

## SELECTION AS A METHOD OF TREE BREEDING<sup>1</sup>

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One objective of tree breeding is to provide trees of better genetic quality. The speed with which the breeder can do this is a good measure of his effectiveness. Therefore, he is inclined to produce new combinations of traits with just as few manipulations as possible, regardless of whether the traits come from individual trees, races, varieties, native species, or introduced species. The tree breeder is more anxious to make use of the opportunities that present themselves, irrespective of the method of breeding or combination of methods, than to follow each classical method, such as tree introduction, selection, hybridization, or polyploid breeding, to the complete exclusion of the others. The more he can work with familiar or local trees, varieties, or species the more certain he can be that some important undesirable traits will not interfere with his plans.

The South is very fortunate in that a fairly wide variety of genetic stock is available in various species, races, and individual trees. This might be called the hope of the tree breeder and the despair of the silviculturists. It is the hope of the breeder because he can create innumerable combinations of traits for various specialized strains without having to worry much about introducing undesirable ones. It is the despair of the silviculturist because no two trees are alike.

In order to appreciate how easy it is to introduce undesirable traits along with a foreign tree species or a hybrid of a native and non-native species, just add up sometime all the factors of soil fertility, soil moisture, temperature, temperature changes, insect pests, disease pests, day length, length of growing season, windstorms and competing vegetation under which southern pines grow fast, reproduce well, and produce a large number of valuable products. A different species or species hybrid, to be more valuable, would have to excell in many traits and have no really poor traits.

Genic action can affect morphological, physiological, or chemical traits. *We* can't do the optimum job in single-tree selection, hybridization, or racial selection, including

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analysis of progeny test data of any kind until we can define variation within species fairly well for all the southern tree species. It is up to the tree breeder and geneticist to make use of the skills of various specialists, such as wood technologists, pulp and paper technologists, plant physiologists, and others to work on various traits. These people are competent in their fields of work, but need advice on how to work on the tree breeders' problems.

Forest genetics research need not be dictated by tree breeders, but it should be made to serve applied tree breeding. We have made studies in such fields as soils, botany, physiology, silvics, wood utilization, and others serve silviculture. Forest genetics should be no exception.

We should all make an effort to see that no gap exists between our basic forest genetics research and research in forest tree improvement or in applied forest tree breeding by research people or industry. Certainly it is profitable to seek out the basic laws with which we are to explain relationships, but we can exercise considerable judgment to choose the subject fields in which we want to search for "laws" and in the choice of tree species or other material with which we work. People other than foresters are concerned with the relationship between fields of research, as you will note from the following excerpt from the report of the Twentieth Century Fund by August Heckscher, Director (1961):

"Of the responsibility of research in contribution to action I would speak in somewhat more detail. The discouraging fact seems to be that research is becoming increasingly divorced from deeds. The social sciences seem to have taken over from the natural sciences the old idea that any addition to human knowledge is of itself a boon, regardless of its seeming pertinence or relevancy. A new fact is expected to come in handy, like the missing piece of a jigsaw puzzle, when it is most needed. The trouble is, of course, that in the world as it actually exists, with its imperious necessities and its huge accumulation of books and surveys, the isolated fact is apt to remain isolated. Having been given no life or destiny by its first begetter, it is all too unlikely ever to be given life by another. It dies within its own solid covers, too remote or detached to influence the rapidly moving stream of events. Research which disavows any responsibility except that of being objective and nonutilitarian may well qualify as pure but it is a kind of purity which a society--particularly a society in an age of change--can over-value."

When a man of the stature of Glenn I. Seaborg--physicist and chancellor of the University of California--in his report as Chairman of the Panel on Basic Research and Graduate Education of the President's Science Advisory Committee (1960) makes a statement like the following

Table 3. Average Survival, Height and DBH of Ten-Year-Old Loblolly Pine by Seed Origin and Planting Locations

Origin of seed	Planted within native range <sup>a/</sup>			Planted outside native range			
	Alabama, Jefferson County	Alabama, Marshall County	So. Carolina, Union County	Arkansas, Newton County	Illinois, Hardin County	Tennessee, Anderson & Union Counties	Kentucky, Marshall County
<u>Survival, percent</u>							
Atlantic Coast:							
Maryland	77	8	73	58	53	79	16
South Carolina, lot 2 <sup>b/</sup>	79	4	58	10	73	90	31
Virginia	71	10	69	65	49	76	56
North Inland:							
Alabama	94	61	94	75	63	95	88
Mississippi	75	46	66	75	59	67	56
Tennessee	94	73	67	92	85	87	60
South Inland:							
Alabama	96	62	94	73	79	93	68
Georgia	96	67	90	96	89	94	78
Mississippi	83	19	73	72	71	81	31
<u>Average height, feet</u>							
Atlantic Coast:							
Maryland	27	22	24	26	20	26	17
South Carolina, lot 2 <sup>c/</sup>	26	25	28	20	19	29	18
Virginia	31	19	25	28	20	26	20
North Inland:							
Alabama	30	23	25	28	21	30	22
Mississippi	29	24	23	28	22	27	20
Tennessee	29	20	23	27	24	27	18
South Inland:							
Alabama	29	24	24	26	20	27	20
Georgia	28	23	23	28	23	28	18
Mississippi	29	20	24	27	21	26	14
<u>Average DBH, inches</u>							
Atlantic Coast:							
Maryland	4.6	5.6	4.8	5.3	3.6	4.5	3.4
South Carolina, lot 2 <sup>d/</sup>	4.0	4.8	4.8	3.5	3.1	4.4	2.9
Virginia	5.4	4.6	5.1	5.5	3.7	4.3	3.4
North Inland:							
Alabama	5.2	5.1	5.4	5.8	4.1	5.4	3.6
Mississippi	5.2	5.3	4.9	5.5	4.2	4.8	4.0
Tennessee	5.2	4.6	5.0	5.7	4.5	4.8	3.6
South Inland:							
Alabama	5.0	5.6	4.9	5.3	4.0	4.9	3.8
Georgia	5.0	5.1	4.8	6.0	4.2	5.1	4.0
Mississippi	5.2	4.8	4.8	5.7	3.8	4.7	2.2

a/ Excludes the planting in Lafayette County, Mississippi, which was dropped as a failure after 5 years.

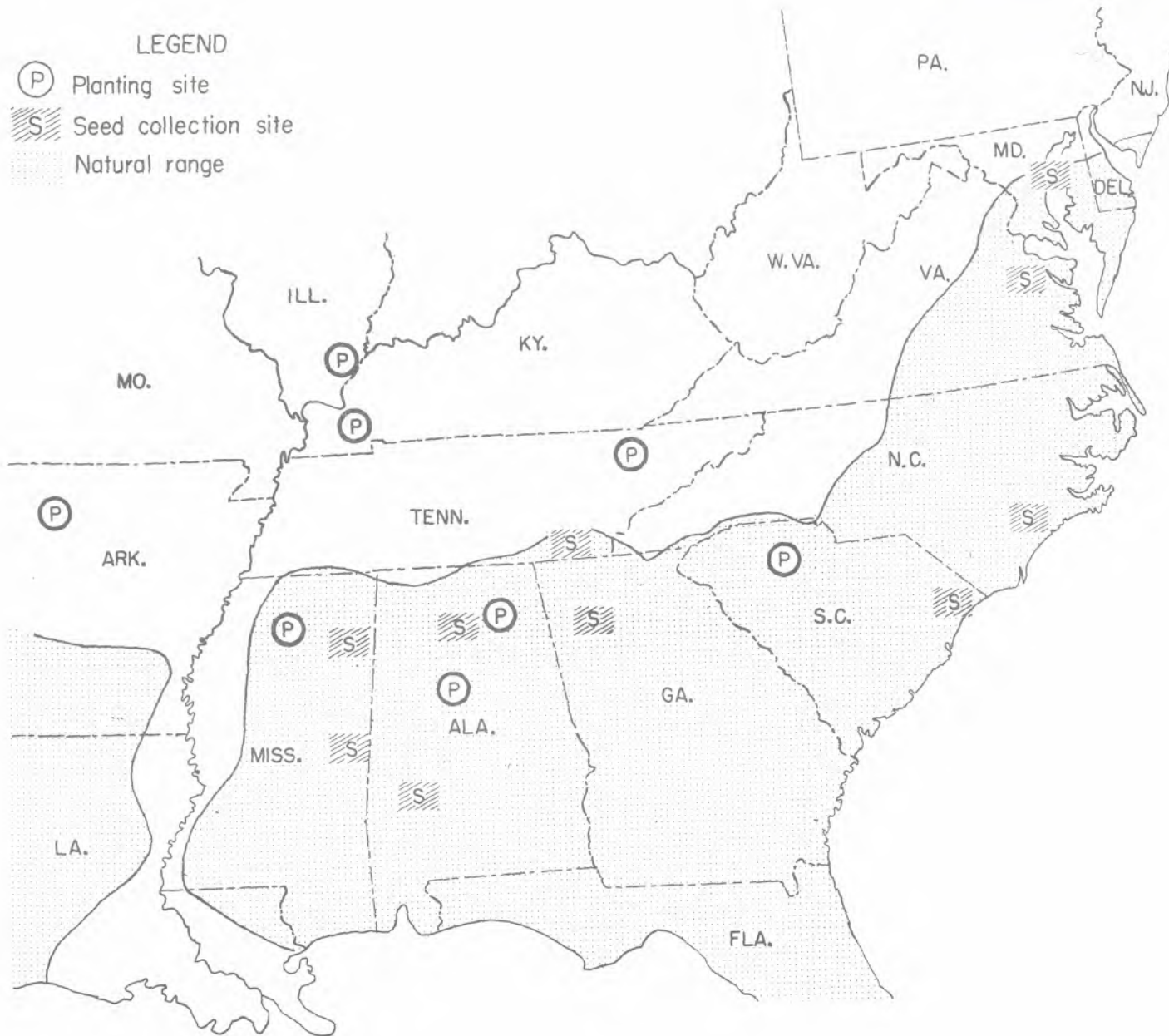
b/ Eighth year survival. The original planting from North Carolina seed failed and was replaced the following year by South Carolina seed lot 1 which also failed. The South Carolina seed lot 2 planting was established in the winter 1951-1952.

c/ Adjusted to 10-year heights; average 8-year heights were four-fifths of the values shown above.

d/ Adjusted to 10-year DBH; average 8-year diameters were four-fifths of the values shown above.

FIG. 1

# COOPERATIVE LOBLOLLY PINE SEED SOURCE STUDY



we should pause to consider it. He says, "Because basic research is aimed at understanding rather than at practical results, the layman sometimes assumes that it is entirely abstract and theoretical, and that only when it becomes a matter of industrial development does it 'come down to earth'." This is a false notion, and its falsity becomes increasingly clear with time. Indeed one striking characteristic of our scientific age has been the disappearance of the barriers between pure and applied science." Later in the same section he says, "Part of the strength of American science stems from close intellectual intercourse between basic and applied scientists. . . . We do not believe in any artificial separation between basic and applied research or between science and engineering. The fact that a scientific advance is useful does not make it unscientific."

The alternative to research in the more important fields of forest genetics with important tree species is work in unimportant fields or with unimportant species. We don't need to go overboard and everyone work on the same problems, It would be ridiculous for all of us to work on variation and inheritance in slash and loblolly pin. It would be equally ridiculous for all of us to work with holly, Chinaberry, or Arizona cypress. However, everyone should take the responsibility for directing his own work to make it effective.

With the objective of service to the tree breeders and silviculturists in mind, the work of the geneticist is often simplified because the subject fields and the species are more accurately delineated. If we accept the fact that genetics is the study of variation and inheritance, then we can pursue studies in these fields with the most important species at different locations. This may seem a narrow definition, yet it is the type emphasized in many publications. The 1936 Yearbook of Agriculture defines genetics as: "The science of heredity, variation, sex determination, and related phenomena." Crane and Lawrence (1952) in their book, "The Genetics of Garden Plants," state: "The study of uniformity and variation, of resemblances and differences between plants and the frequency in which the characters constituting these resemblances and differences appear from generation to generation is the business of the geneticist." Andrews, Warwick , and Legates Rice et al (1957) in their book, "Breeding and Improvement of Farm Animals," say that genetics "can be defined as the science which seeks to explain the resemblances and the differences which are exhibited by related organisms." Montagu (1960) in his book, "Human Heredity," says that "genetics is the branch of biology concerned with the manner in which inherited differences and resemblances come into being between similar organisms."

Since species, racial, and individual tree variations are of such great importance to the tree breeder, strong effort should be directed toward their study. In the southern pine, particularly the major ones, species differences are fairly well defined. Studies of geographic variation are under way in the major southern pines as well as racial variation studies



Undoubtedly, clonal and progeny tests give valuable data on variation and inheritance, and we have to have this information, but tests are slow and tests are expensive. Because they require a lot of space, rarely can they include test trees with a large number of different traits that may occur in a species. Also, to be most useful and productive, they should be based on information about variation so that the selection of traits to test is good and the design of the study is adequate, especially in regard to plot size and number of replications. In other words, to be good the progeny tests should be based on some of the data that they are now being designed to produce.

Studies of variation should be made in a logical sequence to be of the most help in applied breeding. We need them first for the economically important species at different locations over the South. We need studies of important traits of high utility and we need them for waste products, such as bark and lignin. It is common practice in research circles to make a study of a certain subject using one or two species. After the results are reported the tendency is to not follow up with more detailed studies or other species because it would seem to be repetitious. From the standpoint of forest genetics research it might be sufficient to show that trees in fairly uniform stands vary in certain traits. From the standpoint of the tree breeder, this is not adequate, because he wants to know the range of variation in each of a large number of traits, for each species, under some different environmental conditions, particularly on different sites. This is a job for research people, but in the past, most of the data on variation and inheritance has come from applied breeding projects instead of the fundamental or basic research projects.

Studies of variation can be planned to progress in an orderly manner, increasing in cost and precision as the subject merits. Probably the most simple is to sample or measure trees under conditions where most of the factors thought to affect the trait are held as nearly constant as possible. For example, we could work with trees of the same diameter, height, and crown class in a uniformly spaced, even-aged stand on a level site where the understory is nonexistent or very uniform. It is true that this measures phenotypic variation, but it is variation where the environmental effects are as small as it is possible to make them. If no variation of economic importance is found, it certainly would not encourage anyone to test for it further in different environments or with clonal or progeny tests. If the trait does vary widely, however, additional study is warranted. This could be done with trees of different size on the same site, or then, in other studies, with trees of different sizes on different sites. If variation is still present and can't be explained by measurable environmental factors, and it occurs in economically important traits, clonal tests and others with sexually produced progeny are warranted to give information needed in seed orchard or applied breeding work. As stated earlier, these methods of studying variation put the physical effort and cost in studies where the most precision and most useful results to silviculturists and tree breeders are needed. There is little point in studying environmental effects or inheritance of traits that don't vary.







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