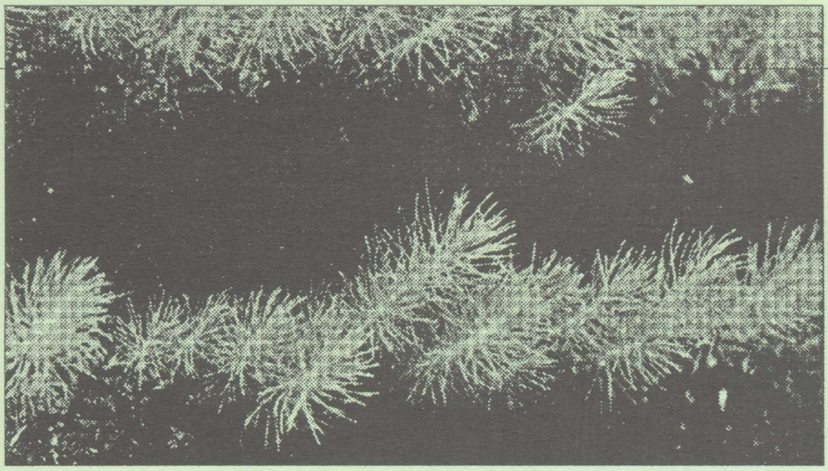

Research Update 1989
FORESTRY

FIRST IN FORESTRY UPDATE SERIES

This is the first forestry research report published in a new series entitled "Research Update," inaugurated in 1989 by the Alabama Agricultural Experiment Station (AAES). The new series is meant to promote timely reporting of research results dealing with a specific commodity, with distribution to all producers of that particular commodity.

Forestry is a billion dollar industry in Alabama—one of the largest in the State, yet the opportunities for growth in the in-State manufacturing use of our forest resource and export out of State and out of country of raw forest materials are all excellent. This report deals with forest products, the end use of our timber resource. Future forestry updates will deal with the production of timber and wise management of forestlands.

Today's highly competitive market and increased dependence on the Southern States for a higher percentage of forest products make it doubly important that forest product producers have available the latest scientific information. Researchers in the School of Forestry are striving to develop the necessary technology to help the State's forest products industry grow, and this report is one method of delivering the vital results of their research. Efforts will be made to maintain up-to-date mailing lists of each producer group, so that all Alabama producers will receive the appropriate report annually.

For more information about forest products and forest production, please contact your county Extension Service office.

Fire Retardant Chemical Use Increasing on Wood Products

The use of wood treated with fire retardants has consistently increased annually to over 9.5 million cubic feet in 1984. While these processes effectively inhibit combustion, problems are being reported in the use of fire retardant treated wood for certain construction applications.

In some situations, over the course of several months, the mechanical properties of fire retardant treated wood has degraded, and the wood has a decayed appearance. The magnitude of the problem is such that the American Plywood Association has withdrawn published strength reductions for fire retardant treated plywood, and is referring all inquiries to treaters and their suppliers. This situation may reduce the competitive position of the material as compared to non-wood alternatives.

While the changes in mechanical properties have been documented, it is logical to assume that the interactions among the fire retardants, the chemical constituents of wood, and the environment are resulting in changes at chemical levels of organization, which are reflected in the mechanical properties. Research is underway to determine the alterations in chemical structure occurring in fire retardant treated wood. The first step of this research is to establish an understanding of the induced chemical modifications. This is essential to eliminate the negative effects produced by current retardant formulations.

T.J. Elder

Mill Feasibility Study Shows Need in Northwest Alabama

In a recent study, forest products researchers confirmed the potential profitability and impact on the local economy of establishing a mill in northwest Alabama to process Alabama's under-utilized hardwood trees. The study evaluated the

ALABAMA AGRICULTURAL EXPERIMENT STATION AUBURN UNIVERSITY
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economic potential of establishing an oriented strandboard mill in Lynn in Winston County.

Previous AAES research demonstrated that some of the under-utilized Southern hardwoods, like sweetgum and yellow poplar, mixed with Southern pines can be used for oriented strandboard (OSB) production. Technically, OSB is composed of compressed flakes or wafers bonded with phenolic resin. These flakes have a length-to-width ratio of about 2 to 1, with the grain of the flake running along the length of the flake. The flakes in the surface layers are oriented along the panel length, and the flakes in the core layers are oriented across the panel width. Hence, OSB has strength and dimensional property characteristics similar to those of plywood. In fact, OSB serves as a replacement for plywood in sheathing grade and other structural applications. For this reason, the full potential of the OSB market could be equated with the predicted demand for structural panels as a whole.

Georgia and Mississippi already have OSB mills with sweetgum, yellow poplar, and other soft Southern hardwoods mixed with Southern pines as raw material inputs, but Alabama, which has a large supply of these trees, has no OSB mill. The lack of specific information on the sufficiency of the wood raw material base for mill operation at a given location and the lack of a definitive assessment on the market potential for OSB products made in Alabama are primary reasons no OSB mill has been established in the State. These issues were addressed in a study to determine the feasibility of establishing an OSB manufacturing plant in Lynn. Three production facility models were examined and their financial feasibility was analyzed.

Results of the study indicate that the projected value of the OSB share of the national structural panel market and the projected Southern Region OSB values are substantial. The outlook for Southern producers, including those in Alabama, is positive. Projected trends in the United States for the coming years look good. There is certainly room for more OSB products than are currently being produced. It also was established that there are adequate wood supplies within a 65-mile radius of Lynn to support an OSB plant with annual capacity of 200 million square feet (3/8-inch basis) or more. The financial analysis showed that, considering a 12-year planning horizon, such a plant can generate positive internal rates of return, positive cash flow, and a reasonable payback period. Clearly, the results of the study indicate that conditions in Lynn, Winston County, Alabama, are favorable for an OSB plant.

H. F. Carino

Sweetgum Flakes Improve Structural Panel

In Alabama, there are 21 million acres of timberland and half are in under-utilized low-grade hardwood forests. Clearly, the development of technologies and techniques for efficiently utilizing these low grade hardwoods in manufacturing value-added products, like wood-based panels, is highly desirable.

A major concern in the development and application of hardwood composites as building panel materials is their serviceability or lifetime performance, especially under severe environments. The structural application of hardwood composite products could be improved if quantitative and reliable information concerning their long-term performance was available. Such information can be provided if the time-dependent properties of the load-carrying capacity of hardwood composite materials under changing environments are fully understood. A multi-phased research program intended to explore these problems was developed at the School of Forestry in cooperation with the Alabama Agricultural Experiment Station and the Southern Forest Experiment Station, a research division of the U.S. Department of Agriculture's Forest Service.

Results of studies already conducted indicate that structural flakeboards fabricated with sweetgum flakes showed much better long-term performance than those made of white oaks under concentrated load and changing environments. Increasing the resin content in the board from 5 to 7 percent significantly improved the long-term performance of boards exposed to changing environments.

R. C. Tang

Composite Wood I-Beams For Building Construction

The forest resource that provides solid sawn timber products traditionally employed for light and medium frame construction in this country is changing. Large tree size is diminishing, and sawlog quality and quantity are slowly declining. Consequently, the larger and longer sections needed for floor and roof framing, such as 2-inch x 10-inch and 2-inch x 12-inch with over 20 foot lengths in structural grades No. 2 and better, are becoming scarce and more expensive.

More complete utilization of Alabama's total forest resource is a goal of forestry research. The use of selected hardwoods, which are often under-utilized offset a shortage of longer and larger solid sawn boards. Auburn research has developed composite structural I-beams to replace the solid sawn wood joists. Results indicated that such composite I-beams, fabricated with finger-jointed small cross sections and short stocks of Southern pine lumber as flanges and composite panels made of under-utilized hardwood as web materials, are suitable for structural applications in building construction. Their engineering performances, such as maximum load and deflection criteria, are equivalent to, and better in some cases, than those of traditionally used solid lumber.

It is estimated that the total replacement of solid sawn wood joists (over 16 feet in length) with the developed composite I-beams in the United States could save approximately 220 million cubic feet of high quality structural lumber annually. In addition, 80 million cubic feet (3/8-inch basis) of composite hardwood panels will be needed annually for the I-beam fabrication. Thus, a successful development of composite I-beam structures may provide the much needed economic advantage for Alabama, as well as for the Southern Region, in the production of building construction structures.

R. C. Tang

Taiwan Potentially Profitable Market For Alabama's Hardwoods

In 1987, approximately $1.2 billion worth of furniture from Taiwan was imported by the United States. This amount is about 32.3 percent of the total value ($3,648 million) of furniture imported into the nation from all other countries that year.

Taiwan is a small island and has little hardwood resources utilizable for furniture making. In 1987, Taiwan imported 140 million cubic feet of logs (85 percent hardwood and 15 percent softwood valued at $445 million), 38 million cubic feet of lumber (80 percent hardwood and 20 percent softwood valued at $320 million), and 1.4 million metric tons of pulpwood and chips (95 percent hardwood and 5 percent softwood valued at $55 million).

Taiwan is a potentially profitable market for Alabama hardwood products and, cognizant of this excellent prospect, officials of the State of Alabama organized two forest products trade mission groups comprised of high ranking government officials and representatives of the forest products industry and the School of Forestry at Auburn. These groups visited Taiwan during the last 3 years to promote and develop sales and trade of Alabama's forest products, particularly hardwoods. In return, two groups of forest industry people from Taiwan visited Alabama during the last 2 years. These contacts have been judged fruitful considering the significant increase in the export sale of Alabama hardwood products to that country. This trend is expected to continue.

R. C. Tang

Narrow Spaced Pines Provide High Quality Lumber

Recent tests indicate that closely spaced, or "plantation," pines may be of higher quality than previously believed. Test results show that a 27-year-old slash pine plantation with 6-foot x 6-foot spacing can provide high quality lumber that meets the Southern Pine Inspection Bureau requirements for visual grades.

Pine plantations in the South have been established primarily with genetically superior seedlings or seeds to improve the quality of trees (bole taper, straightness, branching, and disease resistance) and to maximize the growth per acre per dollar investment. The original spacings in these plantations vary from 6 x 6 to 10 x 10 feet, with several combinations between. In general, thinnings are done on plantations with close spacings. Often, understory vegetation control is performed as part of the silvicultural management of plantations. It has been observed that such intensive management yields impressive growth rates for the first 8 to 10 years and relatively good growth rates (4 to 5 rings per inch) for the next 5 to 6 years. The end use of the timber product of such plantations has been mostly for pulp.

The diameter breast height (dbh) of fast-grown plantation Southern pine timber has been noted to reach 11.2 inches in 5 years and 14.3 inches in 20 years. Not surprisingly, some of these trees have been used for producing lumber. Studies have shown, however, that wood from certain plantations of Southern pine timber has lower density, mechanical properties, and visual quality than that of timber grown naturally. These deficiencies are attributed to the presence of large amounts of juvenile wood, with volumes as high as 90 percent in 15-year-old trees and 60 percent in 20-year-old trees.

Juvenile wood in Southern pines has lower specific gravity, shorter fibers, larger fiber angles, thinner cell walls, larger lumen diameter, and lower percentage of summerwood than mature wood. Thus, lumber with juvenile wood has generally low strength and stiffness and large longitudinal shrinkage. It has been reported, for instance, that lumber from 20-year-old plantations of loblolly and slash pines in Texas had low strength and that a large percentage of the boards produced could not meet the strength and stiffness required by the assigned visual grader.

However, the results of a study at Auburn's Forest Products Laboratory on lumber from a 27-year-old slash pine plantation are encouraging. About 43.4 percent, 48.7 percent, and 7.9 percent of the boards produced were No. 1, No. 2, and No. 3 grades, respectively. Clearly, there is an exceptionally high grade distribution of boards. It was observed that the boards tested have relatively high density and few small knots, which could be attributed to the close original spacing of 6 feet x 6 feet and unthinned condition of the plantation. This observation, however, needs to be verified with additional studies involving other spacings and ages.

E. J. Biblis

Structural Flakeboards Need Added Quality

Presently, commercial structural flakeboard panels in the South are produced from mixtures of Southern pines and sweetgum in 7/16-inch thickness and densities of 40 to 45 pounds per cubic foot with approximately 3-5 percent liquid phenolic resin. These panels are primarily used as sheathing in housing and are significantly heavier than Southern pine plywood and Aspen waferboard of equal thickness. However, these are manufactured to meet the American Plywood Association's Performance Standards for structural panels.

Other uses for Southern structural flakeboards are currently being investigated and there are compelling reasons for doing this. One is to improve the utilization of timber resources which are diminishing in quantity and size. Another is to keep the present and future mills producing panels with added-value at capacity levels which are considered profitable. Extending the uses of the structural flakeboard panels means the development of panels with higher strength, dimensional stability, and durability for exterior uses. Specifically, the following panel properties need to be improved: thickness swelling at edges, edge checking, and surface roughness after the panels are subjected to humidity variations.

In a study at the Forest Products Laboratory, phenolic resin impregnated paper was overlaid and bonded successfully to structural flakeboard panels manufactured from mixtures of Southern pines and hardwoods. Results indicate that the bond between the paper overlay and the board is stronger than the internal bond strength of the flakeboard substrate. The resin impregnated paper when overlaid on one surface of the flakeboard substrate can provide a structural improvement of 10-15 percent for various mechanical properties.

Results of the study also indicate that, when the overlaid surface is exposed to continuous wetting while the back surface is protected from wetting, thickness swelling and checking of the drip edge can be controlled effectively through proper priming, painting, and edge-sealing. However, under the same exposed conditions, the overlaid surface becomes non-smooth with undesirable visual effects known as "telegraphings" which are protrusions of swollen flakes through the overlayer. Unfortunately, in the Auburn tests telegraphing could not be eliminated or controlled with the application of primers or paints.

E. J. Biblis

SELECT: A New Approach To Lumber Allocation

SELECT, a computer program being developed for use on personal computers through AAES research, may help hardwood furniture manufacturers reduce production cost by 25-30 percent. The savings would come primarily from better lumber allocation, though SELECT can be used for lumber procurement and to evaluate the efficiency of sorting lumber according to grades and sizes.

Lumber cost constitutes about 40-60 percent of the total cost in producing hardwood furniture, and incorrect lumber allocation is a major reason for the relatively high cost. Many rough mill production managers have only their intuition and empirical methods for solving the perennial problem of finding the best (or least-cost) mix of lumber in inventory to satisfy a given cutting bill. The problem appears to be simple, but it becomes complex because, on one hand, blanks or dimension parts can be manufactured from different types (i.e., the combination of species, grades, and sizes) of lumber. On the other hand, the yields of blanks and the associated costs (unit and conversion costs) vary with the type of lumber used. This is further complicated by the possibility of cutting different mixes of blanks from a given board.

Yield tables, nomograns, and a variety of computer programs embodying operations research (OR) techniques, particularly linear programming (LP), have been developed to solve the problem. However, these tools have several major flaws which limit their practical application. For one thing, these tools differentiate lumber in a given species group in terms of grade only. Lumber size is not considered a decision variable, making the allocation process as devised insensitive to cost reducing opportunities that result from differences in blank yield. The existing tools cannot be used across species groups because specifications in the grading rules applied to the different species groups differ. Each existing tool is species specific, and moreover, these tools do not indicate output of cutting patterns for each grade/type of lumber to be used. It is important that the cutting pattern for each board in terms of sizes and number of blanks be known to the saw operator in order to maintain an "optimum" mix of lumber input.

To overcome the limitations of currently used tools, forest products research at the AAES developed a heuristic solution procedure called SELECT which handles the lumber allocation problem in three stages. The first stage involves the "conversion" of the lumber into defect-free boards or clear-face cuttings using an integer non-linear programming model to simulate the grading of hardwood lumber by NHLA rules.

In the second stage, the defect-free boards are cut into blanks and the cutting patterns, or instructions on how the cutting should be done, are generated. The crosscutting and ripping operations are simulated via an integer programming model (called LC/SP) with a double knapsack formulation.

In the third stage, various types of available lumber are allocated into the blanks or parts demanded, given a set of cutting patterns. A linear programming model (called LAP) was developed for this purpose. The following steps define the required operations and interfaces between the models in the algorithm SELECT:

(1) For each type of lumber available, solve the conversion model to generate clearface cuttings.

(2) Generate an initial set of cutting patterns or take those currently used by the firm.

(3) Solve the "reduced" version of LAP, that is, without the lumber supply constraints. If first iteration, go to step 5. Otherwise, go to step 4.

(4) Calculate the cost improvement generated for the two immediately preceding iterations. If the total improvement is less than the aspiration level set, go to step 7. Otherwise, go to step 5.

(5) Solve the LC/SP. If no cutting patterns can be generated that can improve (i.e., the solution is non-positive) on the current set of cutting patterns, go to step 7. Otherwise, go to step 6.

(6) Append the set of newly generated cutting patterns to the current set and go to step 3.

(7) Solve the "full" version of LAP, that is, with the lumber supply constraints and stop. The current solution is the best under the present constraints.

The algorithm was used in a case study involving a hardwood cabinet manufacturing operation. It indicated that through a better lumber allocation process it is possible to realize lumber input cost savings of about 26 percent which could accrue from a 24 percent increase in blank recovery or an equivalent reduction in lumber input volume of about 32 percent.

H. F. Carino

Foreign Research Benefits U. S. Forest Industry

A team of forestry researchers, including a member of the School of Forestry, recently reported in the Journal of Forestry on the benefits that research conducted in foreign countries has provided to forestry research in the United States. The Auburn study explored two important questions: (1) does the United States benefit from research conducted in other countries; and (2) to what extent should the United States encourage and facilitate increased interaction between our researchers and those of foreign forestry research institutions?

Science and technology indicators show that foreign countries have been increasing their investment in science and technology while our investment has been increasing at a slower rate, if at all. From 1975 to 1985, U.S. non-defense research and development expenditures increased from about 1.7 percent to 1.8 percent of GNP, while in Japan the change was from 1.9 percent to 2.8 percent and in the Federal Republic of Germany their commitment went from 2.1 percent to 2.6 percent. Between 1960 and 1984, the percentage of U. S. patents granted to foreign inventors jumped from 16 percent to 43 percent. U.S. forestry research constituted 23 percent of global research effort in 1970 and dropped to 19 percent in 1981. Thus, our research scientists need to be aware of foreign research as never before.

Based on the two case studies analyzed, one research project that led to the structural particleboard industry and the other study of containerized forest tree seedlings, the answer to the first question is yes. The United States has definitely gained significantly from foreign research in structural particleboard and containerized forest tree seedlings. Indications of gain also exist in other areas of forest and forest-industry activity, such as acid rain, pest management, and forest harvesting.

The answer to the second question is less clear. From the evidence at hand for research and for science in general, it would seem that further efforts to promote interaction of scientists are justified. That is, more should be done to encourage, promote, and facilitate increased interaction between the United States and foreign forestry research systems. The U.S. research community is increasingly dependent on the work of foreign researchers. Whether additional formal programs and policy support are needed and justified in this area cannot be answered without further and more complete analysis by the U.S. forestry community.

John Haygreen

EDITOR'S NOTE

Mention of company or trade names does not indicate endorsement by the Alabama Agricultural Experiment Station or Auburn University of one brand over another. Any mention of non-label uses or application other than labeled rates of pesticides or other chemicals does not constitute a recommendation. Such use in research is simply part of the scientific investigation necessary to fully evaluate materials and treatments.

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SUPPORT FORESTRY RESEARCH

Funds appropriated by the Alabama legislature provide the major financial support for forestry research in the Alabama Agricultural Experiment Station. McIntire-Stennis funds from the U.S. government also represent an important funding source. Since these funds are limited, many areas of research would go unsupported except for financial support from various granting agencies, commodity groups, and private companies.

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