RELATION OF GROWTH CHARACTERISTICS OF SOUTHERN PINE TO ITS USE IN PULPING

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The current expansion of the pulp and paper industry in the South gives rise to varied expectations according to the experience, background, or personal interest of the observer.

The proponents of an industrial South view the spectacle of new and larger pulp mills with justifiable optimism, considering the investments which they bring, the jobs which they provide, and the income and taxes which they contribute, all built on a foundation of widespread pine resources. In contrast, a certain degree of anxiety may be felt by those industries with which the pulp mills will compete for wood. Foresters, too, have expressed some concern about a situation that might mean the progressive destruction of young pine stands and ultimate loss of all the values they represent.

Both points of view must be fully considered. Undoubtedly this development will contribute much to the prosperity of the southern states. It is going to bring money into the pockets of the farmers and timber producers and to the laborers who find work in the mills. Just as surely, unless timely action is taken, it is going to create a lively hazard of denuding the very forest lands whose rich promise induced the mills to come South in the first instance.

The latter result would disappoint the hopes of many people, including those of us who have made the pulping of southern pines almost a life-time study. More than 25 years ago the Forest Products Laboratory conducted pioneer investigations in the then new sulphate process as it applies to southern pines, and we feel that our work has been a potent influence in the tremendous growth of the southern industry that has followed the use and adaptation of that process. In subsequent research we have developed methods of making white papers from the pines. We have participated in the current experiments relative to newsprint production from southern woods, including the use of semibleached sulphate pulp.

1 Address to convention of Association of Agricultural Workers, Atlanta, Ga., Feb. 3, 1938.
which we consider the most promising answer to the whole southern newsprint problem. Throughout the course of these and many other experiments our view has always been toward the development of southern pulpwood resources not as a grab-bag for quick exploitation but as a productive and self-renewed asset of the country.

As a member of the Forest Service I believe -- and I think you share our belief -- that by a proper approach to the problem, by suitable steps toward conserving, harvesting, and reproducing the forest growth, adequate supplies of wood for any reasonable utilization can be assured. Such steps will provide a permanent source of income to the farmer, the landowner, and the community. This is the forest crop principle, the issues of which are squarely before us today. In establishing the crop system, the information and influence which agricultural extension workers are able to bring to bear will be very nearly all-important.

A prerequisite to intelligent management of any crop is an understanding of the use value and possibilities of that crop as affected by its manner of growth; and it is my purpose to throw a little light on this question with respect to the pine wood crop and what it is good for in pulping processes. Both the farmer's interest in a profitable woodlot and the industry's interest in a permanent and adequate wood supply rest on one basic conception. This is the realization that wood, like any other natural product, is variable in growth characteristics, and that such characteristics are just as important in the use value of wood as in any other farm crop -- spring wheat and winter wheat or sea-island and upland cotton, for instance.

It is common fallacy, even among those who should know better, that "wood is wood," and that little difference exists between trees. Everybody admits, of course, that there is a difference between hardwoods and softwoods, that some species grow larger than others, that clear lumber is better than knotty lumber, and so on. The general tendency, however, is to assume that all loblolly pine, for example, will exhibit the same properties and be suitable for the same uses. Fortunately or unfortunately, this is not true.

Pine trees now growing on southern farm woodlands and in the country at large constitute a source of raw material from which can be made all the types of paper used in the United States. Their varied possibilities arise from the different ways in which they respond to conditions of site, soil, and spacing, being evidenced in a good many ways -- among which I wish to call special attention to the following:

(a) Fast or slow growth, represented by wide or narrow annual rings. Plate I, 1.

(b) Differing amounts of springwood or summerwood in the rings. Plate I, 2.

(c) Differing amounts of sapwood or heartwood in the tree. Plate I, 3.
Everyone who has cut or handled pine -- longleaf, shortleaf, slash, or old-field loblolly, is familiar with these differences, and I think you will easily credit the conclusion that they are effects of individual tree growth rather than strictly species characteristics. It is these that carry over into the character of the pulp produced. Of course, if there is some one species that you favor against all others, I will not dispute your choice. But be sure of the type of growth you want in that species and the kind of paper in view, and work toward them. By proper attention to them it is possible to set up in advance the raw materials best suited to the different pulping processes and products.

Except in a most general way, it is not my province to go into the conditions and cultural practices which develop these various characteristics; in the South this is a special field of the Southern Forest Experiment Station, with whom we are conducting some very interesting cooperative studies. I want to take the material as it exists and point out some of its papermaking relationships.

In the South up to the present time practically all the pulp produced has been of the so-called brown-kraft or sulphate type. In this process the wood, reduced to the form of chips, is treated with an alkaline cooking liquor consisting of sodium hydroxide and sodium sulphide. The process gets its name, sulphate, from the fact that in the important step of recovering the cooking chemicals sodium sulphate is employed. Sulphate liquors are alkaline. They dissolve the resins and readily pulp both heartwood and sapwood. Springwood and summerwood behave differently, but with the ordinary run of material a conglomerate pulp can be produced which is entirely suitable for the paper board, the wrapping and similar coarse papers for which southern pines have been so successfully used.

But the picture is changing. Paper technologists as well as the public are acutely aware of the trend in the South toward bleachable sulphate pulps for book and bond and possibly for newsprint papers. At least four mills are operating or in process of construction with the production of bleachable sulphate pulp in view, and if these developments are to be permanently successful greater care will need to be exercised in growing or selecting the raw material. For one thing, in the interest of smooth or closed sheets, it is desirable that relatively high proportions of thin-walled springwood be employed. Another point is to secure wood of relatively low heart content free from decay and low in resin, as these factors influence color and bleach consumption. In general a wood of different quality is necessary for the bleached pulps than for pulps used in coarser paper grades.

Then there is the very interesting possibility of applying the sulphite process to southern pines; this means newsprint and all manner of white paper products -- even rayon, which is actually to be the first arrival, at Fernandina, Fla. In the sulphite process a solution of bisulphite of lime in mixture with sulphurous acid is the pulping agent. As ordinarily applied, acid sulphite liquors will not reduce heartwood and are powerless to remove resins. It is true that the unpulped heartwood, which is recovered as so-called screenings, can be converted into
boards by additional processing, but it is much more desirable that this low-grade by-product be eliminated if possible through the use of wood containing a minimum amount of heart and low in resin content. In sulphite pulping it is also highly desirable to use material having a relatively high content of springwood. Our experiments have shown that the pulp strength increases proportionately with the amount of springwood present, a fact that is somewhat curious as well as important, as we shall see later. This type of fiber also improved the uniformity and smoothness of the sheet surface, which is of prime importance in printing or writing.

A third pulping method and one which must be thoroughly developed if southern pines are to be used for newsprint is the mechanical process. Here the wood is reduced to pulp by the use of a grindstone. For newsprint, sulphite is the "binder" and groundwood is the "filler." A pulpwood of good color is essential if groundwood pulp of satisfactory properties is to be secured, and again it is desirable that a relatively high quantity of springwood be present for the best results. The proportion of heartwood is of little importance so far as strength properties of pine groundwood pulps are concerned, but since heartwood is usually of a relatively dark color, the presence of much of this type of wood is immediately reflected in the color of the pulp. Resin content is also a factor here. A high resin content is bound to result in a "pitchy" groundwood pulp, which will eventually cause operating difficulties on the paper machine.

With the exception of the mechanical process, all the methods used to reduce wood to pulp require a chemical action which is largely a solution of the lignin and noncellulosic components of the wood, releasing in purified form the cellulosic fibers. One of the conditions necessary to a uniform chemical action is a uniform raw material. For this reason it is rarely practicable to pulp mixtures of species or even widely varying types of the same species. If enough energy is applied to reduce one type of wood, too much action with the other type present destroys much of its inherent value.

In the case of the southern pines, particularly those of extremely rapid growth, we frequently encounter conditions where the springwood and summerwood are so unlike as to be the equivalent of two different species. An example of this is shown in plate II, 1, where the minute structure of the summerwood and springwood are clearly delineated. The springwood fibers are thin-walled and easily amenable to the action of the pulping agents. They are likewise much more easily processed after the pulp has been prepared from the flat, ribbonlike fibers. The summerwood fibers, on the other hand, are thick-walled and hence stiff and resistant to reduction and processing. Hence arises the strange-seeming fact that a stronger pulp is produced from the slenderer, inherently weaker fibers; they "felt" together better. Plate II, 2, shows the difference, at least as far as the sheet surface is concerned. Note the difference between a well-laid sheet (right) and what is called a "brush-heap" conjunction of fibers.

Of course both springwood and summerwood fibers are invariably present in southern pine. This disadvantage, however, can be overcome
if the quantities of each are relatively constant. Difficulty arises when the proportions vary from batch to batch. Inevitably, under such conditions, a nonuniformity of pulp results unless the mill operator can adjust his operations to the particular batch being cooked. This is by no means a simple matter.

There is another characteristic of the rapid growth wood now coming into the southern stands which requires rather careful consideration. This is the so-called compression wood, which we have recently found has a definite bearing on pulp quality. In plate II, 3 is shown a disc which exhibits the characteristics of compression fiber. The condition apparently arises from some state of strain during growth, as when the tree leans from the vertical. Regardless of what method is used to pulp this material, the resulting pulp and paper is of subquality. We believe this is due to a special kind of twist in the internal structure of the fibers; but, regardless of what is the cause, the fact remains that such material is of low value. Extremely rapid growth almost invariably results in a certain amount of compression or abnormal fiber, and hence it appears that management methods directed too exclusively to fast growth are not conducive to a yield of high-grade pulpwod.

There are certain other factors having a bearing on the utilization of wood at the pulp mill. Generally speaking, any material less than 4 inches in diameter is uneconomical; first, because of difficulties in removing the bark, and, second, because of the large number of sticks which must be handled in preparing the chips.

Knots must always be accounted an impairment of the value of pulpwod in proportion to their size and number. The knot fiber is usually dense and hard to penetrate with cooking liquors; no species surpasses the southern pines in this respect. The knotty parts of the chips have to be removed from the pulp mass by screening. They are not necessarily a total loss, as it is the custom at many mills to dump in the screenings with the next cook, but knots are not what the pulpmaker primarily intends to buy as raw material. They are, so to speak, the flies in his ointment, which he must strain out. The careful grower, however, will take pains not to breed too many of them. Much, we know, can be accomplished toward their elimination by proper planting, thinning, and pruning of the stand, which with your help, we hope to see widely established in practice.

The weight of the wood is important to the pulp mill, presupposing that fiber quality is that needed for the particular type of pulp desired. The denser the wood the greater the weight yield of pulp per cord, other things being equal. An exceptionally dense piece, however, is likely to be filled with pitch or to be so resistant to the action of chemicals that the final yield of pulp and the quality of the fibers will be less than would be obtained from a somewhat lighter material.
So far as the mill is concerned, no risk is involved in buying by the cord, as the net weight of actual wood in the average cord of pine of a day's run holds fairly steady. From the point of view of the individual grower, however, the case is different. Purchase by the cord offers no premium on selection or on the production of dense wood by careful growing methods. On this basis, an exceptionally good lot of wood might bring no more than 50 or 75 percent of its inherent value, while light-weight stock brings more than it is actually worth as a source of pulp.

The alternative system of purchase by weight on delivery has recently been inaugurated at one or two mills. Such a system is worthy the careful consideration of owners in any steps they may take toward organized growing and marketing of pulpwood. It would insure every load of wood bringing its proper return at the prevailing scale of prices.

In view of the whole pulpwood-growth picture, which I have sketched only briefly and in the barest outline, one central impression emerges, and that is that if the woodlot owner is to make the most of his timber farming he will attempt to supply the type of material which the pulp mills can best utilize. In so doing he can demand a premium for his product. To some extent he can actually specialize his growing practice, and in any event he can hold back material which is not well adapted to any pulping process and can divert it to one of a half-dozen other uses.

Generally speaking, the best pulpwood will be relatively uniform in growth, which means that the thinning of the woodlots will need to be so handled that extremes of growth rate are not encouraged in any given stand. Despite weight requirements, a relatively high ratio of springwood to summerwood is desirable and can also be regulated by the thinning practice. If the wood contains much heart, it is obviously not suited for sulphite pulping and can be best disposed of to mills operating the sulphate or other alkaline process. The same holds true for groundwood, except that if the heartwood is not dark in color it can be utilized in this process.

Before concluding these comments, perhaps a word as to hard-woods is in order. The recent Forest Survey figures for the lower South show that hardwoods amount to approximately half the existing stands. The Forest Products Laboratory has studied these species as pulpwoods, evaluating their grinding possibilities, their use in sulphite and sulphate pulps, and in the production of newsprint, book, bond and many other grades of papers. A few years ago we even developed a new semi-chemical pulping process now used successfully in the pulping of gum and chestnut for fiberboards and other papers. With conditions as they are, the economics of utilizing southern hardwoods for pulp are somewhat hazy; but a limited use is already an accomplished fact, and as our investigations of the pines approach a successful conclusion more intensive effort is being directed toward the hardwood species. We
feel confident that they, too, will find a prominent place in the general wealth of pulp resources with which the South is endowed.

For his own interest and the larger welfare of the South, the farmer should be made aware of the possibilities of pulpwood as one part of his timber program. With the industry heading South, competition in the purchasing of pulpwood will increase. Other things being equal the price should follow a rising trend, and in all fairness the mills can afford to pay the higher price for pulpwood if the quality of the material which they receive is such that they may realize higher yield and better pulp quality.
Plate I

(1) Fast or slow growth, represented by wide or narrow annual rings, in southern pine.

(2) Differing amounts of springwood or summerwood in the annual rings of southern pine.

(3) Differing amounts of sapwood or heartwood in southern pine trees.
LOBLOLLY PINE - SHIPMENT 1441

Sample 7. Slow growth rate. Medium springwood.

Plate II

(1) Photomicrograph (cross section) showing contrast between thin-walled springwood fibers and the thick-walled summerwood fibers.

(2) Greatly enlarged view of the surface of two sheets of paper, the one on the left made from summerwood fibers, the other from springwood fibers.

(3) Southern pine disc showing an area of compression wood.