Hardwood Silviculture in Tomorrow's Southern Forest

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Some 101 million acres, comprising half the southern forest, are currently dominated by hardwoods. Seventy million of these acres are capable of growing high-quality timber rapidly, and are likely to continue in forest indefinitely (Briegleb and McKnight 1960). The Forest Service's Timber Resource Review (1958) estimated that the Nation's total wood requirements will double in the next decade. For the past half-century, these 70 million acres have been supplying more than half the Nation's needs for factory lumber and veneer logs, and they will have to meet at least an equal portion of the increased demand for these products in the future. In addition, they will have to grow vast amounts of pulpwood. Southern pulp mills sextupled their consumption of hardwoods in the last decade, and the end of this expansion is nowhere in sight.

These facts make it plain that we must intensify our forestry in good hardwood stands as well as in our wonderful pine forests. To what extent silviculture may be practiced in southern hardwoods is the question to be dealt with in this paper.

Some recent results with cottonwood show off the possibilities. In a plantation established by the Missouri Conservation Commission on a good Mississippi River bottom site near Hannibal, dominant trees averaged 6 feet per year in height growth during the first 14 years. Diameter growth over the same period averaged about one-half inch annually. This was achieved with little or no weed control (Wylie 1961).

By carefully cultivating to control weeds during the first year, Chapman and Dewey Lumber Company of Memphis, Tenn., established a cottonwood plantation on a favorable old-field site in the bottoms of the Coldwater River. The trees, which are now 9 years old, have annually grown 7 feet in height and 1 inch in diameter (McKnight 1963).

Intensive cultivation for the first 2 years rewarded another plantation owner, near Vicksburg, Miss., with an average annual growth of 15 feet in height and almost one and three-fourths inches in diameter the first 3 years, according to Virginia McKnight (1962). Considering the values inherent in species such as walnut and cherry and the technical qualities of oak and hickory coupled with their reasonable growth rates, there is no reason to doubt that comparable opportunities exist in species other than the poplars.

Achievement of intensive silviculture will depend a great deal on recognition of appropriate sites for the culture of hardwoods. Good hardwoods can be grown on sites of four physiographic classes: bottom lands of major rivers, uplands with rich soils, bottom lands of creeks and small streams, and some swamps. Within these classes, the growth rate and quality of major timber species are greatly influenced by soils and local drainage.

In several recent reports (Broadfoot 1960, 1961, 1963; Broadfoot and Krinard 1959) the growth capabilities of particular hardwood species are related to the series and phase of soils on which they occur. Growth relationships of white oak to soils of northeast Mississippi have been reported (McClurkin 1963). These are but examples of the classification work that is sure to become more exact and to form the basis for intensified silviculture. Already the soils on some important forest areas have been fully classified and mapped by experts. With accurate soil maps and corresponding capability ratings for hardwood species, the silviculturist can reliably choose the single or several species best adapted to each of his sites.

The intensity of silviculture that can be justified will be measured, partially at least, by soil productivity. On a site that will without amendment produce 400 cubic feet per acre annually, very intensive stand culture is likely to be well repaid. On a site capable of only 80 cubic feet, less intensive measures may be justified.

Hardwood silviculture of the future will recognize the demands for other use of land on which the forests grow. Our hardwood forests are the ideal habitat for game. Some bottom land sites may be inundated by new dams and by waterways. Others may always be in demand for agricultural purposes. The intensity of silviculture must be guided by the interrelationship of timber production with other uses of the forest or the site. Unbalanced multiple use may deter intensive silviculture. For instance, this past spring deer browsing severely damaged hardwoods in a plantation-spacing study of the Southern Hardwoods Laboratory. Some is both expectable and tolerable, but an overpopulation of deer (one deer per 7 acres) seeking food in the forepart of the growing season has

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kept new growth nipped back almost to the ground and very likely ruined a 220-acre study.

Thus, the application of silviculture to both natural and seeded or planted stands will be guided by site-species relationships and take into consideration the multiple uses of the forest or possible alternative use of the land.

A Silviculture For Natural Stands

Within the next decade there will be a marked increase in the effort to eliminate weed-species and culls from stands of hardwoods on qualified sites. But stand improvement is only preliminary silviculture. For mixed hardwoods on good sites, some form of partial cutting will always be necessary to avoid premature harvesting of trees capable of making premium products. The hardwood silviculture of the future will result in a mosaic of even-aged stands and will amount to group selection guided by the growth capability and potential value of the individual trees within the group (Putnam et al. 1960). Thinnings will not only promote good growth but will aid in quality control for specific products. Obviously they will be made practical by the expanding markets for pulpwood from southern hardwood forests.

Intermediate cuts will be made with an eye to favoring species and trees that have the least likelihood of producing epicormic branches and that have little sign of diseases or insects. Some crop trees of potentially superlative value may be protected from boring insects through the periodic spraying of the tree boles with long-lasting insecticides or repellents. In preliminary tests by R. C. Morris of the Southern Hardwoods Laboratory, annual spraying of boles in June with a 0.25 percent water emulsion of BHC has prevented attack by borers for the past 4 years.

In many cases, some site treatment will be required to obtain adequate regeneration of the desired species. Possibilities of such treatment are suggested by recent pilot-scale tests along the banks of the Mississippi River, where considerable acreages of high-quality site were taken over by the tolerant but undesirable boxelder after most of the pioneer cottonwood was logged. In a cooperative effort the Southern Hardwoods Laboratory and the Anderson-Tully Company logged or deadened all overstory trees except cottonwood and then plowed trenches to a depth of 8 inches and a width of 7 feet—the purpose being to prepare a bare, moist seedbed for cottonwood. So far, this site treatment has been very successful when applied in the spring on silty and sandy loam soils (Johnson 1962). Results on clay soils or when plowing was done in the fall have been erratic.

How about nutrition? Will fertilizers be used in hardwood silviculture? In natural stands near Tallulah, La., applications of nitrogen have significantly increased both diameter and height growth of 20-year-old sweetgum, willow oak, and water oak. It is too early to predict the economic significance of fertilizers, but these early results indicate a likely place for their use.

Of several soil amendments tested, supplemental watering has proved most helpful. Broadfoot (1958) found that where clay soils were kept covered with water during the winter, trees grew twice as fast the next growing season as they did on sites where no water had been impounded. These temporary lakes also attract waterfowl into hardwood forests. Particularly on broad slack-water sites, this multiple use management to aid both game and timber is being employed by a number of landowners. To avoid killing of timber, water is trapped only during the winter months and drained off early in spring.

Plantation Possibilities

Plantability of hardwoods has until recently been low, but certain species are now emerging as good candidates for particular sites—cottonwood, yellow-poplar, sweetgum, sycamore, green ash, and some of the oaks. Also, the possibilities of direct seeding are unlimited for open sites or situations where the forest needs to be converted to more desirable species. Discovery of appropriate techniques for repelling rodents from acorns will advance the reforestation of good hardwood sites. Physical properties of the soil as well as the nutrient condition may need to be amended to assure survival and successful growth of future hardwood plantations.

Of course, site will dictate to a certain extent what can be planted or which species should be favored, but Charles A. Heavrin of the Anderson-Tully Company has calculated a Species Value Index to compare the most important species in growth, form, and market value in west Tennessee. The Index is in terms of the dollar value of the annual growth per tree. Using an arbitrary 24-inch diameter for maturity and taking into consideration the average height and form of each species, he divided the volume of the average tree of each species by age to get the average annual growth per tree.

Then he converted the average annual growth per tree into dollars, using the Hardwood Market Report. The resulting Index appears below:

Species	*Value Index*
Black walnut	$1.61
Yellow-poplar	.72
Cottonwood	.70
Willow	.56
Cherrybark oak	.42
Green ash	.40
White ash	.36
Nuttall oak	.35
Sycamore	.34
Sweetgum	.31
Red maple	.30
Pecan	.26
Cypress	.25
American elm	.22
Hackberry	.20
Overcup oak	.19
Hickory	.11
Honeylocust	.10

It can be seen that a yellow-poplar can increase in value at the rate of $0.72 per year, while hickory is only increasing $0.11 annually—a species differential of 6 to 1. But cottonwood, with a lower market value than cherrybark oak, has a greater index because of its fast growth.

Of course relative values may change over the years. For instance, pecan has very recently become an extremely popular furniture wood, and veneer and lumber companies are competing for logs. Pecan is a fast grower on suitable sites and in addition provides food for deer, squirrels, and turkey. These considerations might well raise its position in the desirability index. Change is inevitable, but such an index, if carefully conceived and coupled with site-species evaluations, can provide an admirable guide to choice of species to plant.

Equally important will be site preparation and cultivation appropriate to the value index assigned and to the species to be planted. Illustrating the effects of differences in preparation is a cottonwood plantation on riverfront soils near Greenville, Miss. When it was established 5 years ago, it was given minimum site preparation, cultivation, and weed control. Another planting was made 2 years later on a well-prepared adjacent site where weed control was absolute and cultivation was intensive. Now the younger stand averages 42 feet tall and 6.5 inches d.b.h., while the older is the same height and has an average diameter of 6.7 inches.

In another place sycamore planted in trenches made by a fireplow was killed by excessive competition, whereas in cultivated plantations it performed well.

Rundown sites on alluvial soils may be rejuvenated by extremely deep plowing. Trials with a pan plow indicate that old pastures can be turned over to a depth of 16 inches for a cost of $15 per acre. Full benefits have yet to be determined, and so does the value of deep ditching to aid moisture retention next to planted trees on droughty sites. However, site preparation and maintenance are sure to be part of hardwood plantation management of the future.

When the development of superior planting stock assures us of uniformly good growth and survival, most of the guesswork will disappear from plantation spacing. We will be able to space pretty strictly on the growth requirements of the trees and the need for cultivation. With present-day variation in growth and survival, the conservative course is to space close within the rows, so as to provide against possible heavy mortality and also to allow some choice between survivors of differing form and vigor.

As a hedge against high risks of planting one species, plantations may be of two or more species. For instance, sycamore, sweetgum, and ash are likely to be planted with cottonwood on riverfront sites. Nuttall oak and green ash may be planted in alternating rows on slackwater sites. The degree of intermingling will be determined by factors such as shade tolerance, requirements for growing space, and machine plantability.

Until effective and economic methods of repelling rabbits and deer are developed, special food plants for such game may have to be established to entice the animals away from seedlings or seed and allow for maximum development of the trees.

Eventually these plantations will be started with stock developed or selected for good tree form, fast growth, resistance to insects and disease, and heavy yield of high-value wood products. In the South such planting stock may first be achieved with cottonwood, which is exceptionally suitable for genetics and tree improvement research. Breeding techniques are relatively simple with *Populus.* and improvement once expressed in a single genotype can be maintained indefinitely on a commercial basis by way of vegetative propagation.

It should be clear from the foregoing that genetic improvement of the important plantable species would greatly enhance the returns from money spent on cultural techniques. It is almost a password phrase for the geneticist but it is worth emphasizing that we shall more and more realize that genetic improvement, once established, results in long-term profits without further costs.