# 8. SHORT-TIME AND LONG-TIME POSSIBILITIES OF SELECTION IN FOREST TREES

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The subject assigned to me in this conference on accomplishments in forest tree improvement in the South is the "Short-Time and Long-Time Possibilities of Selection in Forest Trees." Before we get involved in what may be a technical discussion of "maybes" and "if" in forest tree improvement, a definition of selection is in order. One that applies very well to forest tree improvement work is given in the 1936 U. S. Department of Agriculture Yearbook. It was included in a glossary prepared by the American Genetic Association.

## Selection Defined

By definition selection is: "The choice, from a mixed population, of the individuals possessing in common a certain character or a certain degree of some character. Two kinds of selection may be distinguished: (1) natural selection, in which choice is made automatically by the failure to reproduce--through death or some other cause--of the individuals who are not "fit" to pass the tests of the environment (vitality, disease resistance, speed, success in mating, or what not); and (2) artificial selection, in which the choice is made consciously by man, as a plant or livestock breeder, for characters of value to man."

## Natural Selection

Note that a distinction is made between natural selection and artificial. The tree breeder has little control over natural selection, but he can utilize the products of natural selection. We have just heard a discussion of "geographic" races, or "seed source" studies. It has been pointed out that many races are a result of environmental factors that exert selection pressure differing from that in other areas. Natural selection then creates opportunities for selection of races, strains, ecotypes or other groups that occur over geographic space within the natural range of a species. Within races there may occur other types of variation attributable to various genetic effect's which provide opportunities for single tree selection.

## Artificial Selection

The second type of selection, artificial selection, is of great value to the tree breeder. Through selections in mixed populations have come many kinds of better plants and animals. Selection of the better individuals of common crop plants and animals was applied for centuries before the discovery of sex in plants in the Eighteenth

Century--fairly recent times in the history of agriculture. The selected individuals then crossed naturally or were inbred and created additional populations to which selection was applied. If vigor declined it was restored by outcrossing. Each step, over the centuries, in improving the strain might have been small, but the accumulative effect has been large, so large, in fact, that it is impossible to accurately tell the wild ancestors of some crop plants such as corn.

## Basis for Selection

Notice that our definition states selection is the "choice from a mixed population". There must be a mixture of genotypes within a species in order for selection to be effective. This is logical because obviously if no genetic variants existed all individuals would be similar genetically and produce uniform offspring. Genetically, where no variation exists in the genotype, the individuals are a pure line--they are homozygous. This is important because it points up one of the limitations of selection. It is not effective in pure lines. Selection can only isolate variants, it cannot create them.

What basic evidence have we that forest tree species are mixed populations genetically? First, consider the plight of the dendrologist. Beset with difficulties in describing species, he has created varieties, races, and forms to describe differences between groups within species. The many taxonomic categories in species such as Douglas-fir and Scots-pine are strong evidence that these species are not genetically uniform. A variety of slash pine was formally named recently. Several publications have discussed racial variation in loblolly pine. Only recently has the Forest Service, U. S. Department of Agriculture, recognized pond pine as a species rather than as a variety of pitch pine.

Trees probably contain a number of genes for each trait that is important economically. The genes occur in different combination so that no two trees are exactly alike. The lack of uniformity is apparent in every planted stand and is in sharp contrast to the amazing uniformity of trees from rooted cuttings of a single tree or the inbred progeny of a single tree.

Mutations cause still another type of variation. Mutations are. sudden changes in a gene or genes that are passed on through inheritance. Many ornamental plants of unusual type are mutants and numerous commercial varieties of citrus and other fruits are of this origin. The varieties and forms have been isolated by selection and preserved over the years by vegetative propagation.

Certain plants may have more than the usual number of sets of chromosomes. These are polyploids. Some authorities consider this a type of mutation while others do not. Polyploidy occurs frequently in hardwoods and species form polyploid series within certain genera. One species will have two sets, which is normal, while other will have three, four, five, or more.

From this discussion we learn that, within a given tree species, there may be differences between trees or groups of trees that are a result of natural selection--different combinations of genes, mutations, and polyploidy. Each may cause certain desirable or undesirable traits, and they will be inherited in some degree by their offspring. They are the causes for variation in trees and provide the basis for selection.

Certain tree species may be extremely uniform genetically. If so, there will be very little opportunity for improvement through selection. Selection must be very rigorous if it is to be effective. Any undesirable genes the species may have will have to be replaced by those of another species through controlled breeding. If the species is very uniform, there will be little need for careful selection of breeding stock to represent the species in hybridization with other species.

If tree species are variable there is opportunity for selection and isolation of the outstanding individuals or races. Also, there is opportunity for transfer of genes by breeding within the species. In crossing with other species it will be necessary to use several parent trees in order to sample the species. Otherwise, the hybrid offspring may be the offspring of two variants rather than a typical species hybrid.

The practice of leaving well-formed seed trees and collecting seed from trees of good form should result in more uniform stands, and they should be uniformly good. The degree of uniformity in the natural stand or plantation will depend upon the qualities of the parent trees, and, if only a few are involved, the offspring probably would be fairly similar; but if a large number of parent trees are involved, such as in a shelterwood or seed tree stand, more variation between individual offspring is to be expected. It should be pointed out here that not all differences between trees are important economically, and this should be taken into consideration when criteria for selection of crop trees or mother trees are chosen; also, when studies of phenotypic variation are made.

## Studies of Variation Needed

If the value of selection is dependent upon inherent variation, then studies of variation are fundamental to a program of forest tree improvement. There has, however, been a curious lack of willingness on the part of the tree breeders to study variation. In our current programs we find much-to-do about selection of superior trees; but one does not select superior trees, period! He first studies variation. It may be informal--a casting of eyes over two or more trees growing together and a quick comparison of their good and bad points--but study variation he certainly does. He also tries to separate environmental and genetic effects on tree form and growth. No one wants superior trees as such--they want superior trees that produce superior offspring.

The full potential of selection as a crop improvement technique will never be obtained without full knowledge of the variation within plants. Let us not neglect this work any longer. Also, let us report our studies in variation for the benefit of others.

We should learn the range of inherent variation for each important trait in all species of southern pine. We know right now many differences between the major species, but we know less about the minor species, and much less about differences within species. There is a tremendous volume of potential breeding stock among the species and varieties of southern pine. There will be a need for breeding with foreign species in some instances, but perhaps we can get by without using them and thus avoid the problems concerned with the long-time testing of introduced tree species.

Studies of variation may be made by transplant studies of various races such as you have just heard discussed in connection with the seed source studies. Form, wood quality, and other traits can be studied in natural stands and plantations, where a number of environmental factors are constant. Studies of natural stands should provide the basis for additional studies where precise methods are used. Performance of the progeny is the important criterion of inheritance of a trait and progeny may be obtained from seed after wind pollination, controlled pollination between trees, or inbreeding. If vegetatively propagated material (because in this material genetic effect between plants is constant) can be included in progeny tests, an extremely wide range of inheritance data will be obtained. Thus, inheritance data should come from tests that include vegetatively propagated material, in addition to seedlings after inbreeding, controlled breeding with another tree, and wind pollination. By adding a site variable, the interaction of genetic factors and some of the environmental factors can be determined.

The inheritance of commercially important traits must be known if selection is to be highly efficient, because we should know how much weight to give each trait when selected trees are evaluated. The superiority of a plus tree is the sum of the products of the economic value of an important trait and its strength of inheritance. It is fruitless to give great weight to a trait that is not strongly inherited. Thus, our current recommendations for selection of plus trees must be based on estimated values for inheritance. Obviously, the recommendations will become more precise as our knowledge of variation and inheritance increases.

## Benefits of Selection

In the immediate future, selection will isolate existing genotypes of local species. Based on what we know now of variation and inheritance, these trees will be straighter and branches will be smaller; the sterns will have less taper and there will be very little forking. They may grow faster and be less susceptible to attacks by pests. Studies of variation followed by selection of valuable types will bring to use valuable natural mutations, if they occur.

Over the years, selection and controlled breeding will create tree types much superior to any in existence today. Not only will they grow faster than the average trees today, but they will be uniform. Most of the undesirable genes will be bred out of them, and all trees in a stand will have high utility.

Current results in selection of individual trees and studies of variation will be given in papers which are to follow.

## Summary

In summary, selection practices based on studies of variation will disclose valuable genes or valuable gene complexes if they exist within tree species. Selection will not create new types, it merely isolates single trees or races of trees. Many of these variants will be commercially valuable and form the basis for so called "improved strains". Other variants will, over the years ahead, have value as parent stock in selective breeding programs to create gene complexes superior to those found in nature.