has good potential if the IRR exceeds rates from alternative investments with similar risk, timing and capital outlay.

What Happened to Greg

Here is the story of Greg, a farmer who planted white pine on his marginal farmland. You can use Greg’s experience as a reference for estimating the cost of managing your stand, but remember that no situation is ever typical. Greg’s costs are only estimates and will probably be different from your costs.

Site preparation with an herbicide application to control competing vegetation and subsoiling cost Greg \$40 per acre. Greg purchased seedlings for \$90 per thousand trees, and hired someone to plant the seedlings by hand for \$35 per acre.

Greg planted 302 trees per acre in a 12-foot by 12-foot spacing. Unfortunately, dry weather during the first year killed 25 percent of the seedlings. Greg had to replant the next season, which cost \$16 per acre. Then, during the third year, grass and woody plants began to compete with his pines, so Greg used a herbicide spray at a cost of \$70 per acre.

After those initial years, Greg could essentially sit back and watch his investment grow. Only fire protection expenses were necessary, which cost a little more than \$1 per acre per year.

Harvest-time came at year 35. Greg hired a consultant to estimate the volume of his white pine stand in thousand-board-feet (MBF). A sawmill offered him a stumpage price of \$140 per MBF, which Greg accepted. Total volume per acre at harvest averaged 20 MBF and was valued at approximately \$2,800 per acre. Greg paid the consultant a fee of 5 percent of the stumpage price, or about \$7 per MBF.

Once the trees were harvested and sent to market, Greg had some time to think. He wondered if his effort had been worth it. Was the white pine stand a good investment?

Over the 35-year growing period, inflation had averaged 3 percent per year. Greg decided that a 10 percent discount rate was a good estimate of his expected rate of return on the investment. Table 2 shows that his investment generated a profit after income taxes of \$85 per acre. The profit was small because of the long growing period and Greg’s choice of discount rate. Evidently, Greg thought that he could have earned this rate on an alternative investment of his money.

Like many farmers, Greg wondered how the white pine crop compared with row crops planted on the site. The Annual Equivalent Value with Greg’s chosen discount rate of 10 percent was only \$9 per acre after income taxes. If Greg had selected a lower discount rate, the AEV would have been more competitive with row crops on this marginal farmland.

The Internal Rate of Return indicated an 11.5 percent after tax return from the investment. Discounted revenues equaled costs at this breakeven discount rate. If Greg wasn’t confident about selecting a discount rate, the IRR would show that he made a profit only if the discount rate was below 11.5 percent.

Table 2 shows the investment measures Greg used over a range of discount rates:

Table 2. Greg’s Financial Measures (After Income Taxes)

	Discount Rate (%)				
	6	8	10	12	14
Present Net Worth (\$/acre)	\$671	\$282	\$85	-\$17	-\$70
Annual Equivalent Value (\$/acre)	\$46	\$24	\$9	-\$2	-\$10
Internal Rate of Return	11.5%				

Greg's financial analysis does not include land costs or future real stumpage price increases (above the rate of inflation) or decreases. Real stumpage prices for white pine have increased dramatically in the Midsouth, at an annual rate of 2.5 percent for pulpwood and 5 percent for sawtimber from 1988-1998.

This analysis is for marginal land of average productivity. On more productive land with the same assumptions, greater rates of returns would be expected. Alternatively, lower returns would be expected on less productive land.

Evaluating Alternative Tree Crops on Your Farm

Dollar returns and rates of returns are not the sole criteria in deciding whether to invest in a tree crop. Your decision will be based on many factors, such as market conditions in your area, how quickly you need a return on investment and how much time and effort you wish to put into managing the crop. You'll need to consider farm resources such as growing conditions, investment capital, labor costs and your own management ability. Only you know how your money and time are best spent.

The choice between tree crops also depends on the farm's resource base. For example, a particular species may offer a relatively high return per acre but requires a sizeable amount of up-front investment capital to establish the stand. If investment capital is a major concern, then a tree crop such as white pine or loblolly pine may be the best alternative for the site. White pine or loblolly pines do not generate a high dollar return per acre. But they may well give a higher return on your investment capital than more highly valued trees (e.g., black walnut).

Finally, consider risk. Numerous production problems such as weather, disease and insects can reduce the productivity of stand. Also, costs vary widely. While trees are less risky than many agricultural crops, lost income can be considerable if a total disaster occurs. You may want to work through a few examples yourself, varying price and production levels, to get a feel for the risk inherent in the tree crop.

Use Table 3 for information regarding the many factors that should be considered in the decision to grow a particular tree crop.

Once you have decided which tree crops to consider, a financial analysis is necessary. Your local Extension agent, farm management agent or state forester will be able to help.

Table 3. Information Sources for Tree Crops Selection.

Factor	Information Source
Geographic range of the tree crop	County forester, Extension agent
Site conditions – suitability for tree crop	County forester, Extension agent
Local market conditions	County forester, Extension agent
Initial investment cost	County forester, Extension agent
Time and effort required to grow the crop	County forester, Extension agent
Soil conservation, wildlife, and other benefits desired	County conservationist, Extension agent
Insect and disease problems	County forester, Extension agent
Cost share programs	County forester, NRCS office
Harvesting and marketing	Private forestry consultants, Extension agent

Federal and State Cost-Share Programs

If you want to raise a tree crop on your farm, investigate federal or state cost-share programs. In most counties, some money is available for forestry activities such as site preparation, tree planting, fire protection, erosion control and timber stand improvement. To find out what is available in your county, contact your county forester, Extension agent or local Natural Resources Conservation Service (NRCS) representative.

Cost-share funds simply reduce your cost of forestry activities. For example, a 50 percent cost-share on seedlings and tree planting may reduce the cost from \$60 per acre to \$30 per acre. Direct payments from programs such as the Conservation Reserve Program provide income in early years before timber revenue begins.

Other Benefits of Tree Crops

This guide has emphasized only the financial returns of tree crops. Additional benefits and intrinsic values result from planting trees. For example, wildlife are attracted to trees of all ages. Both game and non-game species of animals use plantations. A planting arrangement that increases habitat for wildlife can increase animal populations without sacrifice of wood production.

Trees also prevent soil erosion. Eliminating soil loss enhances land productivity and water quality. By stopping sediment from entering streams, your water resources will be cleaner and therefore more suitable for fish and other aquatic species. Finally, tree crops screen the air and serve as a noise barrier. Again, proper design can maximize these benefits from your tree crop.

Moreover, most people enjoy the natural beauty only a tree or a forest can provide. Plant a tree crop today – and enjoy the many benefits for years to come.

Appendix 1

Assumptions Used for Greg's Financial Analysis:

<u>Item</u>	<u>Assumption</u>
Site index	55 feet at age 25
Planting density	12-feet by 12-feet spacing (302 trees per acre)
Seedling price	\$90 per thousand seedlings
Planting cost	\$35 per acre
Site Preparation	\$40 per acre
Fire protection	\$1.36 per acre
Mortality	25%
Replanting	\$16 per acre
Chemical release	\$70 per acre
Age at harvest	35 years
Sale price	\$140 per thousand feet
Harvest expense	5% of sale revenue
Harvest yield	20 MBF per acre
Marginal income tax rate	28%
Inflation rate	3% per year
Tax treatment	Reforestation credits for planting, all else ordinary income expenses

Growth and financial measures were estimated with WINYIELD, a microcomputer-based timber yield forecasting and planning tool. For further information, contact:

Forest Resources System Institute (FORS)
P. O. Box 1785
Clemson, SC 29633-1785
Phone: (864) 656-7723

Appendix 2

Average Weight to Volume Conversions for Eastern White Pine

2.0 tons per cord (range 3,800 to 4,400 lbs.)

- 4.5 tons per 1,000 board feet (MBF) Doyle Rule (12-inch diameter logs)
- 3.1 tons per 1,000 board feet (MBF) Doyle Rule (18-inch diameter logs)
- 2.7 tons per 1,000 board feet (MBF) Doyle Rule (24-inch diameter logs)

References

- Della-Bianca, L. 1970. Schenck's Old Orchard White Pine Plantation at Biltmore. *Journal of Forestry* 68:479-481.
- Della-Bianca, L. 1981. Thinning Eastern White Pine in the Southern Appalachians. *Southern Journal of Applied Forestry* 5:68-73.
- Elliott, K.J. and J.M. Vose. 1993. Site Preparation Burning to Improve Southern Appalachian Pine-Hardwood Stands: Photosynthesis, Water Relations and Growth of Planted *Pinus strobus* L. during Establishment. *Canadian Journal of Forest Research* 23:2278-2285.
- Fleming, H. 1986. White Pine in the Southern Appalachians. *In* Eastern White Pine: Today and Tomorrow Symposium Proceedings. David T. Funk (compiler). USDA Forest Service Northeastern Forest Experiment Station, General Technical Report WO-51. pp. 114
- Leak, W.B.; J.B. Cullen; and T.S. Frieswyk. 1995. Dynamics of White Pine in New England. USDA Forest Service, Northeastern Forest Experiment Station, Research Paper NE-699. 8 p.
- Sims, D. H. 1986. Eastern White Pine in Southern Highlands. *In* Eastern White Pine: Today and Tomorrow Symposium Proceedings. David T. Funk (compiler). USDA Forest Service Northeastern Forest Experiment Station, General Technical Report WO-51. pp. 115-117
- Vimmerstedt, J. P. 1962. Southern Appalachian White Pine Plantations: Site, Volume, and Yield. USDA Forest Service, Southeastern Forest Experiment Station, Station Paper No. 149. 13 pp.
- Wendel, G.W. and H.C. Smith. 1990. Eastern White Pine. *In* Silvics of North America Vol.1 Conifers. Burns, R.C. and B.H. Honkala (Tech. Coords.). Agric. Handb. 654. USDA Forest Service. pp. 476-488.
- Wendel, G.W. and J.N. Kochenderfer. 1987. Release of 7-Year-Old Underplanted White Pine Using Hexazinone Applied with a Spot Gun. USDA Forest Service, Northeastern Forest Experiment Station, Research Paper NE-614. 7 p.



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