Results of Research on Genetic Phases of wood Properties of Loblolly Pine

by Bruce J. Zobel 1/

As many of you know, the pulp and paper industry in the South is very interested in forest tree improvement. You have heard Dr. Perry tell of his work with a group of companies-- we at North Carolina State also obtain the bulk of our financial support from the pulp and paper industry. There is not sufficient time to discuss with you our program and its relationship to the industry. It is sufficient to say that we expend our funds and energies in the three following ways:

1. Consultation services for the cooperating companies, with special emphasis now on the selection of material and its incorporation into the extensive seed orchards being established. Our operating area covers the States of Virginia, Tennessee, North and South Carolina, Georgia, and Alabama.

2. Basic research on problems of general interest to all cooperating companies. We have specialized. on wood properties such as specific gravity, fiber length, cellulose content, and compression wood.

3. Work with graduate students majoring in forest genetics. The past year we had 3 students; this fall we will have 7 or 8 working either for the Master's or Doctor's degree in forest genetics or as special students concentrating their studies in this field.

I wish to discuss with you one portion of our basic research, and how it applies to the company seed orchards. These orchards are not a small

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thing. The companies with which we work have established or are establishing about 250 acres of seed orchards. Dr. Perry's companies probably are establishing considerably more. This acreage is planned to supply the seed for all the planting to be done by these companies for many years in the future. Thus, for our companies alone, we will have a potential seedling production of 100 million annually of one species. The size of the seed orchard operations should answer your questions as to how important it is to make sure the best trees are used for establishment of the seed orchards.

Mr. R. L. McElwee, the liaison geneticist who works with me, makes the final selection and grading of every tree to be used in each company's seed orchard. In the field he selects for rapid growth, good limb form, straight boles, and other usual criteria used in selection of superior trees. Additionally, however, he obtains wood specimens from all selected and check trees so that they can also be evaluated on wood properties. Before this can be done intelligently, we must first gain some knowledge of the genetics of wood properties.

I have been working on wood. genetics since early 1951, i.e., for 5 years in Texas and now in North Carolina. The comments to follow are based on work done during that period. Some of them have been published and will be familiar to you; some are in press; and many are in the form of data now in my files or in experiments now being pursued. Please be absolutely clear on one point--I'm speaking only about loblolly pine. However, I am speaking about it from two extreme portions of its range, from Texas with its droughts and severe weather to places in North Carolina where loblolly pine sometimes grows on 8 to 12 feet or more of water-saturated peat overlying the mineral soil. Of great interest is the fact that our Texas studies and the studies an the eastern loblolly have yielded the same results.

It will not be possible for me to do more than mention some of the chief points of interest. They are as follows:

1. For over 30 years it has been constantly repeated that there is a close relationship between growth rate and specific gravity. Intensive studies show that there is very little correlation between specific gravity and rate of growth (as expressed in rings per inch) for wood of the same age outside of the central core of juvenile wood. Perhaps all of you have read or been taught that for conifers, fast growth results in low specific gravity and slow growth results in high specific gravity. For loblolly pine, within the framework of commercial rotation age, this just isn't so. Not only our work, but many other recent studies have shown that this relationship is nonexistent. Dr. Perry and Dr. Wang plotted the specific gravities of selected trees that had a volume superiority 2.5 to over 4 times the check trees against the specific gravities of the check trees and found the curves nearly coincided. They did this partially in self defense, because their companies were afraid that by selecting the fast growers they would be propagating trees with low specific-gravity wood.

2. Nearly every stand has a normal curve of specific gravities, from relatively high to relatively low. Stand averages may differ, but all the trees on a uniform site grown under uniform environment do not have the same specific gravities. It is usual to find trees the same age, growing on the same site within a few feet of each other, the same diameter, and same height, that possess opposite extremes of specific gravity.

3. I have been unable to find any relation between site characters (including moistness of site) and specific gravity. Such relationships may exist but they have not yet come to light. For example, the loblolly pine growing on the deep peat, excessively wet sites in coastal North Carolina has wood whose specific gravity is similar to that growing in the "Lost Pines" of Texas under conditions of very low rainfall and high temperature. Under both of these conditions high and low specific-gravity trees were found.

   In slash pine, there appears to be a geographic trend for higher specific gravities in the regions of highest summer rainfall. Although we have not analyzed our data yet, they appear to show a higher average specific gravity in the Coastal Plain than in the Piedmont sites. In spite of this general trend, however, the very highest specific-gravity trees we have located so far are in the Piedmont. Although it would not be too hard to explain a summer rainfall-specific gravity trend from a physiological standpoint, the important fact from a genetic standpoint is that, for all environmental conditions, both high and low specific-gravity trees are found growing together. Do not interprel my comments to mean that environment has no effect on specific gravity. It obviously does as shown by samples of loblolly pine grown in California; the wood of the samples I have observed from the Far West is similar to Virginia pine. However, the variation present, which occurs no matter what the environment, and the inability to tie specific gravity to any individual or to any group of environmental or growth factors leads one to suspect inheritance is of importance.

4. Genetic proof of specific-gravity inheritance is very meager. Research underway has just not been in progress long enough. However, my exploratory observations, as well as those of others, suggest that specific gravity tendencies are quite strongly inherited. In Texas we tested open-pollinated progeny from five trees with known specific gravities. In every case the progeny tended toward the specific gravity of the parent, i.e., parents with high specific gravities have progeny with high specific gravities and vice versa. In Texas there is considerable research material available which can be used to follow up these preliminary observations.

5. We find an extremely high correlation between specific gravity of juvenile wood and mature wood of the same tree. In addition, on young trees, there is a high correlation between the limb specific gravity and juvenile-wood specific gravity. This double relation enables assessment of selection and breeding results at 3 or 4 years instead

of waiting for the full rotation age, without destroying the test material.

6. We are developing relationships on the characteristics of juvenile wood, mature wood, and compression wood as affected by growth and environmental conditions.

7. According to Kramer in Texas, and others, the fiber length of mature wood is related to wood laid down near the end of the juvenile period, i.e., about 10 years. His work, as well as other work in Georgia and elsewhere, all points to the genetic control of fiber length. Just as for specific gravity, fiber length tends towards constancy outside the core of juvenile wood.

8. Yield studies (or lignin-cellulose ratios) mace up the bulk of our current basic research. It appears to date that some trees will yield more usable fiber than others, weight for weight. Very preliminary results based on only a few samples show some trees yielding between 4 and 10 percent more holocellulose and alphacellulose than others. These results are "hot off the press" and the analysis of the bulk of the material awaits my return to the laboratory. We will have samples from the best stands in six States, from many sites from the Tennessee mountains to the Carolina swamps, and latitudinally from Savannah, Ga. to Richmond, Va. We are studying (a) variation from tree to tree within a site (b) variation between sites within a geographic region and (c) variation between geographic regions. For each of the thousands of sample trees we will have recorded on IBM cards complete growth and environmental data, as well as wood property information including holocellulose, alphacellulose, specific gravity, compression growth, percent summerwood, and fiber length.

In my talking about the various wood properties, some of you may have lost sight of the objectives of this research. One of the major ones is to establish seed orchards for the industries, so they will have trees that are not only taller, faster growing, better formed, etc., but also that have the type of wood they most desire for their product. To do so we need to know all we can about the particular wood character and how it: (a) is affected by the environment (b) is affected by the tree's parentage (c) affects the product the industry makes. We can help on the first two. It in a tremendously interesting research challenge.