

## Current status of research

# Genetic Improvement in Southern Hardwoods

By **ROBERT E. FARMER, JR.**

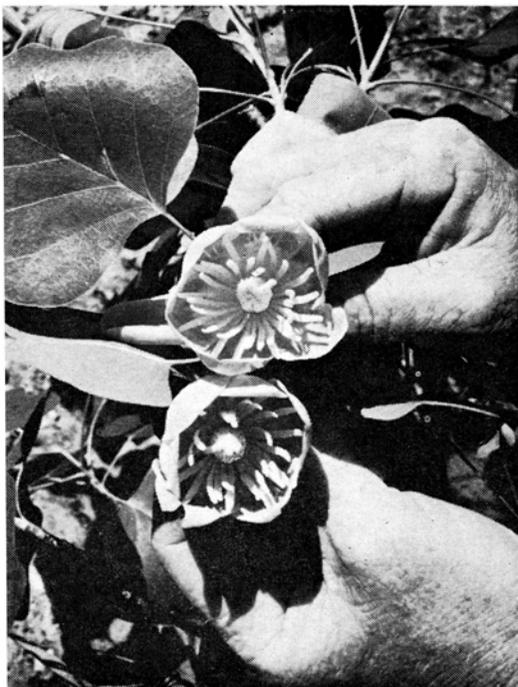
*Southern Forest Experiment Station, U. S. Forest Service*

**G**enetics research in southern hardwoods has moved during the past decade from a minor position in a few organizations to major status in most of the South's forest research establishments. This growing interest in tree improvement has stemmed from the increasing use of hardwoods for pulp and a decreasing supply of high-quality hardwood sawtimber. These two aspects of the southern hardwood situation have stimulated broad programs of investigation in which genetics research is essential.

### Species and Goals

Approximately 30 percent of the South's current tree improvement research is with hardwoods. Most attention is being given to sweetgum, yellow-poplar, cottonwood, sycamore, and the oaks. Sweetgum improvement projects are the most numerous; this tree, widely distributed in the South, is important to both paper and lumber manufacturers.

**Flowers of yellow-poplar. All aspects of hardwood flowering are being studied**



Research on yellow-poplar is concentrated mostly in the southern Appalachians and the Southeast, where the species has high value for lumber. Cottonwood, an especially important pulp and lumber species in the flood plain of the lower Mississippi River, is the subject of intensive research there.

Work is just beginning with some of the more valuable oaks (cherrybark, northern red, and white), and with sycamore, which may be on the verge of new-found economic significance. All of these species have at least three characteristics in common: they are crucially important to one or more major segments of forest industry, they are currently being planted, and they grow rapidly on suitable sites. In other words, they are adaptable to intensive management.

Ultimate goal of hardwood tree improvement research is development of planting stock with genetic potential for superior growth, good form, pest resistance, and desirable wood properties.

**Principal goal of tree improvement is production of high-quality timber at rapid rates of growth. This cherrybark oak exemplifies what is sought in new stands**



### Organizations

Southern hardwood improvement programs are being conducted by the U. S. Forest Service, the Tennessee Valley Authority, several states, forest industries, and universities. Forest Service research at the Southern and Southeastern Forest Experiment Stations ranges from work in genetic theory to breeding projects and supporting work in physiology.

The TVA program consists of applied breeding and related physiological research with six important species in the southern Appalachians: black cherry, black walnut, yellow-poplar, and northern red, white, and chestnut oaks. University research varies from fundamental work in cytogenetics to long-term breeding programs. Most state and industrial work is aimed at producing the best material possible with current knowledge and techniques. Some of the best programs are cooperative efforts between universities, federal agencies, and state and private organizations.

## Current Knowledge

At least two bodies of knowledge are essential to the design of a breeding program for any species:

First, the breeder must know how much his species vary in important characters and how these variations are genetically controlled.

Second, in order to take advantage of variation through selection, he must have silvical information to successfully cross, propagate, and grow his breeding stock.

*Variation*—One of the first steps in assessing genetic variation is to determine the range in tree-to-tree variation in natural stands. This knowledge makes it possible to establish standards for choosing breeding material. In evaluating growth or form, the breeder may simply do a lot of walking and looking, then set realistic, yet high, selection criteria. Variation in wood properties will require more formal study. Variation in most important southern hardwoods has been or is being studied by sampling natural stands, and some useful information has been developed. For example, wood properties vary considerably in sweetgum, cottonwood, yellow-poplar, and tupelo gum. Most of the variation is due to tree-to-tree differences within stands; smaller differences have been found between stands and geological areas.

While surveys of variation in natural stands are useful preliminaries, they give little direct information on the genetic control of variation. Estimates of genetic variation are obtained from provenance, progeny, and clonal tests.

Provenance tests are designed to determine how a species varies genetically from region to region. In brief, they consist of collecting samples from over a species' range and growing them together for comparison purposes at one or more locations in the range.

In the South today provenance tests are under way for cottonwood, sweetgum, sycamore, yellow-poplar, southern red oak, and water tupelo. Studies of northern red oak, black cherry, yellow birch, sugar maple, and black walnut, now being conducted within the commercial ranges of these species, are also of interest to improvers of southern hardwoods.

Results from yellow-poplar provenance tests have shown no difference in juvenile growth among southern sources. However, early results with other species indicate considerable geographic variation. In a Stoneville, Mississippi, test of sweet-

**The form and vigor of this towering cherrybark oak make it an outstanding source of breeding material**



gum from various Mid-south sources, coastal material has shown better early growth than local or Tennessee trees. In central Illinois, cottonwoods from southern Illinois have performed better than local trees. These data suggest the exciting possibility of improving growth rate by using material from a few hundred miles south of the planting site. However, much more testing will be required before this speculation can be transformed into recommendation.

The progeny test, in which performance of seedlings from selected parents is studied, is the breeder's main tool for most species. Briefly, this test is a method of determining a tree's value as a parent, i.e., the degree to which it endows its progeny with genetic potential for superior performance.

Progeny test observations to date have been made only for juvenile characteristics, but may be indicative of future results: In cottonwood and sweetgum, variation between progenies has been noted for height and diameter growth, branch characteristics, and spring foliation dates. Juvenile wood properties and disease resistance in cottonwood have also been shown to be under considerable genetic control. Progeny differences in yellow-poplar growth have been reported. When more data are obtained from these tests, we will be able to predict genetic improvement to be gained by selecting parents on the basis of their progenies' performance.

Some species, such as cottonwood and sycamore, may be easily propagated by cuttings. Plants thus propagated from an individual tree are genetically identical, and are referred to collectively as a clone. Final choice of genetically superior clones is based upon results from clonal tests. To date, such tests have been established only in cottonwood, a species for which considerable data on juvenile variation exists. For example, clonal variation in growth, phenology, specific gravity, and resistance to *Melampsora* rust is under moderate to strong genetic control. Selection can therefore be made for these characters in clonal tests.

*Silvical and Physiological Characteristics*—In early phases of tree improvement research some of the most important work is not genetic, but silvical and physiological. For example, information on a tree's flowering characteristics is essential to developing crossing techniques and to producing seed in orchards.

It is amazing how little foresters have known about the sex life of their trees, perhaps because it all takes place inconspicuously 50 to 100 feet above their heads. Geneticists are now studying flowering from morphological, physiological, and ecological points of view. One of the physical problems in hardwood improvement is making crosses at the tips of brittle branches in tall trees. This difficulty has been overcome in yellow-poplar and cottonwood by shooting down flower-bearing branches, grafting them to potted stock, and crossing in the greenhouse.

Vegetative propagation, necessary to establish breeding arboretums or clonal seed orchards of selected trees, is not as difficult with hardwoods as with pines. During the past 10 years, cuttings from mature cottonwood, sweetgum, and yellow-poplar trees have been grafted and rooted successfully. Stem cuttings from young sycamores root well, and few difficulties are likely to be encountered with mature sycamore. The major propagation problem is with the oaks, which are moderately difficult to graft and very difficult to root.

With a few exceptions, methods for establishing hardwood plantations have not been standardized. Hence, some seedling and planting research is necessarily being done within improvement programs. Here again the oaks present problems because of their slow recovery from planting shock; planting seedlings in containers is, therefore, a promising procedure. Successful establishment of other species depends upon attention to site and cultivation. One important phase of research deals with relationships between cultural techniques, such as fertilization, and the performance of improved stock. This work should provide a silviculture designed to fully utilize improved genetic potential.

*Breeding Systems*—Perhaps the only feature common to all breeding systems is that they begin with selection of high-quality trees from natural stands. Otherwise, systems for individual hardwood species are as variable as the trees' silvical and genetic characteristics. In cottonwood breeding, for example, there may be little place for the progeny-tested seed orchard so familiar to pine improvers. Instead, the goal will be development of vegetatively propagated clones with highly predictable superior attributes. This sort of program is more similar to breeding sugarcane or rubber than pine.

Sweetgum, yellow-poplar, and oak programs, in contrast, will be basically similar to pine breeding systems in that seed orchard establishment will be a central feature.

### Application

What can you, as consumers, expect from hardwood tree improvement research in the next decade? As in southern pine breeding, most of the information acquired early will be of interest chiefly to breeders. Some data on variation and inheritance, flowering characteristics, and grafting procedures are essential to breeding, but have little direct application in management. On the other hand, information on racial variation will be directly applicable to planting programs. For example, within a decade geneticists should be able to tell how far up or down the Mississippi River you can move cottonwood successfully and whether a growth advantage can be obtained by planting trees slightly north of their origin. Silvicultural information obtained from progeny and clonal plantings should also be of considerable use soon. It will include some detailed data on growth and yield of intensively managed experimental plantations on a range of sites.

Results in terms of genetically improved stock will vary a lot with species. Some improved cottonwood clones should be available for pilot plantings with 5 years. Yellow-poplar orchards now being established should be producing seed for commercial use in 10 years. But I won't make a public guess as to when we will have acorns with guaranteed genetic potential for high-quality veneer.

In short, hardwood tree improvement research is advancing knowledge on a number of fronts. Application of this knowledge will not only lead to genetically superior planting stock, but will also help develop an intensive silviculture under which genetic potential can be fully realized in profit terms.

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*When this paper was prepared the author was Plant Geneticist at the Southern Hardwoods Laboratory at Stoneville, Mississippi. He is presently Plant Physiologist, Tree Improvement Section, Division of Forestry Development, Tennessee Valley Authority, Norris, Tennessee.*