CHAPTER 21

COMBINED BREEDING AND SEED PRODUCTION IN CLONAL ORCHARDS AND SEED PRODUCTION AREAS

The second most important job in tree breeding, after establishment of the biological basis for developing genetically better pines, is to produce seed in large volume. This is not a small task. With seedling production in the South at some 400 million a year and assuming a yield of about 10,000 seedlings per pound of seed, the yearly seed requirements amount to about 40,000 pounds. In comparison with an agricultural crop that can be machine sown, tended, and harvested, this is not a particularly large volume, but when we consider the hand labor required for collecting pine seed, and the equipment needed for extraction, cleaning, and storage, it becomes a job of formidable proportions.

This problem of producing seed in volume must be a major consideration in any breeding method. The situation is analogous to some problems in industrial research and development: A process of technique that was fairly simple in the laboratory may be impossible or immensely costly under production conditions for commercial use.

SEED ORCHARDS

In the South, the clonal seed orchards in use by industry and State and Federal agencies are combinations of breeding methods and commercial seed production areas (fig. 203) (Zobel *et al.* 1958; Zobel and McElwee 1964). Their success is a result of a fortunate set of circumstances peculiar to southern pines and of considerable ingenuity on the part of tree breeders to overcome several problems and make the system work.

A few tree breeders working in other regions and unfamiliar with southern pines have viewed with alarm the costs in relation to gain, but few have suggested anything better. This is healthy and normal in developing forestry systems, because new ideas should stand and be challenged. Some debate continues among tree breeders and forest land managers, and refinements in techniques are continuous, but the basic principles and ideas seem to gain in strength and merit.

A point that often escapes attention in discussion of the seed orchard program in southern pines is that considerably more is involved than collection of seed from grafted trees. The seed orchards are but one part of the complex job of producing a large number of good-quality tree seedlings in which a landowner invests time and money in a crop whose harvest date is many years hence.

Figure 203.—An excellent seed orchard of grafted slash pine in Texas. The trees are 10 years old and the ortets were selected for a combination of traits such as rapid growth, good form, and high wood specific gravity. (Texas Forest Service 1972)

A nurseryman for a forest industry may produce 20 million pine seedlings a year. This is enough seedlings to plant 40,000 acres at 500 trees per acre. If 400 trees per acre survive for 30 years, their gross value is $370 per acre, or $14,840,000 for combined products of pulpwood, sawtimber, and gum on areas with a site index of 60 feet at 25 years (Bennett and Clutter 1968). An increase of 10 percent in volume growth from better seed raises net return $1.5 million, 15 percent $2.2 million, and 20 percent $3 million. Furthermore, the seedlings produced each year have this potential.

A subcommittee of the TAPPI Forest Biology Committee is making an in-depth case study of southern pine kraft linerboard, integrating the influence of silvicultural treatments, genetic improvement, and technological modifications, by means of a linear programing model (van Buijtenen 1973). To evaluate a number of major management decisions, some of the important variables studied included interest rate; genetic improvement for growth rate, wood specific gravity, and rust resistance; application of nitrogen fertilizer; and rotation age. The economic values will enable woodland managers to decide which methods should be used to modify woody raw material and will enable pulpmill and papermill managers to decide which fiber sources should be used and how best to utilize them.

Inasmuch as a producing seed orchard is the result of several levels of selection, the factors acting to raise genetic quality are cumulative. The first of these might be racial selection. Several studies show that a race from a slightly warmer location may give increases in height growth of 10 percent or more. This amounts to volume growth per tree of 20 percent or more. In addition, the best trees in the race are selected for seed orchard clones, and volume growth of offspring of these trees may be 20 to 30 percent above average, or more. Furthermore, the seed orchard clones are somewhat more resistant to diseases, which results in higher survival of trees per acre. Progeny testing the seed orchard clones weeds out those with the lowest performance in each trait or combinations of traits, and it may raise production another 10 to 15 percent. Progeny tests with cross-pollinated progeny of plus trees and top crosses of randomly selected orchard clones have shown wood volume increases much higher than those used above. Further progeny testing and careful roguing in seed orchards are expected to raise yields still higher.

Many results of progeny tests are reported in height growth only, because of the relatively young age of the trees. But stem diameter has a much stronger effect on volume than does height; thus, comparisons are misleading. A 20-percent increase in height superiority may mean nearly 40 percent greater volume, and if, in addition, more trees survive because of higher vigor or resistance to disease, the superiority in volume growth per acre may be far greater than indicated if only one trait is considered. If each trait is reported separately and the analysis stopped short of the combined effect of all factors, the amount of genetic gain is underestimated.

If planting stock from seed orchards is used in areas of high disease incidence, much greater benefit is obtained from the disease-resistant traits than if the stock is planted in areas of low incidence. Thus, geographic location of plantations is an important factor in computation of gains from seed orchard projects. For example, in the belt of high incidence of fusiform rust across the South from east to west, the gains will be much higher than in areas either north or south of the broad area. Furthermore, seed orchards to produce seed for use in the area of high disease incidence should give greater weight to resistance to fusiform rust than those in other locations. Improvement in volume growth areawise because of increased resistance to disease might be equal to or even greater than that from increased vigor. But, in practice, it would be difficult and rather pointless to separate the two.

SEED PRODUCTION AREAS

In the absence of seed orchards, the forester is still faced with problems of seed supply. He must obtain each year fairly large volumes of cones and seed. Also, he has the problem of doing this within the limitations imposed by racial and tree-to-tree variation. Thus, prices paid for seed must be high enough to attract private collectors in specific locations who will observe rules regarding choice of trees from which to collect.

Seed production areas (good stands thinned to the best trees and wind-pollinated) offer an alternative in control of genetic quality of the seed somewhere between random purchases from private collector and *seed orchards*. Geographic location of seed sources can be controlled, but quality of individual trees will not be as high as in seed orchards. Choice of stands is an important factor if maximum benefit is to be obtained from seed production areas. Inasmuch as an adequate number of trees must be left for seed production, the more trees there are available in the original stand, the higher the selection differential that can be attained through thinning. Because of the limited number of trees, selection cannot be very high for a combination of many traits. As many good traits as possible should be present in the stand selected. Selection standards should be kept very high for volume growth and resistance to pests, but they might be considerably lower for stem and crown form. This does not mean that low-quality trees will be retained, but that form is sacrificed to growth and pest resistance. Crown and stem form characteristics are certainly important, but if the trees left in the seed production areas are reasonably good, a slight increase is not going to improve value very much.

In establishing seed production areas, every effort should be made to keep selection for vigor as high as possible. Genetic gain is more highly influenced by this trait than any other.

Seed production areas are much less expensive than clonal seed orchards, and they could be used much more frequently than heretofore. Seed from these areas are the result of good racial selection and wind pollination among trees of very good growth and quality. The highest genetic gain will be the result of extremely good planning and execution to take advantage of every opportunity to apply the greatest selection pressure possible. The administrative advantages of using this method of seed procurement likewise depend upon good planning and attention to the basic principles involved.