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1953: The Upland Hardwood Problem In Southern Woodlands

Louisiana State University and Agricultural & Mechanical College

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THE UPLAND HARDWOOD PROBLEM IN SOUTHERN WOODLANDS

PROCEEDINGS
SECOND ANNUAL SYMPOSIUM
SCHOOL OF FORESTRY
LOUISIANA STATE UNIVERSITY
BATON ROUGE LOUISIANA

APRIL 14-15 1953
OFFICIALS

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Charles E. Smith, Dean of the University
J. G. Lee, Jr., Dean of the College of Agriculture
Ralph W. Hayes, Director of the School of Forestry

Moderators

Harold L. Mitchell, Director of the Southern Forest Experiment Station, New Orleans, Louisiana
James E. Mixon, State Forester, Louisiana Forestry Commission, Baton Rouge, Louisiana
W. Morris Palmer Jr., Chief Forester, Nobo Oil Company, Natchitoches, Louisiana
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Upland hardwoods may occur on both hardwood and pine sites in either pure or mixed stands. On hardwood sites, we find the pure stands and stands where the hardwood is mixed with pine as a minor component. On pine sites, hardwoods occur in pure stands where they have already taken over, and in mixed stands where they form the minor component but may be threatening to take over. This symposium is concerned with the latter, or upland hardwoods on pine sites. The majority of such hardwoods, even in the better species, are of poor quality when occurring either in pure stands or in mixture with pine on typical pine sites. This paper is concerned with the processing of these poor-quality hardwoods into products which will yield enough profit to justify their manufacture as a business enterprise.

Forest utilization may be generally defined as the preparation of forest products from trees as they occur in our forest stands, and producing them for use in places and under conditions where they will be best for the specified purposes, or at least the equal of alternative items from other basic materials. We are restricting this paper to a discussion of primary manufacture in the utilization of upland hardwoods. The discussion is further restricted to the sawing process as opposed to the processes of veneering and chemical breakdown, and to the primary products of the log. Further breakdown will be discussed in later papers.

With these limitations in mind, it can readily be seen that our consideration can be applied to the whole field of hardwood utilization as it is related to breakdown by sawing processes.

Upland hardwoods enter the problem phase in our southern woodlands where they occur on pine sites and the hardwood component of the stand offers serious competition to the reproduction and growth of the pine component of such stands.

Even though the hardwood species occurring in these mixtures may be, and nearly always are, among those which we consider high-value species, the individual trees are mainly of low quality when we attempt to convert them into usable products, which are subject to grade specifications. For instance, experience some years ago with a large East Texas lumber concern showed that forked-leaf white oak on large areas of pine sites between the Sabine and Neches Rivers was so poor that, except for a few scattered trees, it was not feasible to process this species through a typical large hardwood mill producing factory lumber. Many similar instances with this and other valuable hardwood species could be cited for other areas throughout the South.
There has been much emphasis in the past on research to find new products and new methods of processing which would more completely utilize the so-called low-grade portion of the total volume of hardwoods. Much of this thought and effort has been misplaced. The existing number of accepted products into which these pieces of wood could be manufactured is tremendous, and has been for a long time, as will be pointed out later. We also have all of the machinery necessary for efficiently breaking down the material and processing it into well-manufactured products. We have the men with the necessary skill and knowledge to operate the machines and produce such well-manufactured products. The answer then is not in searching for new products, machines, and processes for utilizing such material, but rather lies in the field of adapting the use of men, machines, and processes to more efficient production of large volumes of such products at substantially lower costs of production. In other words, much of the effort expended would have been better spent on the economic phases of the problem.

Basic Use Classes for Hardwood Items

Coming down to the questions of primary manufacture or sawing, it is first pointed out that individual items of hardwood products fall into basic use classes. This means that items submit to classification into, and utility for, a given broad set of use requirements. Grade specifications are in turn applied to each item within its basic use class. For a list of such items produced by the sawing process, the following is drawn from the National Hardwood Lumber Association rules for the measurement and inspection of hardwood lumber, issued January 1953, plus a few additions.

<table>
<thead>
<tr>
<th>Factory Lumber</th>
<th>Finish Lumber</th>
<th>Construction Lumber</th>
<th>Local Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basswood Key Stock</td>
<td>Poplar Siding</td>
<td>Oak Bending Lumber</td>
<td>Sheet Piling</td>
</tr>
<tr>
<td>Bung Lumber</td>
<td>A-finish</td>
<td>Select Car Stock</td>
<td>Sewer Sheathing</td>
</tr>
<tr>
<td>Cabinet Ash</td>
<td>B-Finish</td>
<td>Select Dimension</td>
<td>#2 Construction &amp; Utility Brds.</td>
</tr>
<tr>
<td>Maple Heel Stock</td>
<td></td>
<td>Export Wagon Plank</td>
<td>County Highway Bridge Plank</td>
</tr>
<tr>
<td>Panel &amp; Wide #1</td>
<td></td>
<td>Bridge &amp; Crossing Plank</td>
<td>Oilfield Road Plank</td>
</tr>
<tr>
<td>Quartered Poplar</td>
<td></td>
<td>Sound Square Edge</td>
<td>#3 Construction &amp; Utility Brds.</td>
</tr>
<tr>
<td>Still Stock</td>
<td></td>
<td>Common Timbers and industrial blocking</td>
<td>Military, cr, Commercial</td>
</tr>
<tr>
<td>Strips</td>
<td></td>
<td>#1 Construction and</td>
<td>Timbers and framing</td>
</tr>
<tr>
<td>Wagon Box Boards</td>
<td></td>
<td>Utility Boards</td>
<td>#3 Construction &amp; Utility Brds.</td>
</tr>
<tr>
<td>Standard Lumber</td>
<td></td>
<td>Cross Ties</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vehicle Lumber</td>
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<tr>
<td></td>
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<td>Mine Timber products</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>#1 &amp; 2 Dimension</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Switch Ties</td>
<td></td>
</tr>
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The four broad basic use classes include factory lumber, finish lumber, construction lumber, and local use lumber. The factory lumber class includes 10 product items which are high-value in terms of dollars and cents and, as individual pieces, must be of high quality. Factory lumber is composed of pieces which qualify for cutting up into clear-faced cuttings of substantial width and length for further processing. Items in this class lay their main claim to utility because of their appearance rather than for their strength. Let us remember that the two basic factors governing utility are beauty and strength. Items in the first class need not necessarily have superior strength qualities. The second use class is that of finish lumber and includes three items, all of which depend upon beauty and appearance for their utility. The third use class, construction lumber, contains 17 items, all of which depend mainly upon strength qualifications for their utility. The fourth class includes five items which are all of relatively low quality and use, depending mainly upon their ability to hold together to be put in place as a single piece. In this connection it should be pointed out that the items in this last class will not carry the costs necessary to get them into use through the general marketing channels on a National or even a wide Regional basis. In other words, they must be produced close to the point of utilization and handled strictly on a local basis.

At this point, let us examine the tabulation of products item by item as listed in the "Construction Lumber" and "Local Use" product classes, since the majority of our low-grade logs will be best suited for these specific items.

Oak bending lumber is excluded because the grade specifications for this item are so strict that most of it must come from factory lumber, however, a small proportion can be produced from these lower-grade logs.

Select car stock and select dimension are items which will accept sound boxed hearts and planks of such grade specifications as to allow for their being cut from low-grade logs where the log defects are not too concentrated, too large, or too many in an unsound condition.

Export wagon plank is the same as the preceding two items except that it must be free from any shake or unsound defects.

Bridge and Crossing plank is of still lower grade and will admit occasional grab or knot holes, and shake provided it does not exceed one-third the length of the piece or extend from edge to edge or face to face.

Sound square edge again includes boxed hearts and planking and is similar to the select car stock and select dimension described above.

Common timbers and industrial blocking will admit all of the defects for the previously listed items and, in addition, unsound defects that do not seriously impair the strength of the piece enough to prevent its use in its full size.

Construction and utility boards are cut in three grades, namely, 1, 2, and 3. Grade 1 is so specified that it compares with all other items
items in the "Construction Lumber" class, while Grades 2 and 3 are so poor that their specifications admit them to the "Local Use" class. It should be remembered that construction and utility boards can be cut from only that group of species known as the soft hardwoods. This excludes all of the oaks, which form such a large proportion of our upland hardwoods.

Cross ties and switch ties are very important items, but it should be remembered that their grade specifications are so strict as to require their being sawn from a rather respectable log. They must have sound centers, only a very small amount of shake, and no knots with a diameter greater than one-fourth the width of the face on which they occur within the rail bearing area. These logs can, of course, have many defects as long as none of them are unsound or too large.

Vehicle lumber must be sound and will admit knots up to 1½ inches in diameter as long as these are sound. A few worm holes are admitted so long as they do not occur in numerous clusters, as well as an occasional grub hole.

Freight car stock and mine car lumber are again items admitting boxed hearts and planking, and are similar in specifications to select car stock, select dimension, and sound square edge.

Mine lumber and mine timber products include the items: Cribbing blocks, mine caps, wedges, mine rails, mine ties, headers and bars. This material will admit about all of the defects imaginable, the sole requirement being that such defects do not impair the strength so as to prevent the use of the piece in its full size for purposes of strength.

Number 1 and 2 dimension are items cut in nominal 2-inch thickness and used for framing purposes in the same manner as the softwoods.

If the public could be educated to the use of hardwood dimension for framing lumber, this would supply a large outlet for material which could be manufactured from low-grade hardwood logs. A few of us have attempted to persuade some operators to try to influence local retail yards to accept these items, manufactured to pine dimensions and suitably dried, and promote them in their local trade. So far we have found a great deal of interest but have no particular successes to report. Of course the main objections, particularly when we work with the oak species, are those of increased weight and difficulty of nailing.

The items included in the "Local Use" class are sheet piling, sewer sheeting, and #2 and #3 construction and utility boards. Their specifications are such that almost any defect is admissible, the major requirement being that said defects do not impair the strength so as to prevent the use of the piece in its full size. I have added two items to this list, namely, "County Highway Bridge Plank" and "Oilfield Road Plank." During my experience, I have found several mills selling bridge planking and oilfield road plank which will not meet the specifications for "bridge and crossing plank" under the NHLA Grading Rules. These very low-grade pieces seem to be acceptable to both the County Highway Departments and to the Oilfield Operators. If this is the case over wide areas, it would be well for operators to spend additional effort in expanding these markets. Again these would provide additional outlets for low-grade products of the
many species of oak and gum, which constitute such a large proportion of
our upland hardwoods.

Log Classes and Grades

Our unit of raw material, from which all of the listed products will
be cut, is a log with minimum size specifications of 8 inches in diameter
and 8 feet in length. As we have so far emphasized that our main consid-
eration is that of economies, and further the products fall into use classes
in turn subject to grade specifications within the use classes, it is man-
datory that we have available a system of log classes and grade specifi-
cations within each class which can be tied directly to our scheme of pro-
duct classes and grades. We are still in need of considerable research
in this field. As of the present, we have factory lumber log grades,
which cover the first two product classes, namely factory lumber and finish
lumber, fairly satisfactorily. Experience has proved that further re-
search is necessary for log Grade 3 as set forth in these log grades.

This author, together with others, has proposed second and third classes
of logs, none of which will qualify under "Factory Lumber Legs." This sec-
class will qualify to produce most of the products within the construction
lumber class and is designated as tie and timber logs. A third log class,
which will qualify for neither of the above two classes, will produce sub-
stantial volumes of the products listed under the "Local Use" class log.
It should be pointed out that, whereas yield tables in terms of standard
lumber graded by the NHL Grading Rules are available for the factory
lumber class logs, research is still needed to provide yield tables in terms
of products for the last two classes of logs.

This all boils down to a recognition of the necessity for sorting
logs by class and grade and then processing them into those products for
which they are best suited, and which will return the highest value.

Recent research by the Texas Forest Service, in which a log grade classi-
fication for inferior upland hardwoods was established, has proved that it
cannot possibly pay to cut the majority of logs of this type into standard
factory lumber. This classification included all of the Grade 3 logs,
defined in "Forest Products Laboratory Log Grades" and many of the tie and
timber class and local use class logs previously listed as proposed. It
would be interesting to carry this East Texas study a step further and
saw comparable logs into those products for which they are best suited,
after classifying and grading them.

Manufacturing Low Grade Logs

For the average permanent sawmill establishment of medium size class,
with an overhead which includes at least one sales representative, the
processing costs for hardwood logs are about $60.00 per thousand board
feet. This includes only logging and milling. The East Texas study, previ-
ously referred to, establishes that the returns from a large segment

2/ Texas Forest Service, Log Grade Classification Based on Standard Lum-
ber Recovery for Inferior Hardwoods in East Texas. Technical Report
No. 11.
of the logs from our upland hardwoods on pine sites are about $0.00 per thousand board feet when such logs are sawed into standard lumber. It can readily be seen what would happen to an operation which cut considerable of its product volume on this basis. With economic conditions as they are today, it is believed that the average permanent sawmill operation should not be cutting hardwood logs of poorer quality than the #2 log as defined in the FPL Log Grades unless they have a well-established outlet for products such as railroad cross ties and switch ties, square edge and sound structural material, and structural timbers which qualify under the "Structural Stress-Grades of Hardwoods for joists and planks, beams and stringers, and posts and timbers." A possible solution to the problem of utilizing logs from such timber lies in the establishment of specialized operations which are designed to process only the lower class and grade logs into the products for which they are best suited. Such an operation should be relatively small so that the owner-operator can supply most of the necessary supervision and take care of the sales end of the operation, and it should be located close to substantial sources of log supply so as to exclude the necessity for hauling logs over long distances. It should be as highly mechanized as possible, taking care of course not to overload the operation with initial investment costs. There is the possibility of gang sawing round logs to produce ties, timbers, planks, decking, etc. Round log gang saws can be adapted to hardwoods as well as softwoods although of course, the filing will be realized and the feed rates will be lower. There is also the possibility of using mobile sawmill units, similar to the Crosby-Anders mobile sawmill, which has thoroughly established itself as an extremely satisfactory operating unit during the past few years. Such an operation would necessitate the establishment of a concentration yard for the products but, on the other hand, would substantially reduce logging costs by practically doing away with the need for hauling logs with trucks. This is, of course, one of the most costly phases of logging operations and the costs increase proportionately with every additional mile over which the logs are hauled.

Log supply for such an operation should be carefully programmed, especially if the operator utilizes a permanently established mill. Logging costs for the operation must be held to the minimum. Exchange of logs with larger neighboring operators should be inaugurated. High grade logs originating from our operator's logging should be traded to the larger operator for volumes of his low-class and grade logs of equal value. Then there is also the possibility of purchasing the lower class and grade logs from the large operators. This should be a source of cheap logs, as the large operators should be glad to dispose of these logs without the necessity for processing them through their own mills.

It is as necessary for our operator to establish the floor, that is, the lowest grade and value of log to which he can go in his operation, as it is for the large sawmill operator. Trees which will produce only logs below this minimum in quality will have to be left for operations using other methods of utilization, i.e., veneering and chemical, or be disposed of by poisoning or felling as a part of the forest management practices.

In conclusion, it is emphasized that the manufacture of low-class and grade logs is confined strictly to small mill operation if a profitable operation is to be established and maintained.
You have just heard a talk on upland hardwood utilization for primary manufacture. Primary manufacture includes such items as lumber, veneer, ties, timbers, planking, plywood, bolts for specialty items (such as hickory handle stock), poles, piling, posts, mine props, smaller wood, and fuel wood.

This paper is concerned with upland hardwood utilization for secondary manufacture, exclusive of chemical conversion. The subject includes further mechanical conversion of the primary product itself and of the mill residues or by-products resulting from primary manufacture. Secondary manufacture includes remanufacture of lumber into such items as flooring, pallets, boxes and crates, furniture and wall panels. It includes remanufacture of veneer into boxes and crates and plywood and other glued-up products requiring veneer. It also includes remanufacture of mill residues such as veneer cores, veneer clippings, slabs, sanddust, edgings, trim, and planer chips into useful articles.

Exclusive of chemical conversion, the principal use of the hardwoods has been for lumber. This will probably continue to be the case for some time. It is important that in the manufacture of lumber that the maximum yield of the highest quality be maintained. Although secondary manufacture may find a use for residues, or degraded lumber - nevertheless, profit-wise and conservation-wise, the loss through improper primary manufacture can never be fully regained.

### Secondary Manufacture from Lumber

The very fact that we are concerned only with upland hardwoods in the South limits this discussion primarily to low grades of oak and gum. Roughly speaking, less than 20 percent of the oak lumber and less than 25 percent of the gum lumber (from upland logs) is No. 1 Common and Better. The market for these upper grades is no problem. Therefore, secondary manufacture of lumber in this paper is more or less confined to those use requirements that may be satisfied with No. 2 and 3 grades of oak and gum lumber. Some recent studies in East Texas have indicated the following average percent yield from upland logs:

<table>
<thead>
<tr>
<th>Woods</th>
<th>F2S</th>
<th>#1 CGL</th>
<th>#2 CGL</th>
<th>#3 CGL</th>
<th>#3B CGL</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern Red Oak</td>
<td>7</td>
<td>18</td>
<td>29</td>
<td>16</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Post Oak</td>
<td>6</td>
<td>19</td>
<td>25</td>
<td>26</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Sweet Gum</td>
<td>1</td>
<td>17</td>
<td>62</td>
<td>12</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Note that about half of the yield of oak is #3B Common grade; of gum more than half is #2 Common grade.
Of course, other species such as elm, hickory, ash and beech occur in the uplands in less quantity and should also be considered.

FLOORING

Flooring offers one of the greatest opportunities for the utilization of No. 2 and 3 grades of oak lumber. Beech and hickory are also in demand, but to a limited extent.

Conventional oak flooring draws heavily upon No. 2 grade and to a lesser degree upon No. 3 grade. Only 5 to 10 percent of No. 3 grade may be used at flooring plants. No. 1 grade comprises but a small percent of the total. It is in demand when higher grades and longer lengths of flooring are specified. The fact that the public has accepted random lengths and narrower widths and mixtures of red and white oak laid side by side has provided a greater outlet for upland oak. Lengths vary from one foot to six feet and longer and widths vary from 1-1/4" to the 2-1/4" standard. (Plank flooring, of course, is cut in greater widths but this tends to demand better grades.)

Various types of parquet flooring composed of short pieces 3/8 inch, 1/2 inch, and 25/32 inch thick and joined by splines, perforated paper, or even corrugated fasteners to form various size squares are available on the market today. For example, the following sizes of oak flooring are utilized by one firm in the South:

<table>
<thead>
<tr>
<th>WIDTH (inches)</th>
<th>THICKNESS (inches)</th>
<th>SQUARE (in. x in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2</td>
<td>25/32</td>
<td>9 x 9</td>
</tr>
<tr>
<td>2-1/4</td>
<td></td>
<td>9 x 9</td>
</tr>
<tr>
<td>1-1/2</td>
<td></td>
<td>7-1/2 x 7-1/2</td>
</tr>
<tr>
<td>2-1/4</td>
<td></td>
<td>6-1/4 x 6-3/4</td>
</tr>
<tr>
<td>1-1/2</td>
<td>1/2</td>
<td>9 x 9</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>8 x 8</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>10 x10</td>
</tr>
</tbody>
</table>

High labor costs and low yields preclude cutting the bulk of such flooring from stock below No. 2 grade of oak.

Many of you may be familiar with the TVA flooring produced from low grade oak. The lumber is cut into thin strips and the best grade is placed on top, the next best grade on the bottom, and the poorest grade cross-laminated in the middle. One thousand board feet International log rule of low grade oak yields 100 square feet of three-ply flooring surface. This means, of course, that there is considerable residue from the operation for which some type of utilization needs to be developed.

TVA flooring is produced in 12-inch widths and in any lengths desired. It is prefinished and ready to use. It has sufficient strength to permit the elimination of a subfloor in ordinary house construction. The material also may be used for wall paneling. It is claimed that 95 percent of the finished product will grade Select or Better as compared to 35 percent for conventional flooring manufactured from run-of-the-mill rough lumber, or average logs.
Hickory (exclusive of pecan) for flooring has not proved too popular. It contains more defect than oak and is non-uniform in color and texture. Beech tends toward greater uniformity in these respects. Both are hard and serviceable woods for flooring.

With the increased use of concrete slab construction in modern architecture, much of the hardwood flooring market has been lost through the use of asphalt and rubber tile, linoleum, and carpeting. However, these substitutes have not replaced the warmth and resiliency of wooden floors. With improved designs and economies, wooden floors may well stage a comeback from this lost market.

Truck and trailer flooring is a market offering new opportunities for the use of low grade oak. Although much of the truck and trailer dimension used for flooring, side rails, etc., is No. 1 and Better, nevertheless, there are possible markets for 4/4 and 5/4 oak flooring of No. 2 grade. Edge and end gluing of shorts may be in order toward greater utilization of lower grades for this purpose.

PALLETS

Pallet manufacture has suffered under a somewhat haphazard development. In many cases specifications were much more exacting with respect to species and lumber grade than needed for useful service. The industry is gradually taking some form of orderly arrangement which is so necessary for improved utilization.

The National Wooden Pallet Manufacturers Association has set up minimum standard specifications for warehouse or returnable pallets. They specify that "lumber used in pallet construction shall be free of decay, and free of knots with an average diameter greater than one-third of the width of the board. No piece shall contain any defect which would materially weaken the strength of the piece, or hinder its proper fastening."

Species have been classified into four groups which are "equally acceptable on a performance basis for wooden pallet construction according to the customer's desires."

"The most common species employed for pallet construction in each of these groups is as follows:

<table>
<thead>
<tr>
<th>Group</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>Cypress, Fir, alpine, Fir, noble</td>
</tr>
<tr>
<td></td>
<td>Pine, red (lodgepole)</td>
</tr>
<tr>
<td></td>
<td>Pine, ponderosa (western yellow)</td>
</tr>
<tr>
<td></td>
<td>Pine, sugar</td>
</tr>
<tr>
<td></td>
<td>Pine, white</td>
</tr>
<tr>
<td></td>
<td>Redwood</td>
</tr>
<tr>
<td></td>
<td>Spruce</td>
</tr>
<tr>
<td></td>
<td>Yellow Poplar</td>
</tr>
</tbody>
</table>
The pallets may be of either seasoned wood (not exceeding 20 percent moisture content) or unseasoned wood (exceeding 20 percent moisture content).

In military specifications, "M-I-L P-15011 B (CA), Larch 6, 1952, hardwood pallet, four-way, 10" x 18", nailed construction," it is specified that "deck boards, stringers, and posts for all grades shall be any of the following species: beech, birch, hackberry, hickory, hard maple, oak, pecan, rock elm and white ash." A request was made to the military to include softwoods so that gum might be included but approval was made for gum for posts only - not for stringers and deck boards. Two grades of pallets are recognized: Grade A, with the moisture content of all boards, deck and stringer, averaging 18 percent moisture content with no individual piece exceeding 22 percent and the moisture content of the nine posts not exceeding 35 percent; and Grade B pallets, with no moisture content specifications. "For all grades, lumber shall be sound and free from decay. The following defects will be permitted: Firm, tight pith; wane not exceeding, on either edge, 3/8 the thickness, 1/6 the width, and 1/8 the length of the piece; one split not to exceed 1/4 the length of the piece; stain; one shade not exceeding 1/6 the length of the piece; season checks; worm holes not over 1/4" in diameter. Knots with diameter not exceeding 1/3 the width of the board; one 1" knothole in 10" boards and wider; slight cup; slight imperfection in dressing; chipped or torn grain not over 1/16" deep and not exceeding in aggregate area 1/6 the surface of the piece."

From the foregoing and keeping in mind that special purpose pallets may be constructed in almost any fashion as agreed between producer and consumer, it is apparent that there are some real opportunities toward the utilization of upland hardwoods for pallets. One firm, for example, plans on using No. 2, 3A, and 3B grades of oak and No. 2 grade of gum at 25 percent moisture content for pallets for 105 mm. shells. Military and civilian orders may be quite large at times, requiring a considerable volume of lumber.

<table>
<thead>
<tr>
<th>Group II</th>
<th>Group III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larch (tamarack)</td>
<td>Pine, southern</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash, black</td>
</tr>
<tr>
<td>Ash, pumpkin</td>
</tr>
<tr>
<td>Black gum</td>
</tr>
<tr>
<td>Elm, white</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maple, soft</td>
</tr>
<tr>
<td>Sweet gum (red gum)</td>
</tr>
<tr>
<td>Sycamore</td>
</tr>
<tr>
<td>Tupelo, water</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash, white</td>
</tr>
<tr>
<td>Beech</td>
</tr>
<tr>
<td>Birch</td>
</tr>
<tr>
<td>Oak</td>
</tr>
<tr>
<td>Pecan</td>
</tr>
<tr>
<td>Hackberry</td>
</tr>
</tbody>
</table>

The pallets may be of either seasoned wood (not exceeding 20 percent moisture content) or unseasoned wood (exceeding 20 percent moisture content).
FURNITURE:

Perhaps the greatest opportunity for utilization of upland hardwoods in the furniture industry is in the manufacture of upholstered and juvenile furniture. The former utilizes No. 2 grades, usually with the heart center out (from 5 to 8 percent may contain heart center); the latter utilizes small clear pieces which may be cut out from No. 2 or 3A grades of oak or No. 2 grade of gum. However, as with furniture squares or dimension, the additional labor costs and wastage involved from using No. 2 common and lower grades may outweigh the additional cost of No. 1 Common and Better grades. Furniture manufacturers of exposed wooden parts usually employ mainly No. 1 Common and Better grades. Structurally, small knots and other defects in many cases could be permitted; the public, however, must first be educated to accept such "imperfections". Glued-up core stock for table, dresser, and desk tops may offer an outlet for No. 2 grades of oak, gum and magnolia.

BOXES AND CRATES

Gum and oak lumber have not enjoyed much of a demand in one of the largest of wood utilization fields: boxes and crates. The tendency for gum to warp and the difficulty in nailing and the weight of oak have been some principal reasons for their non-use in this field. In fact, hardwoods in general are rather unpopular in this field of utilization. Magnolia and cottonwood (5/8" thickness) are two southern hardwoods that are used, and oftentimes these two species are used only for cleats.

Possibly if methods of dimensional stabilization were developed for gum lumber it might become a favored wood for box and crate construction.

WALL PANELS

I have always been a firm believer in the commercial possibilities of knotty oak for wall paneling. Manufacturers state that usually so many different molding patterns are requested and in such small volume that they can not economically produce the material. However, a few believe that a bulk of the demand could be met with 2 or 3 patterns of 6", 8- and 10-inch widths with several patterns of narrow molding strips to combine with the main panels. The stock could be cut to width and stored in the rough until orders developed. The molding apparently should be done at the sawmill, with distribution of the dressed panel to the wholesaler or retailer handling the order.

I recently viewed an office of limed knotty red oak that has received the admiration and enthusiasm of those who have viewed it. The panels consist of mainly No. 2 common grade, with a small amount of No. 1 common, and about 10 percent No. 3B Common and 20 percent No. 3A Common. The No. 3 grades were selected from a stack of boards of such grade.

I was reading the views of a psychologist on wood, and it is of the opinion that people are attracted to wood because of an inherent instinct associated with our everyday use of wood for such things as
shelter and warmth since the days of the cave man. In other words, we hold an inherent advantage over other materials such as sheetrock and wallpaper finishes and with some initiative and incentive on our part, we might develop extended uses for upland hardwoods for knotty wall paneling. The demand could amount to appreciable volumes of low grade material.

CONSTRUCTION LUMBER

Some southern manufacturers have initiated the sale of gum construction boards of grades comparable to No. 2 southern yellow pine boards. Essentially this is a No. 2 grade of gum which is usually a "drug" on the market. The boards, of course, are cut in two-inch width classes and two-foot length classes and this accounts to a certain amount of "waste" that has not been so noticeable with our use of the conventional random widths and lengths of hardwood lumber. For example, 1x6's, 1x8's, 1x10's and 1x12's in 8- and 16-foot lengths are being cut from gum for construction boards. Oak may likewise be employed. New types of tempered nails with twisted shank permit greater ease in nailing dry oak.

One possible method that might be employed involves the selection of boards near the desired width and length so that the waste is reduced. For example, one manufacturer had an opportunity to sell 1x8 gum boards for construction. He selected three carloads of this material from a million and a half feet of No. 2 gum, in which there was no premium for 1x8's. He estimated that it cost him $3/M to select such material and he received an 8% premium for the 1x8's - thereby netting $5/M on the transaction.

Use of such lumber for sheathing and framing for farm buildings and for corral and ornamental fencing offers opportunities for increased utilization of upland hardwoods.

LAMINATED LUMBER

Although initial developments in the utilization of short pieces for fabrication into larger pieces is taking place primarily with the softwoods, there remains some potential opportunities in this direction in the utilization of low-grade hardwood lumber as produced from our uplands in the South.

SECONDARY MANUFACTURE FROM VENEER

Considerable veneer from upland gum of intermediate sizes is manufactured into boxes and crates. Except for occasionally large trees in upland draws, face veneer is not available to any extend from upland areas for manufacture into plywood.

A box grade of ply-board is being produced in the South utilizing low grade and sound oak veneer. The veneer is covered on each side by a paper-board around 0.015 inches thick. A furniture grade is also produced using a better grade (fewer knots) of oak veneer between the paper-board plys.
SECONDARY MANUFACTURE FROM MILL RESIDUES

Gum and oak-maple handles are produced from slabs. However, the handles must be clear and sound and this more or less eliminates utilization of slabs from upland hardwoods unless of the larger diameters. The same is true for hardwood moldings from edgings. The difficulty with the latter which may require narrow widths - is the 8- and 16-foot length requirements for much of the molding stock.

Wood flour produced from hardwood sawdust is finding limited acceptance in roofing felts in some midwestern states. The general complaint against hardwoods for such use is that hardwood wood flour imparts a lack of the necessary absorptive properties when the felt is dipped into the asphalt baths.

Hardwood wood flour has not gained acceptance for such major uses as linoleum and dynamite. It may find acceptance in the manufacture of certain types of plastics.

Residues from hardwood manufacture is being pressed into blocks for sale as fuel in at least one plant in the South.

Hardwood wood chips are beginning to demonstrate their usefulness as chicken litter, animal bedding, compost material, mulch for crops, soil blanket to prevent erosion, and as a soil conditioner or amendment. Development in this field of utilization could demand a considerable volume of low-grade hardwood material throughout much of the South.

Residues may also be reduced mechanically for use as fertilizers through chemical treatment of the chips.

Planer chips and other chips have been successfully pressed into hardboards for use as core stock for table tops, etc. This offers a potential market for utilization of chips from low-grade material and regular planer chips.

Slabs, edgings, and trim may be reduced to chips for sale to paper or paperboard mills. Most paper products necessitate the elimination of bark while paperboard products may be produced from chipped residues with or without bark.

Gum veneer cores have been utilized for paper and paperboard manufacture. A need exists for the development of the utilization of veneer clippings for the same purpose. Gum veneer cores are sometimes sawn into box stocks for use at box and crate plants. Veneer cores have also been utilized for fence posts and for "log cabin" type siding after saving each core through the middle longitudinally. Some type of preservative treatment may be desirable for the latter two products.
Q. Are there any companies using hardwood for construction lumber?

A. Yes, there are some firms that are cutting up No. 2 gum for construction lumber. I have just been talking to a gentleman here and I would like to have him say something pretty soon. He has been doing just that at his mill. There are several firms as I understand it that have been cutting up their gum rather than selecting it near the even two inch classes -- cutting it up for construction lumber. This gentleman has been doing that at his mill and will tell us about it.

Mr. Bill Postle, Mansfield Hardwood Lumber Company, Mansfield, Louisiana: We are, instead of cutting our gum random widths, cutting it into two inch widths and are making it into shiplap and S&S and selling it locally -- most of it to farmers. The 1 x 6 and 1 x 8 shiplap gum will make as good a barn as pine does and still you can sell it cheaper than pine. We haven't sold too much of it in the open market but we're selling a little of it that way. We don't see any advantage in cutting it in random widths -- we'd just as soon cut it into two inch widths like you do pine, in the lower grade gum logs. We've run some 3B oak into shiplap. Of course there, you have to edge it to get the approved width. But your local farmer's construction will take up a considerable portion of low grade gum. They like it. Of course you may only get back the cost of manufacture out of it, but that is better than letting it sit around and rot because you can't make anything else.

Mr. Quintus Herron, Herron Industries, Idabel, Oklahoma: Our operation is a rather small outfit, a family concern. We have to cope with the utilization of some of the low-grade hardwoods and therefore have instituted a construction company and for a little over three years we have been building and selling houses under FHA and V. specifications on the open market and we have used all the species of hardwood we have. We use elm and oak, low grade, and gum. It is hard for us to sell gum to farmers and other people for building barns and corrals and other things for farm use. We do sell an awful lot of 3B and 3A. Of course we offer it at market price which is rather low.

Q. I thought you indicated that in the manufacture of parquet floor that you would cut up 3B and other low grade material.

A. No, No. I don't think you could do it out of 3B -- I suspect you might be able to do it out of No. 2, and perhaps a little 3.

Q. What is the possibility of using raw chips to make hardboard? There is an outfit in Hope, Arkansas that is doing that and they seem to have a good product.

A. You can make hardboard out of cats and dogs or just about anything. It is strictly a matter of economics and the qualities of the board.
I have seen some awfully good board made from planer chips, and there are about 22 Swedish patents, for example, for core stock made out of planer shavings, dry process boards, and it seems to work out for core stock. Also, they use the same process over at Pineland, Texas, to make toilet seats. It has some possibilities but it is all a matter of economics. If you can get by with a low percentage of resin and have a low labor cost, it is possible that you may be able to compete with other materials. It is no problem technically to produce it.

R. D. Carpenter: We are going to have more and more sales for hardwood chip material actually from the heavy hardwoods in the paper industry. The W. T. Smith Lumber Company over in Chapman, Alabama installed the second Anderson becker in this country and they are now selling pine chips to the St. Regis Paper Company at Pensacola, Florida. They are starting now to bark their oak and gum logs and St. Regis is going to take the oak chips. Thus far, there are only two paper mills in the United States, that I know of, that use oak chips. The West Virginia Pulp and Paper Company's mill at Covington, Kentucky, and I think the one in Charleston, South Carolina. (Ed. Note — also The Champion Paper and Fibre Company's Pasadena, Texas plant, where they do their own chipping of oak pulpwood.) I understand some of that hardwood goes into the high grade book papers. But there is going to be an increasing market for chips from our heavy hardwoods.
UTILIZATION OF UPLAND HARDWOODS FOR CHEMICALLY DERIVED PRODUCTS

By
Wayne E. Moore, Chemist
Forest Products Laboratory, Forest Service
U. S. Department of Agriculture
Madison, Wisconsin

Introduction

One of the advantages of living in the United States is that it has thus far provided abundant resources for people who desire to raise a family. Since so many do raise a family, the population increases at a high rate. It is estimated that this increase amounts to the equivalent of one city of 200,000 people every month. Because of this rapid increase, it is proper that ways and means be considered for getting the most good out of the nation's natural resources in order to conserve them.

When uses for hardwoods are being considered, it might be well to draw some comparisons between hardwoods and softwoods and to indicate where and how differences are important.

The first slide shows a pulp from a hardwood and a pulp from a softwood. The hardwood pulp contains several types of structural members of the tree, while the softwood pulp shows only the long fibers of the tracheids. In addition to the fibers, the hardwood pulp contains vessels and fragments of thin-walled cells called parenchyma. The average length of the fibers of a softwood is about 5 or 6 mm. (something over 1/8 inch), while the length of hardwood fibers is approximately 3 mm. (or about 1/8 inch). This difference is not quite as great as this when pulps are made by the cutting and breaking of fibers during processing with a resultant loss of fines from hardwoods. Nevertheless, the softwoods, because of their longer fiber length, usually give higher paper strengths. In chemical uses, the short fibers of the hardwoods may be responsible for the retention of higher amounts of reagents (for instance, acids during nitration) and thus cause greater losses of reagents. The retention of higher amounts of water by beaten hardwood pulps may be very troublesome during washing, screening, and other processing.

From a chemical-composition standpoint, softwoods and hardwoods may be compared as follows:
This comparison represents average or typical results. Variations from these values will occur, but in general hardwoods will differ from softwoods as indicated here. As may be seen, the lignin content of hardwoods is slightly less than that of softwoods. Lignin is the noncarbohydrate cementing or bonding material of the tree that does not dissolve in concentrated sulphuric acid. What to do with the lignin is an ever-present problem. It contains complex ring-structure compounds that would be useful when separated or fractionated.

Holocellulose represents the total carbohydrate or sugar-producing components of the tree. The holocellulose fraction in hardwoods will run slightly higher than in softwoods.

Alpha cellulose is that fraction of the holocellulose that is insoluble in strong alkali under set or specified conditions. It is generally thought of as being composed of hexose or 6-carbon-atom sugar-building blocks. This is not quite true, but it comprises what most people think of as pure cellulose. The alpha cellulose content of hardwoods and softwoods is about the same.

The hemicellulose represents that fraction of the holocellulose that is soluble in alkali. It is composed of a mixture of sugar-building blocks such as the pentoses (5-carbon-atom sugars) and the hexoses listed here. As may be seen, the total hemicellulose of the hardwoods and of the softwoods is about the same. But the hardwoods contain about twice as much pentosans (5-carbon-atom sugars) as do the softwoods. Pentosans are important because they affect reactivity of pulps for chemical conversion and, by their presence, lower the amount of glucose obtained on hydrolysis and the amount of alcohol that can be obtained on fermentation. They are important for other reasons, some of which will be considered later.

### Comparison of Extractive-free Wood

<table>
<thead>
<tr>
<th></th>
<th>Softwood</th>
<th></th>
<th>Hardwood</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent</td>
<td>Percent</td>
<td></td>
</tr>
<tr>
<td>Ash</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Lignin</td>
<td>25–30</td>
<td>20–25</td>
<td></td>
</tr>
<tr>
<td>Holocellulose</td>
<td>70–75</td>
<td>75–80</td>
<td></td>
</tr>
<tr>
<td>Alpha cellulose</td>
<td>50</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Hemicellulose</td>
<td>20–25</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Xylose</td>
<td>8–10</td>
<td>Xylose</td>
<td>18–23</td>
</tr>
<tr>
<td>Glucose</td>
<td>12</td>
<td>Glucose</td>
<td>2</td>
</tr>
<tr>
<td>Mannose</td>
<td></td>
<td>Mannose</td>
<td>1</td>
</tr>
<tr>
<td>Galactose</td>
<td></td>
<td>Galactose</td>
<td></td>
</tr>
<tr>
<td>Uronic acids</td>
<td>1</td>
<td>Uronic acids</td>
<td>1</td>
</tr>
</tbody>
</table>
Charcoal

One use for hardwoods lies in the production of charcoal. In these days of synthetic chemicals, it is felt by those at the Forest Products laboratory who are concerned with charcoal that small operations, where charcoal is the primary product, hold most promise. In the past, wood distillation provided such chemicals as acetic acid, wood alcohol, and a host of chemicals derived from wood tar. By some the charcoal was considered to be a byproduct. Chemists, largely in the petroleum industry, made it possible to produce these chemicals at a competitive price and were able to meet expanded and increasing demands for them. At the present time retort plants consider charcoal as important as the chemicals recovered. Charcoal is used in various industrial operations and chemical plants. In addition to its use as fuel and for recreational uses, it is used in the production of carbon disulfide and of pig iron, in curing of tobacco, in black gunpowder, and as activated carbon for various uses. At present there is a shortage of granular charcoal.

The most suitable raw materials for charcoal are the dense hardwoods, such as the various oaks, ash, hickory, and gum, among others. A cord of these hardwoods yields about 1,000 pounds of charcoal. Of the several ways by which charcoal is produced, such as by retorts, pits, and kilns, the kiln would seem to be the best choice for small operators.

The economics of a charcoal plant are quite involved. Perhaps the production of charcoal should be considered as a complementary operation instead of an independent undertaking. If the plant could be located in a hardwood lumbering area where wood is cut on a sustained yield, then the tops, cuts, slabs, and edgings could supply the wood. The crew might work in the mill and also on the charcoal operation. A nearby market such as a chemical plant would be desirable. Otherwise the charcoal would have to be packaged and sold for fuel or recreational use. At present, lump charcoal is worth about $10 per ton, while briquettes will bring about $65 per ton. Success would depend on a clever operator.

The Forest Products laboratory is working on a continuous method for the use of wastewood fines such as sawdust. It is considering studies on small portable units that could be integrated with other manufacturing set-ups.

Tannin

One possible use for hardwoods lies in the extraction of tannin for use in the tanning of leather. (Eighty percent of vegetable tannin is imported.) Extracts of chestnut from this country and from quebracho, which is imported, are being used for this purpose. As a result of the chestnut blight, the supply of chestnut for tannin extraction is playing out. The most optimistic estimates indicate that chestnut for this purpose will not last more than 15 years. Some extraction plants are closing up shop.
During the past 10 years, work has been under way by TVA, in con-
junction with the University of North Carolina, and by the University 
of Florida on the extraction of tannin from the oaks. The tannin content 
of some of the oaks is as follows:

<table>
<thead>
<tr>
<th>Oak</th>
<th>Bark Percent</th>
<th>Wood Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>7.9</td>
<td>2.7</td>
</tr>
<tr>
<td>Post</td>
<td>3.1</td>
<td>2.9</td>
</tr>
<tr>
<td>Overcup</td>
<td>6.5</td>
<td>...</td>
</tr>
<tr>
<td>Chestnut</td>
<td>10.8</td>
<td>3.3</td>
</tr>
<tr>
<td>Swamp chestnut</td>
<td>9.1</td>
<td>3.1</td>
</tr>
<tr>
<td>Southern red</td>
<td>8.7</td>
<td>...</td>
</tr>
<tr>
<td>Northern red</td>
<td>10.9</td>
<td>2.5</td>
</tr>
<tr>
<td>Scarlet</td>
<td>6.6</td>
<td>...</td>
</tr>
<tr>
<td>Black</td>
<td>8.4</td>
<td>...</td>
</tr>
<tr>
<td>Willow</td>
<td>4.3</td>
<td>...</td>
</tr>
<tr>
<td>Blackjack</td>
<td>7.7</td>
<td>...</td>
</tr>
<tr>
<td>Pin</td>
<td>4.6</td>
<td>...</td>
</tr>
<tr>
<td>Water</td>
<td>4.6</td>
<td>...</td>
</tr>
<tr>
<td>Scrub (Fla.)</td>
<td>10.0</td>
<td>...</td>
</tr>
</tbody>
</table>

The first studies by the TVA and the universities indicated that mill-
run oak slabs when chipped and extracted yielded anywhere from about 
3 to 6 percent tannin. These extracts produced leather of good color 
and quality. Since most of the tannin is in the bark, later work has had 
to do with the separation of the bark from the chipped slabs. By this 
process the cost of extraction of the tannin could be reduced to about 
one-half of the cost of extracting the whole chips, and the chips could 
be used for pulping. The researchers have also worked with cordwood and 
edgings. The University of Florida has used limbs and branches from scrub 
oak. The bark has been separated from the wood chips by screening followed 
by separation in a gravity type, air-float separator. Some of the chips 
separated from the bark were pulped at the Forest Products Laboratory. 
Indications are that satisfactory corrugating board can be made from oak 
chips in yields of about 70 percent.

TVA estimates that tannin from available slabs in the Tennessee 
Valley could produce 60 million pounds of 25 percent tannin extract per 
year. It estimates in a recent publication (August 1952) that oak slabs 
can be purchased, chipped, screened, and separated for about $8 per ton. 
The processed products from a ton of slabs have an estimated market value 
of $12. From the work at the University of Florida it is estimated that 
there is enough stumpage of scrub oak in the Southeast to provide tannin 
in amounts equivalent to that obtained from chestnut for the next 20 
years. Natural reforestation should assure continued production (six-
million-ton units of extract per month).

It appears that extraction of tannin might be feasible in conjunc-
tion with other operations. Even if no one could get rich overnight by 
selling tannin, a clever operator could show a profit where the tannin 
contents of the bark is about 7 percent or higher.
Hydrolysis

Hardwoods can yield a variety of products through hydrolysis. By this process, dilute acids can be used to convert the carbohydrates of the wood to simple sugars, leaving lignin as a residue. The sugars can be concentrated and used as cattle feed, or can be converted by chemical or biological methods to a variety of products. The lignin, too, can be chemically processed to useful materials.

One of the difficulties lies in the fact that cellulose is extraordinarily difficult to hydrolyze. For instance, it is a hundred times more difficult to hydrolyze than other carbohydrates such as starch. Yet starch and cellulose contain the same sugar-building blocks; the only difference is in the linkage of these sugar groups and the way they are grouped into so-called micelles or groups of chains. Because the reaction is difficult, severe conditions of hydrolysis must be used, which cause decomposition of the product. If strong-acid methods are used to avoid decomposition, plant costs for acid recovery become prohibitive.

The percolation process uses dilute acid that can be discarded, but it requires a fairly elaborate hydrolysis system and produces a dilute sugar solution. Studies in recent years indicate that the resistance of cellulose to hydrolysis is due to its crystalline nature and physical form. Reduction in the crystallinity or compactness of the micelles can cause large changes in the rate of hydrolysis and in the yield of sugar obtained.

At the Forest Products Laboratory work is in progress on the fundamentals of cellulose hydrolysis. It is believed that great benefit would result from some practical process for increasing the ease of hydrolysis by decreasing its crystallinity or compactness.

One successful method for disrupting the crystalline units of cellulose is to bombard them with high-energy electrons such as X-rays. This bombardment causes a certain portion of glucose-anhydride units within the crystallites to be decomposed so as to allow easier penetration by dilute acid. The results are a twofold increase in rate of reaction and a great increase in sugar yield when the sample is subsequently hydrolyzed in 0.1N sulfuric acid at 180°C. Under present circumstances, the use of high-energy electrons is not practical at the dosage required. Future developments might change the situation. The important point is that disruption of crystallites causes hydrolysis to proceed more easily and efficiently.

Through the use of the percolation with dilute-acid technique, yields of sugars of 15 percent for hardwoods and of 50 percent for softwoods have been obtained, based on the dry weight of the wood. Briefly, the process is to cook with about 0.7 percent sulfuric acid at 165°C for 3/4 hour and then with about 0.5 percent sulfuric at 185°C for 2 hours. The total time is 2-1/2 to 3-1/2 hours. The acid is then neutralized with lime, and the sugar solution is filtered. By evaporation the sugar is concentrated to a 50 percent sugar molasses. This molasses can be used for cattle feed. In the case of hardwoods, because of the size of the structural elements of the wood as shown in the slide, a sludge of finely divided wood occurs in the bottom of the digester and causes some difficulty in pumping and separation of the cooked sugar solution.
was any difference it was in favor of the gum. That there is interest in the use of hardwoods for this purpose is shown in an article by Charles L. Taba in the Journal of Forestry of April 1952. A review of the applications for loans and tax amortizations to the National Production Authority revealed that some 60 pulp-mill expansions were under consideration in the South. At that time 28 pulp expansions had been approved and some 30 were pending. Approved and pending expansions would cost 560 million dollars and represent an increased annual pulp production of 1.1 million tons. Wood requirements were 65/2 million cords. A similar thing was the case for this expansion, about 2.4 million acres of hardwood were to be used. This would represent about 35 percent of the expansion requirements. Because of this increased interest in hardwoods, it might be well to consider briefly some newer developments in the pulping of hardwoods.

So far, results at the Forest Products Laboratory have shown that there are no nonpulping southern hardwoods. Some species are more difficult to pulp than others, but all of them can be pulped. Most of them can be pulped by almost any of the usual methods used in the pulping of softwoods. However, certain changes in procedures are necessary to provide satisfactory products for the various end uses.

Although the fibers of hardwoods are short, strong papers can be made by processing so as to obtain good fiber-to-fiber bonding. Papers can be made from neutral sulfite semichemical hardwood pulps that have good strength properties. This is accomplished by cooking to yields of 70 to 75 percent and fiberizing in an attrition mill to a point where the strength of these semichemical papers can be increased by bleaching. These properties are of interest in the production of greaseproof and bond papers. At the Laboratory, a satisfactory 100 percent hardwood bond paper has been made from 51 percent bleached sweetgum neutral sulfite semichemical pulp and 49 percent bleached black tupelo acid sulfite pulp.

Although experience has shown that papers made from 100 percent neutral sulfite semichemical pulps fall short of newsprint quality because of their fineness, low opacity, and other undesirable characteristics, excellent papers of this type have been made at the Laboratory from various combinations of hardwood neutral sulfite semichemical pulps and either softwood groundwood or mixtures of softwood and hardwood groundwood pulps. It was found that the hardwood content of newsprint quality paper can be satisfactorily increased to as high as 80 percent of the total fiber furnish through the use of birch groundwood and semichemical pulps combined with spruce groundwood.

The addition or combination of hardwood pulps with softwood pulps tends to give certain improved properties to finished paper. The short fibers of the hardwood contribute to improved surface, formation, porosity, and printing properties of book papers. In tissues and toweling, they contribute to softness and absorbency. For roofing papers, hardwoods are recognized as more desirable than pine because of their superior asphalt-absorption characteristics. In the preparation of these blends...
of hardwoods and softwoods, they may be cooked separately and then blended in a Better, or they may be cooked together for the blend.

Hardwoods are especially adapted to reduction by high-yield pulping methods such as the sulfate semichemical and the neutral sulfite semichemical processes. These methods consist of a short cooking treatment with small percentages of chemicals followed by mechanical disintegration of the softened or partially cooked chips.

A recent development at the Forest Products Laboratory has been the production of high-yield pulps from aspen by mild treatments with sodium hydroxide. Chips were given mild treatments with sodium hydroxide solutions at atmospheric pressure and then mechanically fiberized to produce pulps in yields of 82 to 95 percent. Optimum treating conditions from the standpoints of treating variables, pulp yield, and pulp strength included a 2-hour treatment at 25° C. with a sodium hydroxide solution having a concentration of 24 grams per liter. A pulp yield of 91 percent was obtained with these conditions. This pulp was converted into corrugating board that compared favorably with commercial hardwood semichemical corrugating board in strength properties.

**Pulps for Chemical Uses**

Until recently, hardwoods were little used in the preparation of dissolving pulps for such uses as viscose rayon, cellulose acetate, nitrate, and the like. The cloudy viscose solution, poor reactivity and filter-ability, the haze in acetates, and the character of the pulp sheet have been problems.

In the preparation of dissolving pulps from hardwoods, there are at least two problems peculiar to hardwoods. One is the high content of pentosan hemicellulose that must be removed, and the other is the low strength of pulp sheets due to the short fibers, vessels, and the amount of parenchyma cells. Because of the short fibers and the high content of parenchyma cells, sheets of purified hardwood pulp are especially weak when in contact with a strong solution of sodium hydroxide. Beating of the purified pulp and compressing the sheet in calendaring have improved strength properties. Slurry steeping, characteristic of the continuous process for preparing viscose, avoids the problem of low sheet strength.

There are many problems connected with the preparation of satisfactory dissolving pulps. Many of the factors are little understood. So far, it has not been possible to use chemical analyses or physical tests to predict how well a pulp will react during processing to produce such things as viscose rayon, acetate, or nitrate. During evaluation, the pulp must be processed through the whole procedure and an acceptable product must be obtained. For several years work has been under way at the Forest Products Laboratory on pulping procedures for high-quality dissolving pulps. These studies are also concerned with ways of characterizing the cellulose or finding differences between various celluloses that might be used to predict suitability for a given product.
Successful pulps for viscose rayon have been made from hardwoods in the Laboratory's pulp and paper division. Experimental yarns of commercially acceptable quality have been made from these hardwood pulps. A rayon has been made from aspen. Of the several procedures used, the prehydrolysis sulfate process yielded pulp sheets with the best strength properties. These studies also indicated that pentosans closely associated with the alpha cellulose of hardwoods may be less harmful to the quality of viscose products than the pentosans of softwoods. Recent studies at the Laboratory have resulted in pulps from aspen that yield cellulose acetate yarns that are equal in quality to yarn made from commercial softwood pulp of acetylation grade. Primary acetic-acid dopes were fairly high in haze, but satisfactory yarn was obtained. An acetate yarn has been made from purified aspen prehydrolysis sulfate pulp. Studies are continuing on the purification of hardwood pulps for chemical use for these and other products. There is yet much to be done, but it may be that in the future it will be more advantageous to use some species of hardwoods for these purposes rather than for the paper-making pulps in which strength is more critical.
Bibliography


Harris, E. E. Wood Saccharification, Advances in Carbohydrate Chemistry, Vol. IV, Academic Press, N. Y.


Mark Twain once said "Don't sit under one tree until overexhaustion sets in; move about from one tree to another." I trust I have moved between enough trees during my nearly 10 years in the predominantly mixed, second-growth shortleaf loblolly pine-hardwood forests of Southwest Arkansas to make a worthwhile contribution to this symposium.

"Great is the power of words" says Homer, words make this way and that way." So today I am going to work from figures which purportedly don't lie and I am also going to work from pictures which on the whole I think will show you that something has happened.

The figures I am working from mainly are based on 19 one-acre check plots scattered over the property of the Ozark Lumber Company and are located specifically in the areas we girdled in 1946 and 1947.

The quickest results from girdling are accidents. Therefore, I feel that I should say something about them since they are likely to occur frequently at the beginning of a girdling program; I have heard of crews being disbanded on this account. During the first three years of our girdling operations we had a total of 31 lost-time accidents. Sixteen of these occurred during the first year. During this year two of the men had three lost-time accidents apiece. Following his third accident one of the men quit, and upon doing so remarked that up until then he had been of the opinion that he knew how to handle an ax.

Injuries to the different parts of the body in these 31 accidents were as follows:

<table>
<thead>
<tr>
<th>Part of body</th>
<th>No. of accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot</td>
<td>11</td>
</tr>
<tr>
<td>Leg</td>
<td>16</td>
</tr>
<tr>
<td>Arm</td>
<td>4</td>
</tr>
<tr>
<td>Head</td>
<td>5</td>
</tr>
<tr>
<td>Shoulder</td>
<td>1</td>
</tr>
</tbody>
</table>

I am glad to say that during the last three years we have not had a lost-time accident, although one or two of the men have intimated that they have had some "close shaves". The only words of caution I have are: Be careful. Have a sharp ax and a firm grip; and lastly be sure there are no obstructions.
The idea of girdling is to sever the cambium at some point on the tree. In our work at the Cana Lumber Company we employ the conventional double-back method which consists of making a series of alternating lower and upper hacks, spaced about three or four inches apart, until a complete ring has been made around the tree. If the cuts are made well into the wood a chip should fly or fall out as the upper hack is made. In this work we use a sharp 3½ pound double-bit ax having a short handle about 28 inches long. The treatment is made at a point on the tree that is convenient for the worker. This is usually three or four feet above the ground.

In the case of trees with open fire scars extra care must be taken to insure that the cambium is severed at all points. If possible it is better and much quicker to girdle such trees above or below the scars.

All species are girdled in the same way except hickory in the spring and early summer months. In the latter case it is usually safer and easier to make light hacks, enough to penetrate the bark. To prevent healing the upper and lower hacks should be spaced about a foot apart. When the hacking is complete the bark is easily removed.

Table I indicates the trouble we had with the healing of girdled hardwoods during the early part of our work. For example it shows that 5 percent of the trees in the 1-3 d.b.h. class healed after being treated. The latter resulted primarily from the use of the single hack or frill method. It is probably better to cut down small trees than to girdle them especially if there is much reproduction in the area that might be damaged from falling girdled trees. The healing of larger girdled trees results mostly from poor work on fire-scarred trees.

Table I. Healing of girdled hardwoods by diameter class

<table>
<thead>
<tr>
<th>D.B.H. (inches)</th>
<th>Percent of girdled hardwoods healing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>5</td>
</tr>
<tr>
<td>4-6</td>
<td>3</td>
</tr>
<tr>
<td>7-9</td>
<td>7</td>
</tr>
<tr>
<td>10 plus</td>
<td>6</td>
</tr>
<tr>
<td>All</td>
<td>5</td>
</tr>
</tbody>
</table>

This table shows that 8% of the girdled trees 10 inches d.b.h. and up healed. Recent observations in stands that were treated in 1948 indicate that we have reduced the number of trees that heal by one-half or from 5% to 2½%. I think we are doing better now than in 1948 although I have not had time to check.

What is the best time of the year to girdle? Based upon my observations the best time of the year to girdle is anytime. So far as I can tell the time of the year has no effect upon sprouting or the degree of crown kill.
To make things simpler I am injecting a new table for sprouting in essentially dense stands, or perhaps I should say stands with a dense overstory.

The amount of sprouting in the 1 to 4 inch classes in both stands are the same but when you get down into the 5 inch class there is quite a difference. For instance, in the open grown stands 99% of the 5 inch trees will sprout whereas in the dense stand only 56% will sprout, and in the 6 inch class, 62% of the trees in the open grown stand will sprout against only 10% in the dense stand. From 7 inches up in the

Table II. Percent of hardwoods sprouting by diameter class in essentially open grown stands

<table>
<thead>
<tr>
<th>D.B.H. (In.)</th>
<th>PERCENT Sprouting</th>
<th>D.B.H. (In.)</th>
<th>PERCENT Sprouting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>99</td>
<td>7</td>
<td>56</td>
</tr>
<tr>
<td>2</td>
<td>94</td>
<td>8</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>90</td>
<td>9</td>
<td>35</td>
</tr>
<tr>
<td>4</td>
<td>83</td>
<td>10 - 13</td>
<td>19</td>
</tr>
<tr>
<td>5</td>
<td>71</td>
<td>14 - 17</td>
<td>11</td>
</tr>
<tr>
<td>6</td>
<td>61</td>
<td>18 plus</td>
<td>0</td>
</tr>
</tbody>
</table>

General observation indicates that hardwoods of poor vigor sprout the least.

Table III. Percent Sprouting

<table>
<thead>
<tr>
<th>D.B.H.</th>
<th>Percent Sprouting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>98</td>
</tr>
<tr>
<td>2</td>
<td>86</td>
</tr>
<tr>
<td>3</td>
<td>80</td>
</tr>
<tr>
<td>4</td>
<td>77</td>
</tr>
<tr>
<td>5</td>
<td>12½</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>7½</td>
<td>0</td>
</tr>
</tbody>
</table>

What are the factors that seem to effect sprouting the most? In fact, the factor most closely related to sprouting is age; that is, as a tree grows old it loses its ability to sprout. The factor of diameter is related to sprouting also, but not closely. Generally speaking as the diameter of a tree increases the tree loses its ability to sprout. On the other hand, an open-grown tree measuring 10 inches d.b.h. is more likely to sprout than is a four inch tree, growing in a dense stand. Sprouting is most profuse in young, open-grown stands of hardwoods, and it is likely to be negligible in stands where there are older trees and trees that have undergone some competition.

The latter leads me up to Table II which gives the percent of hardwoods sprouting by diameter class.
dense stands we have had no sprouting at all. I should qualify this statement by saying that we had some sprouting but they all died back.

Now for Table IV which is headed "overtopping of released pine by sprouts". The rule we follow in girdling is to treat only those trees which are overtopping pine. On this score I think I have had more trouble with the officials of the Company than from the men who are doing the work. The former group did not appreciate, at first, the effect of sprouting especially where there were no pine seedlings to be released. The table shows that the sprouts of small trees are more likely to overtop pine than are large trees.

Table IV. Overtopping of released pine by sprouts

<table>
<thead>
<tr>
<th>D.B.H. (Inches)</th>
<th>Percent of trees sprouting and Overtopping released pine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>8</td>
</tr>
<tr>
<td>4-6</td>
<td>5</td>
</tr>
<tr>
<td>7-9</td>
<td>1</td>
</tr>
<tr>
<td>10 plus</td>
<td>0</td>
</tr>
<tr>
<td>All</td>
<td>4.3</td>
</tr>
</tbody>
</table>

For example, we found that 8% of the trees 1 - 3 inches in d.b.h. will have sprouts on them and will in turn overtop the released trees. On the other hand, when you get into the 10" plus classes, none of the sprouts which may happen to occur on those trees interfere with the released trees.

Why is the percent of sprouting essentially the same in the 1 - 4 inch d.b.h. classes? It is because these trees tend to be reproductive regardless of what kind of stand they are in. In the higher d.b.h. classes the trees in dense stands tend to be suppressed individuals of the older age classes.

The number of hardwoods to treat per acre depends upon the number that are overtopping pine. Table V shows that we treat on average approximately 69 trees per acre.

Table V. Average number of hardwoods treated per acre by diameter class

<table>
<thead>
<tr>
<th>D.B.H. (Inches)</th>
<th>NUMBER TREES</th>
<th>PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 3</td>
<td>24</td>
<td>35</td>
</tr>
<tr>
<td>4 - 6</td>
<td>22</td>
<td>30</td>
</tr>
<tr>
<td>7 - 9</td>
<td>12½</td>
<td>20</td>
</tr>
<tr>
<td>10 plus</td>
<td>10½</td>
<td>15</td>
</tr>
<tr>
<td>All</td>
<td>69</td>
<td>100</td>
</tr>
</tbody>
</table>

Trees in the 1 - 3 inch d.b.h. class are generally cut down. The larger trees are girdled.
One of the first things we do when we go into a stand to girdle it — in fact even before we go into a stand that is to be girdled, if we can do so, we try to remove the merchantable hardwoods which are there. That is what we have done on most areas.

One of the officials of the Company said that he thought I could safely say that this showed great results for such little work.

Comments

Q. Why haven’t you been using manure with your girdling?

A. We tried manure in 1935. At that time it was largely experimental — in fact it may be today for that matter. But the dosages weren’t what they should have been, I assume, and the results weren’t too good, and we dropped it.

Q. How many trees do you find can be girdled per man day, on the average?

A. I would say that in stands of all sizes, a man can treat about 210 per 8-hour day. Some of the cutting operations and the girdling operations went on simultaneously. Most of the cutting operations, however, took place anywhere from one to three years ahead of the girdling.

Q. Have you noticed any difference in results where the girdling was done simultaneously as compared to areas where the girdling was delayed?

A. None in particular. It may be that if you remove the overstory and allow the young hardwoods to recover, you may get more sprouting from the trees that have had a chance to recover. I think that would be true. You might have better luck girdling the remaining trees right after you have taken out the rest of the hardwoods in a commercial logging operation.
CHEMICAL CONTROL OF SOUTHERN UPLAND HARDWOODS

By

Fred A. Peevy, Range Conservationist
Southern Forest Experiment Station
U. S. Forest Service

INTRODUCTION

Chemicals are often used for deadening undesirable hardwoods because they effect a quicker kill, reduce basal sprouting, and require less ax work than straight girdling does. The Southern Forest Experiment Station installed its first experiment for chemical control of hardwoods in 1929 (Bull & Chapman, 1935). From this test it was found that sodium arsenite was the best tree killer available at the time. It was most lethal when applied at the base of the tree trunks in holes 6 inches apart, a half-inch in diameter, and 1 inch deep (Pessin, 1942). Sodium arsenite is still the most effective chemical for deadening undesirable bottomland species (Maisenhelder, 1948), but of course it is extremely hazardous to use.

During the past ten years new chemicals have been developed that are very good killers on upland hardwoods and that ordinarily do not harm humans, livestock, or wildlife. Since 1945, the Alexandria Branch of the Southern Forest Experiment Station has tested the most promising of these new formulations on blackjack oak. The silvicides were tested in different concentrations and applied by several methods of application at the different seasons of the year. Results showed that Amate is more effective than sodium arsenite since it kills trees equally well and is more effective in reducing basal sprouts (Peevy, 1949). The hormone type chemicals, 2,4-D and 2,4,5-T, have also proved very good when applied during spring.

The chemical treatments that have done best on blackjack oak have also been tested in a small way (and during spring and summer only) on southern red oak, post oak, sweetgum, blackgum, and hickory.
The experimental results presented here are from chemical treatments applied from 1945-1952. The trees in the tests fell into two general size classes. The first class included stems 4 to 12 inches in diameter at breast height--too large to be felled economically, but still young enough to send up prolific basal sprouts when treated by the ax alone. The second size class included stems from 1 to 4 inches d.b.h. Since such small trees can be felled about as readily as they can be girdled or cupped, they were treated by chopping them off and applying chemicals to the stump.

Only the three chemical treatments that were most effective at each season are discussed. Ammate solution was not one of the top three chemicals for summer and fall treatments, it was omitted from table 1 for these seasons. For the same reason, 2,4-D is not listed for spring and winter treatments. The use of oil solution of 2,4-D and 2,4,5-T as basal sprays gave poor results at all seasons, and was very costly. It is therefore omitted from the table altogether.

A test of carriers conducted in 1952 shows that the esters of 2,4-D and 2,4,5-T are more effective for sprout control when applied in oil than when mixed in water.

<table>
<thead>
<tr>
<th>Trees Over 4 Inches D.B.H.</th>
</tr>
</thead>
</table>

Table 1 arranges, by order of effectiveness for the different seasons, the best chemicals for killing blackjack oaks from 4 to 12 inches in d.b.h.

The concentration of 2,4,5-T discussed in this paper contained 16 pounds of acid equivalent per 100 gallons of diesel fuel, and the 2,4-D solution contained 24 pounds acid equivalent per 100 gallons of diesel oil. The solution of Ammate was made by mixing two pounds of Ammate per gallon of water. These dilutions were the best of several tested for each chemical.

Spring treatment.--An oil solution of 2,4,5-T (16 pounds of acid equivalent per 100 gallons of solution preparation) was the best spring treatment. Freshly cut frills saturated with 2,4,5-T killed all trees and only 15 percent produced basal sprouts.

Ammate crystals applied at the rate of one tablespoonful per cup (notch) in cups 6 inches apart, edge-to-edge, around the base of the trees killed 90 percent of the trees, but 20 percent of the trees sprouted from the base. Ammate solution in frills killed 90 percent of the trees, but 40 percent of the treated trees produced basal sprouts. Sprouts were more vigorous from the 2,4,5-T treatments than from the Ammate treatment. All chemicals were applied immediately after the trees were frilled or cupped.
Stumps of Trees Under 4 Inches D.B.H.

Table 2 summarizes, by order of effectiveness and season, the best known treatments for controlling the sprouts from blackjack oak stumps. Stumps were treated only for trees too small to be cupped or frilled. Solutions were applied immediately after trees were cut down. The solution was applied to stumps by wetting the entire portion of each stump. For treatments with Animate crystals, stumps were cut so that they had a V-shaped top.

Spring treatments.—2,4,5-T in soil and 2,4-D in oil proved equally effective for spring treatment of stumps. Only 10 percent of the treated stumps produced basal sprouts. Fifty-five percent of the stumps produced basal sprouts when treated with these chemicals. Sprouts appeared on 40 percent of the trees treated with 2,4,5-T and all of those treated with 2,4-D. Animate crystals applied in cups killed 60 percent of the trees; 70 percent of the treated trees sprouted, but the sprouts were abnormal and small.

Summer treatments.—None of the chemicals gave good results on stumps in summer. 2,4,5-T was slightly better than the others, but 45 percent of the treated stumps produced basal sprouts. Fifty-five percent of the stumps sprouted when treated with 2,4-D in oil or Animate.
solution. Sprouts from stumps treated with Ammate were not so vigorous as those from stumps treated with 2,4-D or 2,4,5-T.

Fall treatments.—Ammate in crystal form is the most effective chemical known for treating stumps during the fall. Only 20 percent of the stumps sprouted when treated with Ammate crystals. 2,4,5-T in oil was second-best, but 50 percent of the stumps sprouted, and the sprouts were more vigorous than those from the Ammate-treated stumps.

Winter treatment.—2,4,5-T in oil is the best stump treatment known for winter application to blackjack oaks. It prevented sprouting on all except 10 percent of the stumps. Ammate crystals permitted sprouting on 30 percent of the stumps, but the sprouts were small and less vigorous than those for the stumps treated with 2,4,5-T.

Conclusions.—Fall is the best season for treating blackjack oak stumps with Ammate. 2,4,5-T can be used effectively in either winter or spring. None of the chemicals tested were good for suppressing sprouts from stumps when applied in summer.

RECOMMENDATIONS

The following recommendations for chemical control of blackjack oak are based on results of experiments conducted between 1945 and 1952 by the Alexandria Research Center of the Southern Forest Experiment Station.

For Trees Over 4 Inches in D.B.H.

For spring and fall applications 2,4,5-T in oil applied in frills is the best treatment for killing blackjack oak crowns and suppressing basal sprouts. For winter and summer treatments, Ammate crystals applied at the rate of one tablespoonful per cup in cups spaced 6 inches apart around the base of the tree has been the most lethal treatment.

For Stumps

For poisoning the stumps of blackjack oaks under 4 inches in d.b.h., Ammate crystals are cheaper than 2,4,5-T in oil. However, the 2,4,5-T is somewhat more effective than Ammate crystals during all seasons except fall, when Ammate crystals applied in V-notch stumps are best.

Other Species

Results from small tests conducted on other species at the Alexandria Research Center show that chemical treatments good for controlling blackjack oak are also good for southern red oak and post oak. It has also been found that an oil solution of 2,4,5-T in frills is lethal for hickory during spring and early summer. Sweetgum and blackgum can be deadened during summer by applying Ammate either as crystals in cups or as solution in frills.
Table 1. — Most effective chemicals for seasonal control of blackjack oaks 4 to 12 inches d.b.h. 2/ 

<table>
<thead>
<tr>
<th>Season and treatment</th>
<th>Method of injection</th>
<th>Dead Trees</th>
<th>Trees without basal sprouts</th>
<th>Height of basal sprouts</th>
<th>Cost per tree 2/</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spring</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,4,5-T in oil</td>
<td>Frills</td>
<td>95</td>
<td>35</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>Ammate crystals</td>
<td>Cups</td>
<td>85</td>
<td>20</td>
<td>5.3</td>
<td></td>
</tr>
<tr>
<td>Ammate solution</td>
<td>Frills</td>
<td>80</td>
<td>17</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td><strong>Summer</strong></td>
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<tr>
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<td>90</td>
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<tr>
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<td>Frills</td>
<td>95</td>
<td>3.6</td>
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<td>2,4,5-T in oil</td>
<td>Frills</td>
<td>95</td>
<td>30</td>
<td>3.4</td>
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<td>30</td>
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<td>Frills</td>
<td>100</td>
<td>20</td>
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</tbody>
</table>

1/ Based on treatments applied in 1945-1952.

2/ Cost for chemical and labor for a tree 10 inches d.b.h. The cost is based on:
- $0.75 per hour for labor
- $11.72 per gallon for 2,4,5-T
- $5.65 per gallon for 2,4-D
- $18.00 per hundred pounds for Ammate
Table 2.—Most effective chemicals for seasonal treatment of stumps of small blackjack oaks

<table>
<thead>
<tr>
<th>Season and Chemical</th>
<th>Stumps with basal sprouts</th>
<th>Height of Sprouts</th>
<th>Cost per stump ²/</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Percent</td>
<td>Inches</td>
<td>Cents</td>
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<td>10</td>
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<tr>
<td>Ammate crystals</td>
<td>30</td>
<td>10</td>
<td>1.5</td>
</tr>
</tbody>
</table>

1/ Based on treatments applied 1945-1952.

2/ Cost of chemical and labor for stumps from trees 4 inches d.b.h.
Sprouting from small stumps of gums and hickory can be controlled by spraying 2,4,5-T in oil or applying Ammate crystals in a V-notch. Results are available only for spring and summer treatment.

REFERENCES


Comments

Q. Where do you find is the best place to apply the ammate?

A. At the ground level on the root collar in cups spaced not more than six inches apart. And I'd like to say that it has been my observation that people who have obtained poor results from the use of ammate crystals in cups have usually failed to follow instructions properly. One common mistake is to apply one teaspoonful per cup instead of one tablespoonful. Cups should be spaced not more than six inches apart.

Q. What size crews do you use?

A. We usually use a two-man crew in making cups and applying crystals and a three-man crew in frilling work.

Q. What about degrees of sprouting in relation to tree size? Do you have anything on that?

A. Yes, we found, even with chemicals, that trees under 8" DBH sprouted more severely than trees over that diameter.

Q. Sometimes the sprouts that appear after the use of ammate die back in two or three years. Do they do that with 2,4,5-T?

A. Yes, to some extent, but perhaps not to the same extent as with ammate.
Q. You passed over rather rapidly the results obtainable from basal sprays. I have read recently in the news a glowing account of results from the use of this type of chemical. Would you care to comment further on this?

A. We have tried the application of basal sprays at all seasons of the year as one method of application. Spring was the best season of the year for results obtained—applying the hormone solutions in oil by basal spray. It was not effective at all when the chemists were using water. We got some kill during the winter but results then were more erratic than usual with the spring applications. We have tried everything from 2 to 4% concentrations of 2,4-D and 2,4,5-T as basal sprays. On one plot you may get good results and on another plot the results may not be so good—they don't seem to average out very well.

Q. How many species did you try these out on?

A. We tried them out on blackjack oak, red oak, post oak, hickory, and sweet gum.
It is a pleasure to be here with you today to mutually consider the upland hardwood problem in southern woodland management. I believe it is a commendation to southern foresters that the magnitude of the problem has been recognized so early, that research and management have energetically applied themselves to the problem, and that we are met here to share in the work and results to date and possibly get new ideas for future consideration.

As a matter of orientation this paper will report the research work of the Texas Forest Service in Southeast Texas on the control of undesirable understory hardwoods in pine or pine-hardwood stands by the use of prescribed-fire.

Background

Ecologists recognize that the hardwood type is the climax forest type on most sites in the southern United States. It is thought the combination of complete fire exclusion and preferential cutting of pine has contributed to the build-up of understory hardwoods and the trend toward the climax hardwood type in most pine and pine-hardwood stands. Prescribed-burning is thought useful for holding back the hardwood succession trend and keeping the site in a fire sub-climax stage favorable to the maintenance of relatively pure stands of pine.

The potential of prescribed-burning as a silvicultural tool for limiting the succession of hardwoods was recognized by the Texas Forest Service in 1936. Prescribed burns had been made at periodic intervals since 1931 in longleaf pine to determine the effect on seedbed preparation, brown-spot disease control, and seedling mortality. Additional plots set up in 1936 in a plantation of slash pine were to check the effect of periodic burns on growth and vigor of such pine. The control of undesirable hardwoods was not an objective of these studies, but the absence of such hardwoods in the periodically-burned plots in 1948 brought out the importance of prescribed burns as a possible tool for limiting the hardwood invasion trend (1).

Initiation of Prescribed-Burning Study for Control of Understory Hardwoods:

Observations were made early in 1949 of 35 wildfires or portions of wildfires considered to effect some control on understory hardwoods without adversely affecting overstory pines. These observations indicated it would be desirable to test prescribed burns in the following timber types and condition classes: cut-over pole and surftimer-size loblolly
pine; post and pulpwood-size loblolly of good stocking; and slash pine plantations comparable to pulpwood-size loblolly.

A work plan, approved and initiated in November 1959, included tests in those types and provided for the following seasonal and periodic prescribed burns: Spring (March 1 - 30) when hardwoods are in transition stage, Early Fall (August 1 - September 15), and Winter (Dec. 15 - Jan. 30), when hardwoods are dormant. Burns are planned for two frequencies for each season: every second year, and every third year. Burning treatments are applied to three-acre study plots and each treatment is replicated three times.

We are seeking the "know-how" and most practical and economical use of prescribed burning for desirable silvicultural objectives. We want to determine the following: when and how to make a safe and satisfactory burn under given weather conditions and forest fuel; season to burn; frequency to burn; sites and condition classes of pine where desirable and possible to burn; place in even-aged and unmanaged management; effect of fire on soil and site; economies of fire use; affect on species; and effect on wildlife and watershed values. A secondary objective studied in cooperation with the Texas Agricultural Experiment Station is to determine the effect of periodic prescribed fires on the kind, composition and total density of forage species associated with managed pine overstories.

Understory and overstory woody vegetation populations have been inventoried before and after burning treatments initiated in the winter of 1959. Prescribed burns will be made through the fall of 1955. It is anticipated that following the completion of this phase, burning will be continued under objectives for brush control maintenance and seedbed preparation. After pine regeneration has been obtained, periodic burns will be planned at intervals, between five and ten years to keep brush under control.

Summary of Initial Observations on Prescribed-burning Tests:

The first and second burning treatments have been made on all plots scheduled for burns every second year and on a portion of the plots to be burned every third year.

Reactions to conditions holding for the burning treatments made to date suggest that the following observations may be substantiated as further burns are made and data are analyzed:

Fuel Moisture: Moisture content of ground fuel, as rated by moisture sticks exposed in the timber classes treated, is the most reliable index for safe and satisfactory prescribed burns. Fuel moisture ranges considered desirable are: 10 to 25 percent for slash pine and 1 to 8 percent for loblolly pine.

Satisfactory burns have been made at lower fuel moisture ranges in slash pine, but those levels would probably be found risky for average public use. Satisfactory prescribed burns at fuel moisture ranges above those listed can be made only when other factors such as wind velocity, relative humidity, fuel depth and fuel continuity are extremely favorable.
Wind Stability, Direction and Velocity: A stable wind is most desirable to permit uniform back-fires or head-fires and reduce risk when burns are made at the lowest fuel moisture index previously listed. Steady winds limit the rise of heat and crown-scorching of pine.

Wind stability is most certain during "dry-northers" that occur during the winter and early spring. Such periods are most desirable for prescribed-burning, especially in slash pine stands where fuel is heavy. Winds out of the southwest generally hold throughout a burning day, especially when the velocity in the open is of five miles per hour or greater. Winds out of the southeast or east are often shifty and are apt to change before a burn can be completed.

Wind velocity in the interior of stands was seldom found to exceed one mile per hour at ground level even though velocities above crown level ranged above five miles per hour. Steady winds of one mile per hour velocity at ground level permitted safe and uniform back-fires wherever there was a good stand of pine. Wind velocities of two miles per hour at ground level were found desirable to permit uniform and satisfactory burns in light fuels in loblolly stands. Only "lopping" head-fires gave uniform burns in sparse fuels under cut-over swaths.

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Relative Humidity: Wet and dry-bulb psychrometer readings are taken before and during each burn made. Air moisture levels are helpful in anticipating flame intensity and ease of handling fires at given fuel moisture levels.

A high relative humidity (75 percent or higher) was helpful in making safe burns in heavy, draped fuels in slash pine plantations in combination with favorable fuel moisture and air temperature. It was found during repeat burns in loblolly stands that a combination of low humidity (31-50 percent) and wind velocities near two miles per hour gave satisfactory burns at fuel moisture levels up to eight percent even where hardwood leaf litter predominated. The first burn at similar fuel moisture levels but higher humidity levels was too light for control of hardwoods over one inch in diameter and did not carry when hardwood leaf litter predominated.

Air Temperature: Low dry-bulb temperatures, 50°F. or less, permit burning with little crown-scorching of the pine overstory. Even with temporary windshifts or flashing of fire in draped fuels, crown scorching is less with a dry-bulb temperature of 50°F. or lower than when air temperatures are high.

Fuel Types: The depth of pine litter under slash pine plantations was found to average 2.35, 2.25, and 1.66 inches just prior to winter, spring, and early fall burns, respectively. This relatively heavy litter was found to burn readily one or two days after precipitation up to one inch. Backfires move uniformly through such fuel with good flame intensity. Occasional hardwood clumps where red gum or dogwood leaves predominated in the fuel fail to carry a backfire and burn only with moderate intensity when fired with a "lopping" headfire six to twenty feet in advance of the backfire.

1/ "Lopping" headfire - a fire-line set 6 to 120 feet ahead of the back fire line to burn out pockets or successive bands of fuel.
Pine litter is generally uniformly distributed in the fuel under young, well-stocked pulpwood-size loblolly-shortleaf stands. Fuel depth averaged 1.1, 1.05, and 1.18 inches just prior to winter, spring, and early fall burns, respectively, in this type. It has been observed that shortleaf pine needles make a more compact fuel of less depth and do not burn with as much intensity as loblolly.

Pine litter is found only under residual pine and in a "patch-work" fashion in cut-over pole and sawtimber-size loblolly pine stands. The understory hardwoods predominate in openings where pine has been removed by intermediate thinnings or selection of pole stock. Fuel depth averaged 1.23 and 0.85 inches just prior to winter and fall burns, respectively, in this type. The uneven distribution of pine needles makes uniform and complete burns difficult in such stands.

Type of Fire: Backfires appear more effective and most desirable where practicable, since the heat is held around hardwood stems longer and permits more complete girdling. There is also less chance of crown-scouring with backfires.

Backfires are generally not possible in cut-over pole and sawtimber-size loblolly stands because of the lack of fuel uniformity, fuel compaction, and shading where understory hardwoods predominate. Backfires that will move satisfactorily in adjacent pine litter do not carry across these "islands" of hardwood fuel. Satisfactory burning of such areas has been obtained only by using a "lopping" headfire set in successive bands of 10 to 120 feet width. Wind velocities up to two miles per hour helped such headfires burn out the narrow bands of hardwood fuel without throwing heat to the crowns or building up an intense ground-fire. This type of fire burns rapidly and with uniformity. Three-acre plots were burned in 75 to 90 minutes with successive lines of head-fires.

Terrain: All burns have been made in the "flatwoods" area of little or only moderate drainage. Slope on one plot has been observed to affect fuel moisture, flame intensity and effectiveness of burn.

It would be expected that fuel on south and west slopes would have generally lower moisture levels and burn more readily than those on north or east slopes or areas of limited or moderate drainage. Pronounced slopes as found on Upper Coastal Plain sites might be expected to also affect draft and fire intensity and behavior.

Relative Control of Undesirable Understory Hardwoods:

Observations of brush populations following treatment indicate that some 95 percent of the understory hardwoods that come in under slash pine plantations are killed-back following the second prescribed burn. This includes hardwoods of the larger sizes in stands that have been under fire protection for as long as 22 years since establishment. Only the largest red and black gum, water oak, and dogwood of five or six inch diameter or greater at 5 feet height escape complete girdling. It would appear desirable to plan the first hardwood-control burn at an age of 10 to fifteen years to effect control over hardwoods at an earlier date.
Most thin-bark hardwoods up to three inches in diameter at 0.5 feet height, such as yaupon, myrtle, huckleberry, holly, ash, witch hazel, silverbell, sweetleaf, mossy greybeard, and maple can be readily killed back by the first or second burn in pulpwood-size loblolly stands where pine litter is uniform. The effects of the first repeat burn indicate we may expect greater control over red and black gum, red and water oak, and dogwood of three to five inches in diameter than was first anticipated.

Prescribed Burns in Relation to Stand Condition:

The work to date stresses the importance of making prescribed burns for understory hardwood control before appreciable thinning or selective cutting is done, especially in the loblolly-shortleaf-hardwood type. Removal of a portion of the pine overstory reduces the amount and uniformity of pine litter and makes uniform burning difficult. It also limits the possibility of using backfires.

We are finding we can move "lopping" headfires across sparse and non-uniform fuels in cut-over pine-hardwood stands under favorable conditions. The number of burning days of favorable climatological conditions for satisfactory burns is limited, however. We recognize that the effectiveness of prescribed burning is limited in cut-over sawtimber-size stands. Poor burns and lack of hardwood control in openings between residual pine will limit the use of fire since these are the key areas from which competing hardwoods must be removed before satisfactory pine regeneration can be obtained prior to the final cut.

Prescribed Burning Costs:

Costs related to prescribed burns on the three-acre plots are, of course, not indicative of costs to be expected where larger acreages can be burned and longer fire lines can be used.

Experience with recent management burns made on the state forests in Texas indicates total costs for backfires in uniform pine-hardwood fuel can be held to about 30 cents per acre per burn. Use of "lopping" headfires in pulpwood-size or cut-over sawstock loblolly stands will eliminate considerable firebreak construction and permit faster burning so that costs should run about 18 to 30 cents per acre. It appears that smaller acreages per man unit might be required to burn slash pine plantations without undue risk and that costs might run from $0.50 to 1.00 per acre when backfires are used.

Hardwood Understory Species as Plant Indicators:

A further study of the understory hardwoods and herbaceous species may show their value as indicators of: successional stages; browse utilization levels; and favorable conditions for pine regeneration.

Sweetleaf or horse-sugar (Symplocos tinctoria) is observed to thrive and increase only where given protection against fire and where it is not browsed heavily by cattle. It is a thin-barked tree that is readily killed back by even light prescribed burns. It sprouts profusely, however, and appears to persist along drainage-ways not completely burned out or over-grazed on "free range" areas. Its fruit is apparently eaten and scattered
An abundance of sassafras, sumach, French mulberry, and vacciniun species appear to indicate a more xerophytic site. New pine seedlings are usually concentrated where these species predominate but are not generally found in sufficient number as to thoroughly shade the ground. Presence of these species in appreciable number may indicate their use as indicators of desirable seedbed and site condition for pine regeneration.

Some agencies are proposing the use of, or are using, understory species as indicators of site quality. It appears from the current study that leads may be obtained that may assist in the further classification and handling of Southern forest stands on an ecological basis.

Supplemental Treatment:

Our prescribed burning study is not seeking the elimination of all hardwoods from pine stands but rather the successional stage where numbers and competition will be under control. We readily recognize that hardwood utilization should be employed wherever currently possible. It appears that the larger hardwoods not killed-back by fire may be utilized for pulpwood or other products in the not-too-distant future. Where such material seriously limits immediate desired pine regeneration it would appear that supplemental treatment could be used to control such hardwoods which might remain following prescribed burns.

Potential Application of Research

In conclusion, we feel the research work conducted to date has given us much of the "know-how" we were looking for when the project was started in 1969. The initial results indicate that prescribed-burning for understory hardwood control has a practical place in the management of southern pine or pine-hardwood stands. The information and experience we have gained on prescribed-burning is now being used to public management burns for hardwood control on Texas state forest demonstration areas. We expect that guides will be developed shortly for use by trained and qualified men to judiciously supervise prescribed-burning for hardwood control on private lands.

References Cited:

Comment: We've been talking a lot about girdling and burning and the use of chemicals to get rid of undesirable hardwoods. Not long ago, one of our foresters found a note in the woods that read like this:

"You've got the money
We've got the time.
You girdle the hardwoods
And we'll burn the pine."

Q. You mentioned wind with your burning, and you mentioned one or two miles an hour. Is a one or two mile wind better than a heavier wind — say four to six miles per hour?

A. We don't get those winds. We have found that the winds exceed one or two miles an hour on just a few occasions at the ground level, inside the stands. Generally it is one-half to one mile in velocity.

Q. Would you like to have heavier winds?

A. Yes, we would like to have the type that comes with a dry norther, particularly on backfires in slash pine stands, because you have a constant wind that lays the heat down along the ground and doesn't let it drift up into the crowns, but often we get a wind of less than one mile per hour at the ground level.

Q. You made the statement that burning was generally done in small blocks of two or three acres. Has that been done on larger areas and if so did you get an even burn or was it erratic or different?

A. No, under conditions of management I think the largest we have done was 70 acres and we did get an even burn all the way across. This is in rolling land.

Q. What do you mean by a lopping fire?

A. These are successive bands of backfire across our plots. This reduces fire line construction and speeds the burn up considerably. We found it has been necessary. We started out with the idea of trying to get a hotter fire for our cutover pole and sawtimber stands with a relatively high crown canopy. We figured these would take a hotter fire without crown scorch. We wanted a hotter fire but we haven't been able to obtain the heat we want unless we start with a fuel moisture of around 60% and it is hard to get except during the fall season and drought periods.

Q. How long does it take to burn 10 acres?

A. It depends on how you go at it. We found that a backfire moves about seven tenths of a foot per minute. If you run fire breaks through the way you do in the longleaf type, about five chains apart, a fire will move through that five chain strip during the burning condition, say from about 11:00 A.M. until about 5:00 to 6:00 o'clock in the evening. Thus by using five chain strips you can burn as much acreage as you have personnel to cope with it. The longer the fireline the better, in loblolly pine.
A. Tie prefer to wait as late as we can in the fall of the year preceding planting, primarily because we anticipate some sprouting no matter what kind of treatment has been given the area.

Q. Mr. Sentell, would you burn your brush cut areas as soon as they will burn, or would you prefer to wait for six or eight months until the fuels have had a chance to season more? Which do you think gives best results?

A. Yes, in slash pine we like to watch it pretty close—in heavy fuel we prefer to have air temperatures below 50°F Fahrenheit. There we have dropped fuels we have tried burning high in temperatures and have had flames that flashed to the tops of 60 to 70 foot trees, but burning in 30°F temperatures in such stands we have experienced no crown scorch at all. So the lower the temperature under heavy fuel conditions, the better should be the results. The fuels under loblolly stands are not heavy enough to concern us under most conditions, as far as crown scorch is concerned.

Q. In your controlled fires, have you tried setting them at dusk and letting them burn all night?

A. No. The only night fire we have resorted to was in slash pine when we had a heavy fuel. We were operating on a strict research schedule and were trying to get a burn during the season of the year we desired, and frequently at the tail end of our burning season we have had to make a night burn, burning under conditions comparable to day burning. In slash pine we got some very nice burns at night.

Q. Mr. Sentell touched on air temperatures very lightly. What, if any, importance do you attach to air temperatures?

A. I don't think so. Whenever you start planting in "rough" woods, even though all of the vegetation has been levelled, there are so many roots and stumps and similar obstructions that the planting machine is constantly jumping up in the planter's face and you can lose teeth that way so we find it best to plant these areas by hand even though we should like to plant them with machines.

Q. Mr. Silker touched on air temperatures very lightly. What, if any, importance do you attach to air temperatures?

A. Yes, in slash pine we like to watch it pretty close—in heavy fuel we prefer to have air temperatures below 50°F Fahrenheit. There we have dropped fuels we have tried burning high in temperatures and have had flames that flashed to the tops of 60 to 70 foot trees, but burning in 30°F temperatures in such stands we have experienced no crown scorch at all. So the lower the temperature under heavy fuel conditions, the better should be the results. The fuels under loblolly stands are not heavy enough to concern us under most conditions, as far as crown scorch is concerned.

Q. Mr. Sentell, would you burn your brush cut areas as soon as they will burn, or would you prefer to wait for six or eight months until the fuels have had a chance to season more? Which do you think gives best results?

A. We prefer to wait as late as we can in the fall of the year preceding planting, primarily because we anticipate some sprouting no matter what kind of treatment has been given the area.
Q. Mr. Santell, what was the price of that 18,000 pound brush cutter that you mentioned?

A. The price may have changed recently, but I believe the price quoted us was around $4,600. We were not sold on the method, and the cost of transportation of the machine up to Hodge would have been around $500 so we figured it might cost around $1,000 plus the cost of rental of the machine and for not too much more money we decided we could build our own. We weren't sure we could justify the cost of construction, but we plan on being in the forestry business for a long time and we figured that somehow we would be able to get our money back.

Q. Mr. Campbell, have you had any experience with the Rototiller?

A. Yes, I was paid twenty-five cents an hour to operate the first one brought over to this country, I believe. We used it to make fire lines around plantations, to cultivate between red pine planted about 3 x 3 and larch planted about the same way, and until Svend Heiberg put some phosphorus on in the stuff hadn't grown more than a foot in eighteen years.
Since the beginning of our intensive forestry program in 1926, we, like many others, have been constantly searching for better and more economical ways for removing undesirable hardwoods from our pine-hardwood sites in order to increase the composition of pine.

We soon found that there was no one method which was a panacea to all conditions. In some areas we came to the conclusion that control by ordinary cutting and girdling was the answer. In other areas, we decided that a combination of cutting, girdling, frilling and the use of poisons was the best. In still other areas, we could see the advantages of prescribed burning.

We soon set about using each of these methods as we felt best applied on relatively large areas of land. However, there was one stand condition that kept us worried. This was a dense stand of hardwoods ranging from 1/2 to 3 inches in diameter containing fuel conditions of such nature that it would burn only under the most extreme conditions. Prescribed burning in these areas would be either ineffective or dangerous. Cutting and poisoning could be done, but the cost would be extremely high, if not prohibitive. The need for a mechanical contraption to level the hardwood long enough for pine reproduction or planted seedlings to get ahead became more and more apparent.

We have learned that others had used bulldozers with not too much success and since we felt that a tool to be efficient should move continuously forward rather than dead-heading part of the time like a bulldozer, we conceived the idea of breaking the ground by plowing it with a Mathis fire plow. We treated an area of about 10 acres in this manner, but soon found it not too successful. The plow continually became clogged with stems and made the costs run high. Also, the piling of topsoil in rows was a questionable practice.

It was at this stage of the game, through the courtesy of Mr. A. S. McKean, Extension Forester, that we had the opportunity of observing an 18,000-pound brush cutter work in a stand located a few miles out of the city of Baton Rouge. This machine was built following the principal of the ordinary cotton stalk-cutter and was manufactured by E. L. Caldwell & Sons of Corpus Christi, Texas.

At the time we observed the machine, although it was being operated for the purpose of clearing pasture land, it was working in a dense stand of young hardwood and making such progress that it was not difficult to imagine its possible value when used for forestry purposes in similar stands in North Louisiana.
The decision was made to acquire a similar machine for our use. However, after inquiring into the purchase price of the machine and the freight rates from Corpus Christi to Hodge, it was found that since we had much of the necessary material in our scrap iron piles, it would be cheaper for us to construct a like machine in our own shops.

The machine is simply a giant roller fitted with nine bulldozer blades set 14 inches apart around its circumference. Weight is supplied by three solid iron castings 32 inches in diameter cast in half-sections and bolted around the center shaft. These castings, incidentally, were the most expensive item in the construction of the machine. However, since the cutting is accomplished by the sheer weight of the machine forcing the blades through the tree stems, weight per cubic foot is most important and could not have been obtained using cheaper materials.

The machine is 10 feet wide, 13 feet long and 10 inches high. It cuts a path 8 feet wide and weighs approximately 22,000 pounds. It cost us $2,500.00 to build.

Although we have pulled the brush cutter with a D-6 and a D-8 Caterpillar, we prefer the D-7 with a dozer blade. The D-6 does not have sufficient power to handle the machine under all conditions and the D-8 is so heavy that transportation is a problem. Both the tractor and the machine can be transported on a single float-type semi-trailer; however, owing to the extraordinary weight it has been found best to haul them separately. The dozer blade is used for filling stream beds and making crossings and for pushing over the hardwood ahead of the machine. It is also used to build a fire line around the area treated when the cutting job is completed.

The machine works best on firm, level ground where the hardwoods are less than 3 inches in diameter. In these areas practically all stems are levelled and remain levelled. If they are not cut up in 1\(\frac{1}{2}\) inch sections, they are either broken over at the ground line or uprooted.

The effectiveness of the machine was at once demonstrated when it was found that natives from the surrounding countryside were coming in with sleds and wagons to pick up stove wood behind the operation. Naturally, the cutter does not work perfectly under all conditions. It does not work well in soft, rain-soaked soil, as it merely presses the stems into the ground. Neither does it work well in rough terrain where gravitation becomes a problem. Its progress is also slowed by the presence of large hardwoods or pines which must be by-passed.

It was first thought that the use of the brush cutter would necessarily be confined to the mid-summer and fall months so that hardwood sprouts would not have a head start on the pines planted or seeded the following winter. However, it was found that if the debris on the ground was given six weeks or more to dry that under most conditions the cut area would burn very intensely. These fires not only killed back the sprouts which had developed but also killed many tree stubbles and consumed much of the brush left on the ground. Now we cut anytime during the spring or summer and burn when conditions are right in the fall.
Following brush cutting and burning, the areas are in excellent condition for either planting, direct seeding or natural seeding. We prefer planting as we feel that the additional cost of planting is more than justified in order to get the most from monies expended in clearing. We prefer planting for many other reasons, but this is really another topic and will not be discussed here.

Costs for the operations are just as variable as the stands and terrain involved. We have treated as many as 13 acres per day and barring breakdowns, I don't believe that we have ever treated less than 5 acres per day. A good average is about 7 acres per day.

Using the best available cost figures for the operation of the D-7 Caterpillar and allowing for two operators (for safety reasons) we find that the operation costs about $51.36 per 8-hour day. Using the above acreages, we arrive at the costs of: maximum $10.27 per acre, minimum $3.94 per acre, and probable average $7.33 per acre.

If the area is burned, of course there is an additional cost. This cost also varies, but for all practical purposes fifty cents per acre should be a sufficient allowance. This brings us up to a total average cost of $7.83 per acre to put almost worthless brush lands in a very good condition for planting or seeding to pine. We do not believe it can be done as well on the land described by any other method known.

The modern day farmer is adding flail machines and chemical weed controls to his tools for the raising of field crops. The modern day forester is also adding mechanical and chemical devices to his tools for the raising of forest crops. We are firmly convinced that the brush cutter has a place among these tools.
MECHANICAL DEVICES FOR HARDWOOD CONTROL

By

David Campbell, Division Forester, Arkansas
International Paper Company
Camden, Arkansas

The term "Hardwood Control" as applied to some of our silvicultural practices has a rather negative connotation. I prefer a more positive statement to suggest the purpose of the control. Such statements would be "Site Preparation" for reproduction, either natural or artificial, "Weeding", "Pasture Development" or similar terms. These terms suggest the purpose for which the control is used and help us answer the tremendously important question of "why". Why do we thin? Why are we proposing to cut timber? Why are we proposing to plant trees? Why are we considering the construction of a certain road? And so on for a very long list of "whys" to cover all of our forest activities, and to include the question of "why do we want to control hardwoods?".

Obviously, Hardwood Control is not a new idea or activity. The early settlers "controlled" millions of acres of hardwoods to clear "new ground", transportation routes and community sites. Economic developments such as Rights-of-Way have required additional "Hardwood Control". The greater part of these types of "Hardwood Control" has been a combination of mechanical means with chemical means. The agency of fire was of course used in the earliest, and by far the most popular, chemical process. The mechanical tools employed ranged from knives, axes and hoes, through saws, flails, and mowing devices; plows, drags and harrows, and either simple or complex systems of levers, piles or pulleys; whenever possible, of course, men replaced his efforts with those of animals and in the years since 1920 gasoline or diesel power has replaced that of the animals.

Since the advent of mechanical power, many existing devices have been modified, strengthened and adapted for clearing land for all purposes, as far as I know, however, no machine has been devised for clearing land of trees, shrubs and grass for a specific use. The nearest approach to a clearing mechanism designed for a specific land use is the so called, "Brush Blade" to be used in lieu of a standard bulldozer blade. This specialized blade is designed as an open grid, rather than a solid "shoving" blade, equipped with deep running, heavy tines. The tines tear the roots from the ground, and the open grid retains the roots and tops but permits the soil to shake off. In this way the maximum brush may be piled with the least movement of soil and the land has been cleared for the specific purpose of agricultural cultivation.

Before discussing some of the hardwood control mechanisms with which I have some familiarity, I should like to return your attention to my opening suggestion - that the question to be asked and answered before any job is undertaken is the infant's interrogation "WHAT". The purpose for which hardwood control is undertaken will determine the type and method of operation of any mechanical device to be used.
The self-propelled Leather C-saw is an example of the smallest machine of this type, while the BRUSH-MASTER, manufactured by H. P. Manufacturing Company, Livingston, Texas, is an example of the larger, wheel-tractor mounted type.

II. A slicing, front mounted cutter consists of two horizontal cutting blades attached to the A frame from which a bulldozer blade has been removed. The two blades form the sides of an isosceles triangle, whose base is equal to the overall width of the tractor to which it is attached, while the distance from the base to the tip is about twenty-five percent greater than the width of the tractor. The horizontal cutting blades are attached to, and supported and reinforced by, a triangular "prow" of sheet steel and reinforcing framing. The "prow" throws the severed trees and brush to one side or the other and to protect the operator. All the machines of this nature that are known are light and suited best for small material up to about 6" D.B.H. There is no disintegration of the severed material so that foresters would probably have to follow up with fire. Since the cutting is clean and above the root collar, sprouting can be expected. Chemical treatment of the stump, either individually or broadcast, should stop the sprouting and there is a possibility of using high mowing to help control the sprouts after they develop. There is no soil dislocation or cultivation, and all grasses and small plants are released. This machine seems best suited for recovering the use of abandoned fields for pastures or for the cutting of standing, relatively small brush, ti-ti, sweet boy, gallberry, and the like, prior to discing or plowing.

Mechanical devices used at present for "Hardwood Control" in our forests are largely non-selective, that is, they hope to control all, or nothing. The exception to this statement lies only in the case of the various saws. Hand and hand-held power saws are of course entirely selective; wheel mounted power saws are generally selective and tractor or jeep mounted saws partially so.

To a forester, the large, heavy non-selective machines for hardwood control seem best suited to prepare sites for some type of reproduction. This is a vague answer to the specific question "why are you controlling hardwoods by mechanical means?". A specific answer will have to include the type of reproduction, whether it be natural seeding, artificial seeding, hand planting or machine planting; the habits of the seedling; the desire with particular reference to its tolerance of various soil conditions; and, not I fear finally, but equally importantly, the need of the seedling for shade, or its intolerance of shade. The answer to this last question will indicate the amount of control required, that is, all plants, or only the larger woody plants, and the length of time over which the control must be effective after the machine has completed its work.

Among the machines that may answer some of the purposes are the following:

I. A horizontal circular saw, or saws, mounted in front of a wheel or light track-type tractor or jeep. Arrangements are usually made to control the height of the blade and a series of guards are employed to cast the severed brush to one side or the other to protect the operator. All the machines of this nature that I know of are light and suited best for small material up to about 6" D.B.H. There is no disintegration of the severed material so that foresters would probably have to follow up with fire. Since the cutting is clean and above the root collar, sprouting can be expected. Chemical treatment of the stump, either individually or broadcast, should stop the sprouting and there is a possibility of using high mowing to help control the sprouts after they develop. There is no soil dislocation, or cultivation, and all grasses and small plants are released. This machine seems best suited for recovering the use of abandoned fields for pastures or for the cutting of relatively small brush, ti-ti, sweet boy, gallberry, and the like, prior to discing or plowing.

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side of the machine or the other. Rather than being sharpened to straight chisel edges, the two long cutting blades are ground first into a series of shallow curves. The entire length is then sharpened to a repand cutting edge somewhat similar to some types of bread knives.

The entire cutting edge is movable up and down with the normal dozer controls for ease in maneuvering. Actual cutting or slicing is done with the blade in the "float" position.

Surprising large trees may be severed provided that the machine is operated at a high speed (3rd or 4th gear). Because of the sharp angle to the "prow", forward motion of the tool results in a long slicing cut when a tree or brush is encountered. With the cutter a D-2 tractor (a small light one) is capable of cutting 6" Oak, Hickory, or Gum with only one pass. Larger trees may be severed with more cuts.

As the "prow", with attached blades, slides over the ground all firmly rooted trees and shrubs are felled with a clean practically horizontal cut, or only slightly above, the root collar. Loose firm trees and plants are ripped from the ground with torn roots and macerated root collars and stems.

In heavy hardwoods, up to 7" D.B.H., a D-2 equipped with this cutter cleared 1/2 an acre in 1/2 an hour. Very little soil was moved and the brush was evenly distributed. At the end of the period the tractor was overheated and 1/2 an hour was required for it to cool. This was a reflection on the operator rather than on the machine since similar machines operated full days with no overheating.

This type of cutter has been installed on dozer frames on D-2, D-4, and D-6 tractors and used during the last 18 months for land clearing for pasture purposes in Arkansas. Some sprouting results unless heavy discing or plowing follows the clearing. The sample on International Paper Company land seems to have been well prepared for natural reproduction of loblolly and shortleaf pine. Since we have seed trees available in the area we are somewhat optimistic.

The cutters described are made locally for J. A. Higgs Tractor Company in Little Rock, Arkansas, and vary in price from $650.00 installed on the D-2 to about $1,600.00 on the D-6.

III. A more primitive front cutter is obtained with either a bulldozer or an angle dozer blade set in the "float" position. This tool will cut some hardwoods and uproot others, all accumulate in front of the machine and the brush must be hopped, or piled in windrows.

Dozing for site preparation results in considerable loosening and some movement of the surface soil and some stump holes result. However, more mineral soil is exposed than with the machines mentioned previously, since a very large part of the litter is swept by the severed brush as it is moved to the piles.
The cost of doing will vary, of course, with the size and density of the material to be moved, the principal species involved, and the soil condition as it affects tractor operation. We have prepared natural seed beds on small patches totaling somewhat less than one thousand acres for an average of $6.50 per acre (with a variation of from $3.00 to $18.00 per acre).

On an additional 1,600 acres, we have done essentially the same work but have, in addition, removed more roots and saved less dirt by using a "brush blade" in lieu of a regular dozer blade. The cost has run about one dollar more per acre more than with the dozer. We hope that sprouting will be reduced and that the results will justify the extra cost.

While our brush blade was built as a special order to obtain heavy, easily removable stems, both brush blades and various dozer blades are readily available from heavy equipment dealers.

IV. An adaptation of the flail mine exploder as used on army tanks has been named the "BUSHWACKER". The effective mechanism consists of a rotating horizontal shaft mounted crosswise of a tractor and positioned a few feet ahead of it. Attached to the shaft (or drum) are twenty flails, each consisting of a short length of chain ends of 19 1/2 pound heads, or hammers, with one sharpened cutting edge. When the shaft is rotated at a speed of 1000 r.p.m., the flail heads travel at a velocity of 11,530 feet per minute within a 2 inch diameter circle. Flails are arranged in four rows of five to give a cutting, or disintegrating width of six feet.

The flail assembly is supported on depth gauge wheels and is preceded by a "pusher bar", which bends the trees and brush so that the flails may chop the woody material while it is under tension. The bar also serves the purpose of directing the severed material to the ground directly in front of the machine to be completely chipped and shredded by the time the machine passes over it.

The driving motor for the flail head is an independent motor mounted on the other end of a seesaw from the flail. The seesaw is long enough so that a tractor can fit between the flail and its motor for length and between the two bars of the seesaw for width. The fulcrum for the seesaw is on the tractor some two feet above the position of the normal dozer trunnion. The tractor, on which the mechanism is usually mounted, is an International Harvester TD-9, which is a medium weight machine.

The machine is limited to hardwood trees up to 6" D.B.H. and softwoods up to 7" D.B.H. Performance will depend upon the density and size of the brush and on the terrain, but claims of up to one acre per hour have been made. On the area cleared, all woody material above the ground is chopped, chipped and shredded and such stubble of stems that remain on the ground are frayed and denuded of bark. There is no disturbance of the soil and no brush disposal problem.

1 year ago one of these machines was operating in Oklahoma. At that time the flail drive was by means of five 16-ft. V belts in a rather exposed position. Twigs and litter were picked up by them and considerable breakage occurred. At the same time, chisels were dalled and chains
We intend to place a heavy Marden Cutter in operation this spring. We're choosing a tandem cutter with the shafts set at a slight angle rather than parallel, in order to obtain a cross-chopping effect and a slicing cut rather than a straight cut. As far as we can see, the upper limit on the size of the material cut will be largest size tree that can be pushed, or bent, over by a HD-18 tractor with dozer, without stopping its forward motion.

The machine will be used to prepare good natural seeding conditions in areas where we have cut Loblolly and Shortleaf pine to seed tree stands and in which there is new a low, dense hardwood and shrub cover. Our object is seed bed preparation and hardwood control for a period sufficiently long so that the young pines can get a start and stay ahead of any competition that may develop.

Work on the limited part of our currently or recently cut stands, in need of some hardwood control and other silvicultural clean-up for optimum reproduction conditions, will cover about 6,000 acres per year. On this area the shrub and hardwood cover, while dense in spots, is usually young and less than 12 feet high. While there are many stumps in the areas, we do not foresee any insurmountable difficulties and confidently expect to obtain established released seeding at the rate of 2,000 or more to the acre for a cost of $7.50 per acre or less.

An additional 60,000 acres in an area of extreme hardwood virility causes us some concern. This area has developed over the past 25 years for a variety of reasons and the scrub hardwood cover is well established. During the period of development, but faster in recent years, pines have...
become re-established but not in numbers sufficient to be classified as satisfactory. On this rather large area we expect our greatest success to come from methods of control or destruction that combine mechanical with chemical means and which are specifically directed from site to site to the specific requirements of the site. As far as reproduction is concerned, we will, I feel, need different preparation in advance of natural seeding as compared with artificial seeding, and both types may vary from that best suitable if the land is to be either hand planted or machine planted.

We are progressing with our methods of "Mechanical Hardwood Control". Every machine tried so far has had many limitations and there appears to be no simple universal mechanical tool. Each forester must still analyze the conditions under which his trees grow and choose the machine that will best accomplish his purposes, after he has answered completely the question, "Why am I going to control these hardwoods?".
Although the actual scope of our general subject, "upland hardwoods", should be fairly well understood by this stage of our discussions, I want to try my hand at definitely outlining its nature and extent. Perhaps I can thereby rule myself out of my subject and save a lot of brain fog. At any rate, in order to afford any pertinent or relevant object for discussion of management, it is certainly imperative to restrict and specify our interests within this very broad and heterogeneous field.

At the outset, it must be recognized that a very large proportion of this so-called "upland hardwood" is either relatively or absolutely so worthless and unpromising, economically, as to be beyond reasonable consideration for management for timber production. Much of it consists of outright weed species, including some inherently scrub oaks, while much more is of respectable species but definitely restricted to scrub status by site deficiencies. Except as management of this stock in some degree may be desirable for the good of the site, the principal problem here is to liquidate or eliminate it in the most economical manner. In either case, it is an aspect of management for production of pine timber, the various phases of which are ably discussed here by others.

At the other extreme is the very considerable aggregate area of hardwood and pine-hardwood which is capable of producing economically important and relatively valuable timber in substantial proportions at reasonable growth rates, over areas of manageable extent. I should roughly define this category as including all areas of minimum, independently manageable extent which normally support substantial proportions of high class hardwoods; that is, a class which is inherently capable of producing at least 50% of No. 2 factory lumber logs or better and of growing, under extensive management, at an average rate of about 2" in ten years. Such stands can be separately managed for maximum volume and value; the hardwoods on their merits, as such, and all species, whether hardwoods or pine, on their relative merits. Quite logically, this category is reserved to be treated as a phase of the broad subject of hardwood management at some future symposium.

Incidentally, it may be well to recognize that any line drawn between "upland" and "bottomland" is less important for the present purpose than the distinction just made as to inherent quality and it would have to be either superficial and arbitrary to be practical. As I see it, the essential distinction is between, on the one hand, hardwood and pine-hardwood on areas where the hardwoods can logically and economically be managed as such on their absolute and relative merits; and, on the other hand, the areas, whether technically bottomland or upland, on which the hardwoods must be managed secondarily or incidentally to pine management, if at all.
Distinction of the two extremes, as above, leaves us to consider only such of the intermingled and interspersed hardwood, necessarily encountered by the upland or pineland manager, as may be of material actual or potential economic value but which cannot reasonably be afforded conventional stand or area management independently on its own merits. That is, either its actual or prospective stand density is so light, its general quality or growth rate so poor or its units of area are so small that it must be managed secondarily and incidentally to management of the pine, if at all, and generally as individual trees or groups. Nevertheless, to clarify here, the hardwoods of any given area must obviously proffer actual or potential products of such real economic value as to demand rational consideration of their relative merits and of their appropriate silvicultural disposition from that viewpoint.

Leaving out the high-class hardwoods which demand independent or coordinate treatment, this intermediate class of hardwoods probably constitutes no more than a substantial minority of all the hardwood which confronts the pine manager; however, it is definitely the most important and questionable part. At the same time, it has received almost no consideration, from the viewpoint assumed here, being disowned by both the pine and hardwood people. The amount, extent, kind and distribution of it have never been determined and distinguished and almost no inquiry has been made into its actual utility or potential utilities and values, concentrations, feasible methods of handling, growth rates, silvical relationships, etc. So far as I know, the only systematic work yet attempted on it has been at the Crossett Branch and, presumably, no experimental results are available or someone besides me should be in this spot.

Actually, the problem is not one of conventional overall management of a recognized forest type. It is, rather, largely a complex of separate questions of relative values and growth rates, practicable appropriate uses or marketing, silvical relationships and values, etc., which must be integrated to determine whether continued competition of individual hardwood trees with the pine is warranted. On an occasional low wet spot or strip, inherent silvical conditions may dictate maintenance of pure or nearly pure hardwood. In such case, hardwood silviculture must apply but the overall management will still be subsidiary to the exigencies of the pine management.

Accordingly, about all that can be attempted here will be to more clearly define the general proposition and the specific or implied problems, discuss principles briefly, and suggest some broad possibilities hoping to incite some helpful discussion.

To begin with; an outline of the forest types and sites and the species and classes of trees under consideration:

In all natural or original loblolly pine-hardwood and all loblolly-shortleaf-hardwood country, the oaks rather commonly develop at least crosstie form and quality while, on the choice sites, a substantial proportion will produce No. 2 or better logs at a fair rate of growth. Likewise, sweetgum will produce pulpwood fairly rapidly on any really good site and it is timber rather slowly while, on moist sites with pervious sub-soils, satisfactory No. 2 and better logs will develop slowly. East
of the Mississippi, yellow poplar develops satisfactorily in all branch heads and sheltered coves and ravines. On the better sites, a fair proportion of the hickory will produce handle stock quality while a little ash occasionally shows promise. Although it commands the best sites, beech is consistently poor and slow of growth.

In the original longleaf and slash pine territory, most of the true upland fails to produce even a good crooked class of oak in material quantities but substantial amounts of No. 3 do develop in coves and sheltered lower slopes. No. 2 and better oak is a relatively insignificant rarity and occurs only in veritable bottom or hammock situations and on the edge of swamps. Likewise, on the true uplands of the longleaf country, both sweetgum and hickory seldom attain more than cordwood status regardless of size, and that slowly. Now, if any, other species venture far from the sheltered ravines, branch heads, and swamps.

However, upon the limited proportion of such favorable sites which is neither too poor nor too good and extensive to qualify here, a number of desirable species do fairly well. In the coves, threads of bottoms and branch heads, tie and structural grades of oak develop rapidly with a fair salting of quality stock. However, the most promise lies in the so-called soft hardwoods of the branches, bottoms and swamps. In the branches and bottoms, sweetgum, poplar, maple, and magnolia make structural and box timber rapidly and high-grade lumber and veneer timber at a fair rate. In the swamps, tupelo, swamp black gum, bay, and maple do likewise.

Viewed with proper discretion and discrimination, which is the imperative approach in hardwood work, it seems apparent that there is, in the aggregate, a really substantial resource of hardwood, intermingled and scattered practically inseparably throughout much of the pine area. Obviously, this resource should not be wasted if any net return is reasonably in prospect, either near or soon. On the other hand, whether it may be wise to promote its growth and development, not to mention regeneration, through management measures, is not so obvious. This brings us to the nub of this discussion; that is, what sort of management may be appropriate and justifiable and in what circumstances and on what basis?

The basic assumption in answering these questions is that the full course of stand management for sustained yield of hardwoods on a coordinate basis with the pine, is not justified unless the situation is inherently capable of producing a high proportion of No. 2 and better logs of the better species at a rapid rate. Within the narrow scope of our present discussions, only the isolated patches or pockets and threads of choice upland site and of actual bottoms and swamps would be eligible. This would leave the great majority economically subject to only limited management because it is quite apparent that in the long run pine will produce greater values than slow growing or inferior hardwoods which must, therefore, yield the growing space.

Thus the appropriate management for the bulk of the area and volume under consideration is simply to make sure of realistic recognition and appraisal of the value and utility of all fortuitous or volunteer hardwood stock and then to accurately pick the time and means for liquidating it to greatest overall advantage. This means, simply, that trees having
Cash value should not be deadened or destroyed out of ignorance or heedlessness. Likewise, it is practically as wasteful and foolish to under-rate and misuse especially valuable stock or to liquidate trees prematurely. Even though the great bulk of this timber is either low grade or of slow growth, or both, there are two vital and often compelling considerations against the usual indiscriminate and reckless treatment.

In the first place, there is usually a considerable proportion of it useful for higher purposes than the readily recognizable lowest common denominator which is as far as consideration usually goes. Where volumes are of any material consequence, this often represents opportunity for substantially greater realization at some trouble but little cost. Pulpwood is coming to be worth materially more than nothing. Creosote and structural stock is worth two or three times as much as pulpwood and legitimate timber for standard lumber production is worth two to four times as much as creosote timber while tight cooperage and veneer timber is worth indefinitely more than lumber timber. It is doubtful if any softwoods are capable of developing the values now inherent in the finest veneer timber and gold is where you find it.

Just the other day, a mill taking the produce of an improvement cutting on a tract in which we are interested at $9 per thousand board feet found some gold. They laid out into the veneer pile from a decadent snag which the logger had almost refrained from cutting, about 1300 feet valued at about $30. Believe it or not, very substantial values often go down the drain as a result of indiscriminate hardwood control. As a profession, we have long played upon the indispensibility of forest products, the increasing value and impending famine unless something is done quick but now, faced with a famine actually materializing in the sort of hardwood that it takes to keep the wheels turning we act as though that is something else again. It isn’t even worthwhile to distinguish and separate indispensable from the useless. It is no doubt a virtue for the manufacturer to stick to his own line; the shoemaker should stick to his first. However, I see no virtue in professional foresters being so narrow in land management and utilization of the produce.

The second vital consideration against reckless liquidation is the fact that even though most of this stock is of slow growth, being actually in existence and generally well advanced through its rotation, it has a head start or handicap which may put at least the best of it on a par with the pine. Furthermore, often a great many trees require only a little more growth to transform literally from nothing to something or from low unit value to high. Thus it may be quite reasonable to postpone liquidation and allow some part of this hardwood to compete for another cutting cycle or two or even indefinitely.

In more cases than is generally realized rapid growth is combined with possibilities of exceptional value increment. The possibilities of yellow poplar are at least partially recognized but it is not nearly well enough known that cherrybark and shumard oaks not only make veneer but grow faster than the average pine while cow oak is not too much slower and is still more valuable. Often these species are clustered into most promising groups or groves which merit special consideration and where the full course of management from regeneration on out may be justifiable.
I want to emphasize in closing that I am perhaps even more aware than most of you of the complications and obstacles of general and particular circumstances. Obviously it is easy to oversimplify such a varied and complex matter and the saying is much easier than the doing. Nevertheless, it can be worked out rationally in appropriate circumstances if we learn to recognize them and what else are we on the job for but to work things out.

Now as to technical management measures, there is not much to be said that can be said briefly. However, it is essential to realize that, except for sorting the produce for its most appropriate use, none of this can be done on a clear cutting basis or even by diameter limit. Also, it is very important to realize that there is no logic in specifying whole species to be either favored or eliminated. The very essence of good hardwood work is tree by tree and log by log discrimination as to utility, quality and growth capacity. At the same time, there is, of course, an important differential in species preference, other things being equal. The most promising hardwood species commonly competing with pines under the various circumstances are probably as follows: yellow poplar, cherry-bark oak, shumard oak, cow oak, white oak, southern red oak, sweet gum, magnolia, swamp black gum, sweet bay and red maple. Individual trees of other species may be fit to compete on their merits but they are much less generally worth considering.

Finally, it is important to realize that to have much chance with this stuff it is necessary to put on hardwood working clothes and thinking cap and get properly oriented. One of the greatest obstacles is that the hardwood job is seldom undertaken separately on its merits as such. I would advise careful study of at least Agr. Handbook #4, "Log Defects in Southern Hardwoods" before dipping far into this work.

I want to emphasize in closing that I am perhaps even more aware than most of you of the complications and obstacles of general and particular circumstances. Obviously it is easy to oversimplify such a varied and complex matter and the saying is much easier than the doing. Nevertheless, it can be worked out rationally in appropriate circumstances if we learn to recognize them and what else are we on the job for but to work things out.
Q. Do you think we should mark the trees to be girdled?
A. Yes, especially in creek bottoms and similar locations it certainly will not pay to turn the usual girdler loose to do promiscuous girdling.

Q. What about the use of controlled fire in pine areas where some hardwoods are being retained?
A. It won't work if you are going to maintain the hardwood as a component of the stand, i.e., carry those trees for 30-40 years. Even a light fire will cause scarring and will leave avenues for rot.

Q. Don't you think lack of fire protection is the reason for a lot of the sorry looking big upland hardwood trees that now exist?
A. Yes, I think you have a strong point there. The prevalence of fire on upland pine sites contributes tremendously to the poor grade of hardwood found there because fire affects the hardwood trees several times as seriously as it does the pines. It causes mineral stain, opens up pathways for insects and fungi, and reduces grade. If fire is excluded there will be sites which do not now produce good hardwood which will in the future produce good hardwoods.

Q. Considering the present day difference in stumpage values between pine and hardwood, their difference in rate of growth and the relation of bole diameter to crown diameter, can you justify, on strictly a dollar and cents basis, growing hardwoods in pine stands?
A. Remember I started off by ruling out large areas on that very basis but there is territory where it will work. Of course, we have to grow bigger trees and they may take half again as long as the pine to reach the size we want - say, for veneer stock - but you can afford to wait longer because of the price of good hardwood stumpage. I sold some oak up in Indiana couple of years ago for better than $700 a thousand on the stump.

Q. In pine management we consider density of the stand to obtain height growth and natural pruning. How should we manage hardwoods?
A. That's the ideal. You want to build up stocking that will produce as long a clear stem length as you can.

Q. In all your hardwood management do you have a personal preference as to the best way to kill hardwoods?
A. Really our big job is killing hardwoods. T thrilled work the same as you have. We have just started but we feel that probably frilling with poison is the most practical way - maybe just girdling but the vigorous bottomland hardwood is naturally slow to die and slowly inclined to sprout.
Q. Are there any desirable hardwood pine mixtures that you have observed that you would like to encourage rather than pure pine?

A. Yes, there are sites—creeks bottoms and loessial bluffs along the East side of the Mississippi River where the prettiest forest you can grow would be pine hardwood. On these sites you just can’t get a pure pine forest without a fight to the finish. I don’t see the sense in killing off valuable species to get a pure forest. On the other hand, if you treat each tree on its own merits you will probably wind up with more pine in the stand than hardwood.

Q. Don’t you think the value of upland hardwood has been somewhat obscured by the fact that the mills that cut them are usually pine mills and they cut them mill run without attempting to sort the valuable.

A. They mix the bad with the good and it all turns out junk. You can’t sell hardwood that way—you should expect to ship the good log 100 miles or more.

Q. Something that has always bothered me is to see, say, a 15 inch sweet gum that has potentially 3 or 3-1/2 logs in it cut down and 1-1/2 logs only cut out and the rest left to rot.

A. That’s right—there is many a tree cut which would grow 15 to 20\% compound interest on its present value. You’d have to grow a lot of pulpwood in the meantime, to take it’s place. The present value is what floors most people. A poor hardwood will remain so, but a good hardwood is apt to become pretty valuable. There isn’t enough discrimination used in cutting hardwood and that is the nub of the problem. We should quit wasting time on the poor hardwoods and put our efforts more on the good hardwood trees and species.
POSSIBLE EFFECTS OF HARDWOOD REMOVAL ON UPLAND SOILS

By

Martin B. Applequist
Assistant Professor of Forestry
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Baton Rouge, Louisiana

One of the papers presented at last year's symposium dealt with the problems of a forest manager during the early stages of management. Mr. Art Nelson of Flintkote Corporation was the speaker. One of the points he touched on was the job of controlling undesirable hardwoods on pine sites in the South. At the conclusion of his talk a rather lively discussion developed on the pros and cons of hardwood control, and one of the disadvantages mentioned was the reduction in soil fertility that would result from such a program. It was obvious from the comments made by foresters present that a lot of them had been thinking about this possibility and some were more than a little concerned. It is against such a background that this subject is included on this year's program, and it is the purpose of this paper to present available information that may have a bearing on this problem.

REVIEW OF LITERATURE

Basically this question resolves itself into the old controversy of pure stands versus mixed stands. In this case are we going to grow pure pine, pine-hardwood mixtures, or perhaps a mixed hardwood forest? The Europeans have been arguing this matter for 200 years and still are not in agreement. And therein lies an explanation for some of the concern present-day foresters have shown.

Silvicultural texts used in forestry schools in this country almost invariably point out the sad experiences of German foresters with pure stands of Norway spruce in Saxony. That such failures occurred is a matter of fact, but seldom are all the involved factors disclosed. It is implied that the raw acid litter deposited by such stands of pure spruce greatly deteriorated the soil and resulted in reductions in growth and yield. From this it naturally follows that soil deterioration is a disadvantage inherent in pure stands. Baker in his recent text "Principles of Silviculture" (1) states, "Some pure forests, notably of conifers, may cause a slow deterioration of the upper soil layers by fostering the formation of the same sort of acid raw humus that is produced by under-growths of heathers. The needles of pines and spruces in particular decompose very slowly and tend to form deep layers of this poorly decomposed raw humus material in which seedlings find it difficult to grow. If trees with leaves which decompose readily - usually hardwoods - are mixed with the conifers, they not only improve the humus layer directly, but they also tend to develop conditions in which the decomposition of the coniferous needles themselves is considerably accelerated."

Here in America this same concept of soil deterioration under stands of pure conifers was advanced by Fisher as early as 1928 (6). Working
with Eastern white pine on the Harvard Forest he reported a "strongly
podzolized" condition under pine stands. Thus this example reported
close to home added more fuel to the fire started by the Europeans.

And finally in 1939 a serious disease called littleleaf was found on
shortleaf pines in South Carolina. Second only to the chestnut blight
in its seriousness in the Southeast, this disease complex now occurs on
30,000,000 acres in seven states including Mississippi. Furthermore
research definitely points to soil deterioration as a contributing factor
if not the primary cause of the trouble. Hepting and Jemison (7) in sum­
marizing the available evidence state that littleleaf results primarily
from a nitrogen deficiency in the feeder-root system. Most of the trouble
occurs on old field sites that suffered heavy erosion during the period
of cultivation. Littleleaf is most common and severe on soils with com­
 pact subsoils and poor internal drainage. They suggest as a possible
solution a long-time program of soil improvement involving a stand com­
 position change from pure pine to a forest type including soil-building
hardwoods. The hickories, yellow poplar, dogwood, redcedar, and others
whose litter is high in calcium are specifically recommended.

Fortunately for us, Louisiana has been spared the littleleaf head­
ache so far. But that is no positive assurance that our stands are immune.
Foresters responsible for managing shortleaf pine should keep abreast
of developments in the Southeast, particularly recommendations for allevi­
ating this serious disease.

DEFINING THE PROBLEM IN SOUTHERN PINE UPLANDS

It is believed that any adverse or beneficial effects on soil fer­
tility that may result from converting a pine-hardwood mixture to pure
pine are dependent on the characteristics of the litter involved. If
soil deterioration is suspected there must be evidence to show superior
characteristics of the hardwood leaves as compared to pine straw.

In this connection it is necessary to be specific. The old genera­
 lity that all hardwoods are good and all conifers are bad for soil fer­
tility is not supported by facts. Here again the European situation is
 quite different from that in American forests. Our native flora includes
 so many different species; many fit into the general rule but there also
exist numerous exceptions.

For this reason it was necessary to obtain data on the actual species
composition of inferior hardwood stands in the Deep South. In other words
what species are we actually girdling or poisoning and in what relative
numbers.

An effort was made to obtain such information for Louisiana, Missis­
ippi, Texas, and Arkansas. Stand data are available for all of these
states except Mississippi.

Chart 1 shows graphically the composition by species of upland
hardwood stands on the L.S.U. School Forest in Washington Parish, Louisiana.
Southern red oak, blackjack oak, post oak, and sandjack oak are obviously
the most numerous. Note that hickory accounts for only 2% of all stems.
<table>
<thead>
<tr>
<th>Hardwood</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO. RED OAK</td>
<td>55%</td>
</tr>
<tr>
<td>BLACKJACK OAK</td>
<td>22%</td>
</tr>
<tr>
<td>POST OAK</td>
<td>11%</td>
</tr>
<tr>
<td>SANDJACK OAK</td>
<td>3%</td>
</tr>
<tr>
<td>HICKORY</td>
<td>2%</td>
</tr>
<tr>
<td>OTHER HDWDS.</td>
<td>8%</td>
</tr>
</tbody>
</table>

**Chart 1**

**Stand Composition - Undesirable Hardwoods**

Washington Parish, Louisiana

---

**TOTAL NUMBER STEMS 4.5' TALL AND LARGER**
Chart 2 shows stand composition in St. Helena Parish, about 50 miles northeast of Baton Rouge. Southern red oak, post oak, and blackjack oak combined account for 94% of all stems tallied.

Chart 3 is based on plots measured by T. H. Silker near Wiergate, Texas. This particular site was almost completely dominated by sandjack oak.

Chart 4 represents data collected by T. H. Moberg on Ozan Lumber Company lands in southwest Arkansas. The picture here is somewhat different due to the greater abundance of sweetgum, hickory, blackgum, and other hardwoods.

Chart 5 summarizes all of these data in terms of the potential soil-improving components of our upland hardwood stands. For purposes of this discussion "good soil improvers" include those species whose litter usually contains more than 2% calcium; "intermediate soil improvers" include species with 1% to 2% calcium in their litter; and the poor soil-improvers, shown on the chart as "scrub oak" usually have less than 1% calcium in their litter. This grouping is similar to one used by Lutz and Chandler (9), and while admittedly quite arbitrary can be used for comparative purposes.

The most obvious thing on this chart is the predominance of the scrub oak component, being 90% or greater for the Louisiana and Texas areas. Even for southwest Arkansas only 13% of all stems are of species whose litter is rich in calcium.

I believe it is apparent from these data plus casual observations by all foresters throughout most of the South that the so-called scrub oaks are the chief intruders in our uplands where we are attempting to grow pine. To be more exact our problem species are southern red oak, blackjack oak, and post oak with lesser amounts of white oak, sandjack oak, water oak, willow oak, turkey oak, and others.

The question then is this: what differences are known to exist between the characteristics and composition of litter of these scrub oaks as compared to the pine species which are being favored?

LITTER CHARACTERISTICS AFFECTING FERTILITY

Quantitative measurements that have a bearing on this particular problem are few in number. Most of the data to be presented here are from litter analyses by Metz working in the South Carolina Piedmont (10), and from Coile’s work in the North Carolina Piedmont (1, 5).

1. Calcium

First on the list of litter characteristics is calcium. This element has been studied more than others because of its effects on surface soil characteristics. Being basic in nature it tends to reduce acidity. It stimulates rapid and complete decomposition of organic matter; it favors the development of the so-called null humus type, and it stimulates soil animal activity.
CHART 2
STAND COMPOSITION - UNDESIRABLE HARDWOODS
ST. HELENA PARISH, LOUISIANA

- TOTAL NUMBER STEMS 3" D.B.H. AND LARGER
CHART 3
STAND COMPOSITION - UNDESIRABLE HARDWOODS
NEAR WIERGATE, TEXAS

<table>
<thead>
<tr>
<th>Tree Type</th>
<th>Percentage</th>
<th>Legend</th>
</tr>
</thead>
<tbody>
<tr>
<td>SANDJACK OAK</td>
<td>81%</td>
<td></td>
</tr>
<tr>
<td>POST OAK</td>
<td>11%</td>
<td></td>
</tr>
<tr>
<td>HICKORY</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>SOUTHERN RED OAK</td>
<td>1%</td>
<td></td>
</tr>
</tbody>
</table>

Legend: 0 - 20, 40 - 60, 80

TOTAL NUMBER STEMS 4.5' TALL AND LARGER
# Chart 4

**Stand Composition - Undesirable Hardwoods**

**Southwest, Arkansas**

<table>
<thead>
<tr>
<th>Species</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Oak</td>
<td>19%</td>
</tr>
<tr>
<td>Sweetgum</td>
<td>19%</td>
</tr>
<tr>
<td>So. Red Oak</td>
<td>18%</td>
</tr>
<tr>
<td>White Oak</td>
<td>10%</td>
</tr>
<tr>
<td>Hickory</td>
<td>10%</td>
</tr>
<tr>
<td>Blackgum</td>
<td>8%</td>
</tr>
<tr>
<td>Willow and Water Oaks</td>
<td>5%</td>
</tr>
<tr>
<td>Blackjack Oak</td>
<td>2%</td>
</tr>
<tr>
<td>Other HDWs</td>
<td>9%</td>
</tr>
</tbody>
</table>

% Total number stems 10" D.B.H. and larger
CHART 5

SOIL IMPROVING COMPONENT OF UNDESIRABLE HARDWOODS

WASHINGTON
PARISH
LOUISIANA
ST. HELENA
PARISH
LOUISIANA
EAST TEXAS
SOUTHWEST
ARKANSAS

GOOD SOIL IMPROVERS
INT. SOIL IMPROVERS
SCRUB OAK

TOTAL NUMBER SITES
Chart 6 indicates average amounts of calcium in litter of different species. Dogwood litter is consistently rich in calcium and pine straw is consistently poor. Redbud, an understory species like dogwood, has litter high in calcium and its retention in the stand has been suggested where soil improvement seems necessary. Of the top five species which are so-called soil improvers, hickory is the only one likely to be included in an extensive deadening program. And even hickory is usually quite scattered when compared to the abundance of the scrub oaks.

The most important point here is that the three important scrub oak species are the poorest of all our hardwoods in calcium content, while definitely superior to the pines, the amounts involved are small and probably of minor importance.

In passing, mention should be made of redcedar. It is a notable exception among the conifers in having litter rich in calcium. Its capacity to rehabilitate poor soils in northern Mississippi has been pointed out by Broadfoot (2).

2. Nitrogen

Nitrogen of course is well known as an essential element for plant growth. Other things being equal, the more nitrogen contained in a tree's leaves the more desirable the species.

As can be seen from Chart 7, the available information is conflicting. A given species does not always produce litter with a fixed level of nitrogen. In fact nitrogen is the only element where it seems certain there is a direct relationship between the available nitrogen in the soil and the amount of nitrogen in the leaves. Yellowpoplar leaves for example are reported by Hata to have 0.5% nitrogen in the South Carolina Piedmont while Jemison (8) found four times this amount for the same species in the Appalachian Mountains.

With the exception of legumes such as black locust and redbud, upland hardwoods growing in average southern soils produce litter with relatively small amounts of nitrogen. The contradictory evidence makes a statement on the superiority of hardwoods over pine of doubtful value.

Mention should be made of one additional point concerning nitrogen. Of 15 soil amendments and treatments tested in research on littleleaf, the addition of inorganic nitrogenous fertilizers is the only one that has shown favorable results (12). This fact ties in well with the nitrogen deficiency known to exist in littleleaf needles.

3. Litter pH or acidity

Mature unweathered leaves of most tree species, hardwoods and conifers alike, are quite acid in reaction. In a detailed study of 27 species, Plise (11) found most all of them to have a litter pH between 4.0 and 4.5. In another study dealing with species found in the South, Coile (3) found very small and unimportant differences in reaction under seven different forest types in the Duke Forest. Again redcedar was the exception with only slightly acid litter. Any species with considerable calcium or other basic elements in its foliage will usually produce less acid litter. On the basis of available information, however, there is no reason to believe that the scrub oaks we are deadening in the South are superior to the pines in this respect.
<table>
<thead>
<tr>
<th>Plant</th>
<th>Calcium (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogwood</td>
<td>3.1%</td>
</tr>
<tr>
<td>Redbud</td>
<td>2.9%</td>
</tr>
<tr>
<td>Hickory</td>
<td>2.6%</td>
</tr>
<tr>
<td>Yellowpoplar</td>
<td>2.3%</td>
</tr>
<tr>
<td>Redcedar</td>
<td>2.0%</td>
</tr>
<tr>
<td>Sweetgum</td>
<td>1.2%</td>
</tr>
<tr>
<td>Blackjack Oak</td>
<td>0.9%</td>
</tr>
<tr>
<td>So. Red Oak</td>
<td>0.9%</td>
</tr>
<tr>
<td>Post Oak</td>
<td>0.8%</td>
</tr>
<tr>
<td>Shortleaf Pine</td>
<td>0.6%</td>
</tr>
<tr>
<td>Loblolly Pine</td>
<td>0.4%</td>
</tr>
</tbody>
</table>

% Calcium on D.Wt. Basis
<table>
<thead>
<tr>
<th>Plant Type</th>
<th>Nitrogen Content (O.D.Wt. Basis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shortleaf Pine</td>
<td>1.00%</td>
</tr>
<tr>
<td>Lobolly Pine</td>
<td>0.31%</td>
</tr>
<tr>
<td>Redbud</td>
<td>0.98%</td>
</tr>
<tr>
<td>Post Oak</td>
<td>0.71%</td>
</tr>
<tr>
<td>Blackjack Oak</td>
<td>0.70%</td>
</tr>
<tr>
<td>Dogwood</td>
<td>0.65%</td>
</tr>
<tr>
<td>Hickory</td>
<td>0.62%</td>
</tr>
<tr>
<td>So. Red Oak</td>
<td>0.60%</td>
</tr>
<tr>
<td>Sweetgum</td>
<td>0.56%</td>
</tr>
<tr>
<td>Yellowpoplar</td>
<td>0.51%</td>
</tr>
</tbody>
</table>
5. Other Factors Affecting Litter Decomposition

It is known that litter of some species decomposes slowly for reasons other than low calcium or nitrogen levels. Pine straw contains considerable waxes and resins which retard decomposition. Similarly relatively large amounts of lignin, tannin, and silica in oak leaves lengthen the time required for complete decomposition. At this point I would like to show a few color slides illustrating some of these differences as found in the field. These pictures were taken in late February about three to four months after leaf fall.

1. So. red oak litter
2. Post oak litter
3. Blackjack
4. Pine (longleaf)
5. Sweetgum - difficult to find entire leaf
6. Dogwood
7. Vertical cut - A_1 under cedar

6. Humus Types

A combination of high temperatures, long growing season, and considerable rainfall make for rapid decomposition of organic matter throughout the southern pine region. Seldom does the forest floor exceed a depth of three inches. For this reason forest humus types have not been studied in great detail as in the Northeast.

Coile's study in North Carolina (5) offers the closest parallel to the problem being discussed here. Under loblolly pine stands 60 to 100 years old he found a strong tendency toward the development of a mull humus type with a relatively deep A_1 horizon. Under the white oak-black oak-red oak type, however, a mor humus type prevailed. It formed a matlike covering of interwoven roots and had a poorly developed A_1 horizon. These differences were due in large part to the presence of a dense dogwood understory under the pine stand. This calcium-rich litter stimulates rapid decomposition, deep organic matter incorporation, and the development of mull humus types.

E. L. Stone in a recently published forest soil problem analysis of the Crossett area (13) has this to say: "Stands high in certain hardwoods, particularly dogwood, often develop a loose spongy surface (A layer) that is presumably due to the activity of soil animals. Although the physical properties of such a layer are well suited for water entry and root growth, it does not necessarily follow that the surface layers
# Chart 8

**Antacid Buffering Capacity of Litter**

<table>
<thead>
<tr>
<th>Plant Type</th>
<th>pH Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellowpoplar</td>
<td>4.96</td>
</tr>
<tr>
<td>Dogwood</td>
<td>4.95</td>
</tr>
<tr>
<td>Hickory</td>
<td>4.70</td>
</tr>
<tr>
<td>Loblolly-Dogwood</td>
<td>4.68</td>
</tr>
<tr>
<td>Redcedar</td>
<td>3.00</td>
</tr>
<tr>
<td>Sweetgum</td>
<td>3.00</td>
</tr>
<tr>
<td>Blackjack Oak</td>
<td>2.60</td>
</tr>
<tr>
<td>Post Oak</td>
<td>2.60</td>
</tr>
<tr>
<td>Loblolly Pine</td>
<td>2.31</td>
</tr>
</tbody>
</table>

1\textsuperscript{st} H-Ions Inactivated
under pine fail to provide aeration and infiltration adequate for optimum growth. Moreover, it appears that, under the natural stands of the area, growth is affected more by inherent differences in the permeability of the deeper soil layers than by surface variations. It is not enough to demonstrate that surface differences exist; it must be shown that they are of significance under field conditions."

The exact nature and name of a humus type developed under a stand of loblolly pine are not of great importance to the forest manager unless it can be shown by quantitative measurements that such a condition adversely affects the growth and yield of the pine stand. Evidence of any such change for our southern pines has not been found thus far. It seems quite unlikely to develop in the future.

It is believed the same reasoning applies equally well to the other litter characteristics just discussed. The data presented on calcium content, nitrogen content, pH, and antacid buffering capacity are all the result of laboratory analyses made under carefully controlled conditions. These figures are very helpful in explaining some of the differences known to exist in the upper few inches of topsoil. But until it can be demonstrated under field conditions that a certain type of litter or humus condition actually reduces the growth of the pine species, statements of the superiority of hardwoods over pine are of dubious value.

In summarizing the following points seem worthy of mention:

1. Southern red oak, post oak, blackjack oak, and other scrub oaks are the commonest hardwoods in southern pine uplands.

2. Calcium content of tree leaves varies considerably between species. Dogwood, redbud, hickory, yellowpoplar, and redbedar are all rich in calcium. Blackjack, southern red, and post oak are low in this element and only slightly superior to the pines.

3. Hickory is probably the only soil-improving tree species being controlled extensively in southern pine uplands, and it is relatively scattered in occurrence.

4. The nitrogen content of litter varies considerably within a species. These contradictions make an appraisal of different species difficult.

5. The pH of litter of most of our species falls within a rather narrow range, being moderately to strongly acid.

6. A loblolly pine - dogwood mixture of litter is highly buffered against acids and appears more desirable than pure pine or scrub oak litter in this respect.

7. Certain forest humus types characteristically develop under certain forest types. There is no evidence to show that humus layers under pure pine are inferior to those under our upland hardwood stands.

8. The average hardwood control program does not envision eliminating all hardwoods in our uplands. We will always have a hardwood component in our pine stands and such a mixture seems desirable from the soil fertility standpoint.
Foresters should recognize that changes in forest composition commonly call forth changes in soil conditions. The silviculturist who develops a pure stand of white pine, spruce, or some other species on land which previously supported a mixed stand should anticipate a change, not necessarily a deterioration, in soil properties as a natural accompaniment of such a stand.

In closing I would like to quote a paragraph from Lutz and Chandler's text on forest soils (9).

"In many parts of this country naturally occurring pure forests are to be found. There are no grounds for believing that the soil under these stands has been or will be deteriorated as a result of purity of the crop alone. Artificially established pure stands of conifers are being developed over substantial areas in the eastern United States. Where the species are adapted to the site and are given proper silvicultural care, there seems no reason to fear soil deterioration as a result of producing one pure crop.

"Foresters should recognize that changes in forest composition commonly call forth changes in soil conditions. The silviculturist who develops a pure stand of white pine, spruce, or some other species on land which previously supported a mixed stand should anticipate a change, not necessarily a deterioration, in soil properties as a natural accompaniment of such a stand."
REFERENCES


Q. What changes in fauna and flora of the forest would you expect as a result of changes in composition?

A. If you have calcium-rich species like dogwood, cedar, etc., the surface soil (the upper two or three inches) is going to be less acid and the less acid the soil, the greater the activity of soil animals of all types. Decomposition experts say that the fungi are responsible for most of our decomposition in pine because it is a little more acid, whereas the bacteria and worms, etc., become more common as you approach alkalinity.

Q. What effect does prescribed burning have on any of this?

A. Heyward did much research on the effect of fire on soils - mostly in longleaf and slash pine - and found that soil becomes less acid when burning occurs and more calcium and more nitrogen result. There are, of course, disadvantages. The soil is changed, won't take up water as quickly - the physical characteristics seem to deteriorate slightly but there is no argument against fire from a basis of chemical analysis.

Q. If you do a lot of hardwood girdling, there is a tremendous amount of wood and bark that will fall down and become a part of the soil structure. Where does that enter into the picture?

A. Not very important because wood is known to be very low in fertility values and therefore there would be little improvement as a result of this situation. The leaves are the most important factor as far as soil fertility goes, with bark next and wood last.

Q. Does underbrush and lesser species have any effect on soil fertility?

A. Work done by Lutz at Yale, and others indicates that lesser vegetation are pretty rich in fertility values and although we kill all of the hardwoods, we will still maintain a ground cover that will help fertility - some people think to a considerable degree.

Q. What is the action of chips and tops on soil fertility?

A. Research is now being conducted along these lines and some people are actually depositing chips on the soil to see what happens. Chips as such are nothing more than wood and as such are not a fertilizer but as a mulch they may help from the physical standpoint as well as reducing the fire hazard.

Comment: Wood chips rob the soil of nitrogen - don't forget that.

A. Yes, you have to keep that in mind. It was tried in Georgia or South Carolina on littleleaf areas and in most cases made it worse because it only intensified the nitrogen deficiency.
PUBLIC REACTION TO HARDWOOD CONTROL WORK

By
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It would be pleasant if a forester needed to be guided only by the technical and economic aspects of management practices. As if this were not difficult enough, it is essential that the public relations side of every move be considered. Not only does one need to be a silviculturist and an economist but also an amateur psychologist - and you had better not be too much of an amateur either if your management is to be completely successful.

The most sound forest management practices can be instigated, but if they incite the animosity of the public or even a segment of the public, it is possible to come out on the short end of the balance sheet. The direction this antagonism can take is varied. It can result in the mass of the local population feeling generally against a company. This can show up in many ways - at the polls, for example, with the possibility of unfavorable tax repercussions or operating restrictions; in personnel and labor matters; and in any activity in which a spirit of neighborliness is necessary or desirable. Or the antagonism can be more direct and result in the malicious incendiaryism with which most of us in the South are only too familiar. This has been the big weapon of retaliation, but there may also be attempts at timber trespass and property destruction as well.

Here in the South we are probably burdened with a greater public relations problem in forest management than is found in any other part of the country. The open range custom, once universal and still widespread, as well as the custom of free access to all land, have fostered a public domain attitude toward the larger landholdings in particular. This feeling of having certain "use rights" to all land makes the public much more prone to watch and question the management policies in effect. The degree to which these feelings are felt and voiced seems to be directly proportional to the size of the holding. In short, the man with 20 or 100 acres can do just about as he pleases with his land with little fear of action or even comment from his neighbors. The company, however, with several hundred thousand acres, appears as a big, impersonal thing and is subject to the gauntlet of public reaction if its policies are disliked. Size alone is not the only factor. A large company with broken, scattered ownership is not as awesome to the individual as a smaller company may be with more concentrated ownership, which may seem to surround and dominate him.

During this program most of the means of dealing with the hardwood problem in pine lands have been discussed. Those which seem to give the most headaches from a public relations viewpoint are the girdling, poisoning, and controlled burning phases. This ties in directly with the use of the forest for hog and cattle grazing. Surprisingly enough, one can "slaughter" his forest in most any manner so long as all products are...
cut and utilized for something and there will be no kick-back even though it may ruin the hog mast. But destruction through the apparently wasteful process of girdling or poisoning seems to initially outrage the public, particularly that portion which has the most to gain from the resource eliminated. It does not matter that the economics of the operation may be named for the owner. That point is difficult to sell. And it is natural since, after all, we all have self interest somewhat at heart.

Girdling and poisoning also bring forth fears that the game will be destroyed by eliminating both den trees and food. Other groups object to ruining the scenic beauty through elimination of picturesque and flower-bearing trees. And a large group is always against any new practice simply because it is new and novel.

When one contemplates adopting some new practice, what are the alternatives if a public reaction is to be expected? One answer might be to go ahead prudently with a broad publicity and educational program to reach the entire local population. This has the advantage of making one's objectives known right from the beginning and eliminating some of the speculation which might occur otherwise. It has the drawback of arousing everyone at once, possibly many whose attention might not have been attracted otherwise. The opposite course of action is to make no public announcements about policy, but to gradually start in on the operation, making personal contacts and explanations to those most concerned and as the occasion arises. This general policy about reverses the advantage and may result in initial public speculation to wild heights. An intensive selling job can be done, however, to the relative few who might be most inclined to take drastic action against it. Policy can take an intermediate position or fluctuate between the two extremes outlined. Which is best depends on the specific people one is dealing with as well as the nature of the operation and basic grounds for reaction against it.

At Crossett our policy has generally been to work into new or controversial forest management practices with a minimum of fanfare to the public as a whole. We have, however, explained our objectives to key individuals and we have attempted to get others sold to where they would do considerable talking for us. This approach has reached people living adjacent, who are most apt to be aroused and who can hurt the program, and is less likely to stir up those who have little real concern over it.

In order to illustrate some of the reaction one encounters in establishing hardwood control measures, I would like to trace the history and describe some of the results we have obtained at Crossett in recent years.

The first thing we began which might be classed as a hardwood control measure was the cutting of low-quality hardwood (largely oak) for chemical wood. Since this involved harvesting for a usable product, there was, as you might expect, practically no reaction. Also the areas covered did not seem great. In 1955 we began on a small scale to girdle on chemical wood jobs culled hardwood trees which would not make wood and which needed to be taken out to fully release pine reproduction. In the following year we began to use a straight girdling operation to accomplish this same objective. Although the girdling took generally a poorer quality hardwood
tree than we were cutting for chemical wood, the reaction was immediate.
We were destroying a valuable resource and ruining the hog range. The
reaction tended to boil up most actively around the areas where we had done
some of our first work. We explained what we were trying to do to key
individuals and to influential people who were sympathetic with the com-
pany. The individual who can be reasoned with under no approach we felt
largely alone. Our explanatory work was done by personal contact of
District Foresters or their men, who all live in their areas incidentally,
or by a special company public relations man. The contact work attempted
and was quite successful in getting friends of ours to do much of our talk-
ing for us. The opinions and views of an influential resident, who has
no official connection with the company, can be much more effective to many
than anything we might say ourselves.

However, a vast amount of talking was done about the new practice of
girdling and some of it was rather rough and threatening. It seemed to
be borne out by experience, though, that those who talked the loudest
seldom did anything. Beware, however, of the man who was worked up but
said little. His "steam" was more apt to be released with incendiaryism.

The basic kick was that this practice was injurious to the hog range
upon which many of the people partly depended. We therefore tried to play
up the aspects of our program which countered this. One of these was the
limited scope of the hardwood removal. We were not getting into bottom-
lands or straight hardwood areas at all and in pine areas were leaving
all sawtimber hardwood trees or those having considerable potential saw-
log value. In addition we were removing no hardwood unless it would release
pine. Thus we could point out that much of the hardwood we were taking
was of little value from a mast production viewpoint anyway.

Some persons hold objections on very specific grounds of self inte-
rest, but realize the company's privilege to do as it sees fit to such
an extent that they will not voice their real objections, but rather
criticize the program on other grounds. Questioning whether it will be
successful, pointing out that the trees girdled will have great future
value, commenting about the fire hazard it will create, and discussing
the effects on game were all arguments used by men who were basically
worried about their hogs.

Our story was sometimes hurt by the inevitable errors which occur
on an operation of any scale. Sooner or later a sawlog tree or two would
be girdled by mistake and from the comment one would think that the entire
woods were full of them. Keeping such mistakes to a minimum is a great
aid in getting public acceptance of the program.

We continued our program of girdling in spite of the flurry of
initial reaction. With a huge backlog of suppressed pine reproduction which
had accumulated for some years under low quality hardwood, it was essential
to get on with the job before the pine weakened and died. A strong at-
tempt was made in the work to keep it confined to the most high priority
areas and to make the job strictly a release of existing reproduction.
By doing this, we were on safer ground in explaining the objectives be-
cause they were more obvious and so sound that few could argue with them.
Many loud threats were made, but a relative few of them ever materialized into action. We had one case of spotters being run out of the woods while attempting to mark for girdling. Possibly one might say instead that the men considered it more diplomatic to leave in order to avoid trouble. We had one instance of pine tree girdling, but it was a relative few and they were quickly salvaged. A threat was made that spikes would be found in our pine trees, but I think the cost of spikes discouraged that in a hurry. The most common threatening comment was that if any girdles showed up in such small amounts, there would be a lot less care shown with fire there in the future.

Our fire records show that we did get increased incendiarism about the time of the beginning of girdling work, but it was not as greatly different from previous experience as one would anticipate. From 1947 through 1952 (the period over which we have been doing hardwood control work) 65% of our fires were of incendiary origin. From 1939 through 1946, the comparable percent was 60%. The main reason for the lower figure during the pre-girdling era seems to be because of an abnormally low amount of incendiarism during several of the war years. In 1946, when we had barely begun girdling, the incendiarism was up to 62%. The year we really started, 1947, jumped to 66%. 1948 declined to 62%, and 1949, further, to 62%. In 1950 and 1951 we hit the top with 71% each year and during last year's bad fire weather we dropped clear down to only 58% of our fires of incendiary origin.

Thus the degree of incendiarism seems to have hit its peaks when we first started the program and in the years of most progress in the program. In 1950 when the incendiarism went up to 71%, we covered more ground than we had in the entire previous three years. We have not yet tapered off our program, and we hope that last year's decline in incendiarism is the beginning of a downward trend.

It is difficult to analyze the effect on numbers of fires because of the vagaries of the weather. If we assume that 1939 through 1946 is comparable to 1947 through 1952, we have had an increase of 21% in numbers of fires during the postwar girdling period. This again may be due to some of the war years as the four year period, 1939 through 1942, was slightly higher than the postwar period. At any rate, we may conclude that we have not reduced our numbers of fires while engaged in a hardwood control program and we may have worsened it somewhat.

In addition to the comment stemming from hog range effects, a certain amount was heard which comes more in the category of nature-loving sentiment. It deplored the destruction of the natural beauty of the forest, the picturesque trees, the dogwood, the redbud, and the holly. In addition, we as well as others received a resolution from the South Arkansas Beekeepers Association which deplored the wanton destruction of black gum, holly, persimmon, and basswood through girdling practices. Fortunately our girdling of these particular species was rather light so that we could inform these people that we were not driving them out of business.

As well as talking to people, we followed several other public relations practices which helped to get people on our side. For years, we
had followed a standard procedure of giving forest residents any hard‐
wood they might want for their own use as long as it was not sawtimber.
This naturally included girdled trees which were sometimes taken for
firewood or fence posts. In addition we followed a policy of giving
deer camp permits to groups of individuals permitting them to construct
camps on our land. These were confined to people living in our ownership
area and gave us many a good opportunity to promote care with fire. The
hunters’ dislike of fire in his deer hunting area undoubtedly helped a
lot in reducing incendiarism.

After the first year of girdling, the clamor died down considerably,
and after two years critical comment became much less common. By this
time, it was largely from those who appear to remain unalterably opposed.
One factor which after several years goes a long way to cut out some of
the talk is that the early work begins to show up very successfully. No
one but those with closed minds can fail to see and be impressed by the
remarkable recovery and growth made by released pine reproduction. Most
people begin to have more sympathy with the owner’s viewpoint in doing the
work. If the girdling program attains any magnitude, there are many of
the local people who sooner or later find employment in some contract crew
or special Company crew doing it. All of this makes them tolerant of the
operation if not actually enthusiastic for it. Our experience was that
some of the small owners also begin to do some girdling work of their own.
And lastly when anything goes on long enough people just get used to it.

We did not use poison, except experimentally, until 1951 and it
was not until 1952 that the use became quite widespread. This was largely
245-T in a water solution applied in frills. No comment has ever been
heard that amounts to anything in regard to poisoning. We had passed the
word that any poisons we used were not injurious to animals or game, and
no case has ever come up where this has been questioned. Thus as far
as reaction to poisoning is concerned, no one in our area looks on it in
any different light than plain girdling. Whether our experience in this
is unique or not, I cannot say. Our neighbors at Fordyce Lumber Company,
who have made rather extensive use of ammate in their hardwood control,
took the initial precaution of carefully referring to the work as "chemi-

cal treatment" rather than poisoning. This is likely a very good idea to
get away from the stigma which the public might attach to the word, poison.

We have also gone in for controlled burning at Crossett to help lick
certain hardwood and regeneration problems. With the considerable amount
of incendiarism and wildfire which we have always had, this new practice
had the very definite possibility of giving us some public relations prob-
lems. One must use fast footwork to preach fire protection one moment
and be soon burning the woods the next. Of course that position is en-
tirely sound, but it is not the easiest thing in the world to explain.
Prevention efforts in the past over much of the South have been under-
standably single-minded in promoting total exclusion of fire. Thus those
whom we have sold best on it are usually the first to become confused.

We started out very slowly with some small burns of an experimental
nature in 1947. A few were made during varying seasons for the next few
years up to 1951. None of this amounted to much in the aggregate and we
careful to keep them hidden from view, even going to the lengths of not particularly explaining unless asked as to whether they were wildfires or not. As a result, the reaction on these few fires did not amount to much. Since 1951, we have control burned on a little bigger scale and have made no secret of the fact. However, we did not make any public announcements either. Instead, we have let adjoining neighbors know what we were doing and have explained as the opportunity arose the theory behind our burning to all who might be particularly concerned. This has seemed to work very well and we have had practically no critical comment. The most serious thing we have had has been from people who are entirely sold on forestry and fire protection and who can see no good to come from the burning. This has not been helped by one or two instances where in our experimentation and learning we did not burn just right and ended up with rather severe scorch or some mortality. From the public relations viewpoint this should be avoided at all costs.

I rather suspect that the group which liked controlled burning the least was the State Forestry Personnel. One could hardly expect them to be overjoyed with any practice which could complicate wildfire control to such an extent. They, of course, understand fully what one is trying to do and have had the experience to know that such work can be highly successful, but the apprehension arises from fear of what the general public might think or do.

We have had little kick about what we are doing to the game population by burning. The argument for game, which we put to such good use in promoting wildfire prevention, could “come home to roost.” Our fires have been relatively small, however, and the area in aggregate is not particularly noticeable. Also we are rather careful not to burn in inappropriate areas or at inopportune times such as during the deer hunting season. In short, I do not feel that we have weakened fire protection or prevention to any degree by practicing controlled burning so far.

I have at some length commented on our public relations experience at Crossett during the period that we have been going in for considerable hardwood control work. What can one say in general that will guide in meeting anticipated public reaction? I seriously doubt whether generalization or the adoption of a standard approach for all problems and places can be done. In our experience, we have largely used one philosophy, that of going ahead and explaining as the need and occasion arise. Whether this was the wisest course, I cannot say. Possibly something else might have worked better, but we have not had bad results as we have done. It appears that the only general approach that can be suggested is to avoid a “public be damned” attitude and to chart your course on a good evaluation of the nature of the people you are dealing with and the nature of the operation as it affects them. Good judgement and experience on this will help avoid serious conflicts.

Possibly, the general public relations of most companies or agencies could be better than they are. If a company has been thoroughly sold as a power for good in an area, it becomes easier to take care of these periodic problems of a more specific nature. In this paper I have largely been speaking of meeting current public reaction on specific matters. From a longer range viewpoint the promotion of forestry educational work...
Q. You spoke about acquainting the general public with your program. Does that involve radio publicity, newspaper articles and so forth, concerning the forestry program?

A. My comment was that a great many companies may be a little weak on this score. I think we are, and it must be true of many others. I think it is primarily due to a lack of overall coordination on the part of all the people in the various companies, connected with this sort of thing. In some companies there is one man who takes care of one phase of publicity and another who handles another phase, and there may be a certain lack of long range planning for all programs. I think work through young people's groups, through school, 4H clubs, FFA and all that sort of thing is one of the best approaches to the problem. Some of these old people are a little hard to change.

Q. What do you do when you catch someone setting fires?

A. We have never caught anyone. Seriously, I think when you get down to the hard core of what I call "incorrigibles", and when the sentiment of the general public gets right, and I think we are just about at that point already, then I think the time comes for a little law enforcement.

Q. What is your policy on hiring negroes in the woods crews?

A. I'd say that 50% of the crews are negro. We do not have company crews — they are contract crews under contract and we make no attempt to tell the contractor whom he hires.

Q. We have found that one of our best media for public relations on this sort of work is through the very men who do the work. Usually the men who do the work are interested in what they are doing and it is surprising the way in which they talk about the results from their work. Don't you find this to be true?

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A. That is a very good point. We have both contractor and company crews doing this girdling work and with that broad coverage we get men from every community who are actually doing it. On some of our company crews we have employed individuals who were formerly incendiariests. We didn't hire them for that purpose -- it more or less happened that way, but it pretty well cured them of their incendiarism -- at least while they're working for us.

Q. Has there ever been any effort on the part of your company to take any of your sawmill or papermill people into the woods to show them the results of what you are doing in this type of work?

A. Not on any large scale. I think that is a very good suggestion.