RESEARCH IN FOREST PRODUCTS

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Extent of natural resources does not of itself make a nation great or a civilization secure. Savages of the American wilderness managed only a miserable existence amid surroundings of natural wealth that have since enriched the world. The strength of the modern economic order rests on its ability to command the gifts of nature and apply them in manifold forms to the developing wants of society.

Considered as a timber resource, the forest has an increasingly important function in American economy. As a source of useful commodities and as a source of useful employment in commodity production, its value must be maintained and expanded. At present, more than six million people in the United States draw their support directly or indirectly from jobs based on utilization of forest materials. That this number might be greatly increased through scientific developments and application of improved wood-utilization techniques is by no means a remote possibility. It is through utilization-employment that the forest crop may be expected to make its most direct social and economic contribution to the America of tomorrow -- in more goods for the consumer, in jobs for millions of workers, in profitable use for submarginal lands, and in a strengthened basis for self-supporting community life. Safeguarding the utility value of its crop is therefore a vital part of American forestry. Scientific means of making utilization methods more efficient and its products cheaper, more diversified, and more satisfactory to the user are of definite concern to the Forest Service, and this interest takes practical expression in the research of the Forest Products Laboratory. Its work of investigation and experiment reaches into the major fields of present utilization and is pioneering the way into new fields.

Improved Use of Wood in Building and Construction

The greatest need of America today is a low-cost house that meets American standards of living. Prefabrication, combined with quantity production, offers one means to obtain such a house. There has been a general impression that materials other than wood are better adapted to prefabrication. One of the first tasks of the Laboratory in the low-cost building field has therefore been to show that the prefabrication of houses of wood -- the traditional low-cost building material of the American people -- is feasible. During the year, by the erection of two small experimental houses, the prefabricated

plywood-panel system as developed at the Laboratory was found technically sound and practical both for one and two story structures and for flat and sloping roof styles; the panels are well adapted to factory methods of production, the erection time is short, the architectural effects satisfactory, and, despite the thin walls, the houses are strong and well insulated. With the engineering features thus established, attention is now being directed to reducing construction costs. Although it is difficult to determine just what the costs would be on mass-production basis, many opportunities for reducing costs in the two experimental houses erected at the Laboratory have been discovered. The costs are still not low enough for those persons in the suffering-income brackets, but by making the houses good, instead of excellent, they may be brought down to the required cost level.

Plywood with the outer faces treated with synthetic resin-forming materials was found to withstand drastic weathering conditions. Because of this weathering resistance, painting may be shown to be unnecessary for exterior use in the construction of low-cost plywood houses. To add to the esthetic effect, however, tests have been made on combining a dyeing treatment with the synthetic resin treatment. A number of cheap, water-soluble dyes were made to penetrate the plywood together with the treating solution. The dyes were then fixed within the resin to make them water insoluble. Although the grain of the wood is visible through the dyes, the color is more uniform than when oil stains are applied to the untreated wood. It is estimated that the cost of the resin-treated plywood would be increased by only one-fourth cent per square foot when the dye is used.

One of the outstanding advances in recent years in house construction has been the improvement in tightness by means of weather stripping and the addition of thermal insulation to the walls and roofs. Along with this advance, most heating units have incorporated some means of adding moisture to the air to raise the humidities within the tight dwelling. This has created a new problem in house construction -- the collection of excessive moisture condensation within the walls and roofs, thus creating decay hazards and apparent "sunny day" leaks. The Laboratory has been working on methods of preventing such condensation and its attendant troubles and has devised an effective method. The method consists of placing, on the warm side of the wall, a lining, known as a moisture barrier, that is impervious to moisture. The most effective and economical barriers of the many tested to date were found to be asphaltic building papers of the hard glossy type. Other building materials, such as aluminum paint and phenolic-resin glues are also effective. The advantages of insulation, improved tightness of construction, and additional moisture, which were in danger of being offset due to the excessive maintenance costs arising from decay and moisture damage to interior finishes, are through the use of moisture barriers now placed on firm ground.

Future supplies of heavy building material must of necessity come from trees of smaller size. The pioneer work of the Laboratory on laminated construction, which consists of making arches, beams, rafters, and other wood members of large dimensions or pleasing architectural curvatures by gluing together boards of small size, has at last caught the fancy of the public. Since the erection of the first glued laminated structure in the United States at the Laboratory in 1935, more than a hundred other structures, employing glued laminated construction, ranging from small barns to massive auditoriums and ornamental churches, have been built in various parts of the country. To further this progressive step in more efficient wood utilization, a manuscript on the design and manufacture of glued laminated members was prepared during the year for publication as a technical bulletin.

The Laboratory's method of substituting chemical seasoning for mechanical seasoning has been proved practical in its initial tests under commercial conditions. Heavy Douglas fir timbers of various sizes and grades were seasoned with phenomenal reductions in drying time and seasoning degrade. Wood in many heavy structures has been rapidly forced into the background due to the inability to satisfactorily dry large timbers by mechanical or natural methods. The significance of chemical seasoning large timbers may be better appreciated when it is known that even in this first commercial demonstration, 16- by 24-inch walking beams for oil derricks were so satisfactorily seasoned that this particular structural field, which was seriously threatened by substitute materials, is now opened to wood on an equivalent technical basis with other competing materials.

Improved Chemical Utilization of Wood

The best field in which to search for diversification of products is that of chemical conversion by new processes into new chemical products. This field is also attractive in that it may utilize material that on account of size, shape, structural defects, or species characteristics, is unsuitable for utilization in any other manner. In this field lies even the possibility of utilizing material that now has a minus value, such as mill and logging wastes that constitute a forest fire hazard unless expensively disposed of. The possibilities of this field are matched only by its difficulties and complexities, but recent progress has been very encouraging.

An outstanding achievement during the year in the chemical utilization of wood waste was the conversion of lignin into new and useful products.

Next to cellulose it is the largest chemical constituent of wood, but has always been figured as a waste to be gotten rid of as expeditiously as possible. Earlier studies had indicated that lignin is not fully saturated and that therefore, under proper conditions, atoms of hydrogen might be added. Accordingly, lignin was mixed

in a heavy steel container with the solvent dioxan and subjected in the presence of hydrogen and a catalyzer to a high pressure and temperature for several hours. Upon removing the material from the container it was surprising to find that, instead of the brown powdery material with which investigators have been familiar for so many years, it was a transparent liquid. Four compounds, never before obtained from wood, together with the industrially well-known methanol, were obtained from this liquid. Three of the new compounds have been definitely identified chemically and the composition of the fourth partly established. All the products are colorless, two are high-boiling liquids, one is a crystalline, and one a glassy solid. All four products give promise of usefulness as solvents, fungicides, adhesives, or plasticisers. Methanol was obtained in quantities larger than any hitherto obtained from wood.

One ready source of large supplies of lignin is the 1,500,000 tons of material, annually discarded by factories making pulp for rayon and for better grades of white paper. Another source is the lignin residues obtained by the Bergius and Schöller processes in the production of alcohol and sugar in Germany. These processes are at present not considered economical in this country, but the utilization of the residual lignin for plastics and other products might make the combined process successful in the United States. The demand for plastic material is evidenced by the fact that during the year commercial production was begun of the wood plastic previously developed at the Laboratory. The factory manufacturing this plastic is located near the forests in northern Wisconsin and is using low-quality aspen as raw material.

Incidental to the work on the composition and properties of lignin, the incorporation of lignin with the negative plate in storage batteries was found to enable the battery to maintain its maximum power in zero weather four times as long as formerly and the life of the battery was also prolonged.

The foregoing accomplishments are illustrative of the type of more efficient wood utilization that is possible through chemistry. They represent only a scratch in the surface of the chemical utilization field. Much more attention should be given to this type of research than has been afforded it in the past.

Pulp and Paper

The continuing development of the pulp and paper industry in the South and West and the increasing use of other species than spruce, particularly the southern pines, western hemlock, and various hardwoods, has amply justified the investigations of these regional pulpwood resources which have comprised so large a part of the pulp and paper work over the past several years.

During the past year marked progress was made in methods of producing high-grade bleached papers from southern loblolly pine sulphate pulps, and in the comparison of this species with its northern prototype, jack pine. Improved procedures in pulping and the multiple-stage chlorination bleaching of both of these pulpwoods was accomplished. Highly satisfactory papers were produced from both, although the jack pine yielded the better quality, all things considered. In some respects the jack pine papers were superior to certain grades of spruce sulphite papers now in the market.

One of the most baffling problems in sulphite pulping is the reduction of heartwood. For reasons which are obscure, the sulphite process as usually practiced does not reduce pine heartwood fibers satisfactorily. Attempts in this direction customarily yield low-quality pulps and high screenings, and thus effectively limit the age class that can be utilized for pulp by this method. Notwithstanding the notable advances that have been made in matching sulphite pulp quality by improved alkaline pulping methods, the specific qualities of sulphite fiber still endow it with a definite superiority in certain use fields. Accordingly, if the sulphite process could be adapted to species for which it is not at present believed applicable, a marked advantage would be gained. Hence, it is more encouraging to report that some of the disadvantages of heartwood in sulphite pulping have been overcome by certain modifications in the process, such as the use of a higher liquor concentration and extended penetration periods at low temperature before attaining active pulping temperatures. These measures have tended to minimize the adverse influence of the heartwood and in repeated instances gave satisfactory sulphite pulps from the standpoint of both yield and quality. The results thus far obtained are merely indicative and require further intensive study to develop their full value both from a technical and economic standpoint. However, the fact that this recalcitrant material can be dealt with leads to the belief that heart-containing pines will inevitably be included in the sulphite pulping species.

The characteristics of sulphite and sulphate pulps made from naturally blue-stained shortleaf pine were evaluated. Blue stain darkens the unbleached color and increases bleach consumption, but does not affect pulp strength or other quality even when present in considerable amount.

Experiments were initiated with black jack oak and several other southern hardwoods looking toward the production of corrugating and other papers from these widely occurring species.

Improved Harvesting and Utilization of Wood

The practice of forestry on farm woodlands, which comprise one-third of the forest acreage of the United States, is based on the

ability of the farmer to obtain a fair return from his forest crop by using the products himself, by entering the competitive market, or both. Under present conditions he is not obtaining adequate returns from this important element of farm property. This is largely due to lack of adequate harvesting and marketing facilities which may be overcome through the development of simple methods of economic organization that will give farmers the benefit of collective action. But as a first step harvesting facilities for farm timber, at present antiquated and inefficient, must be improved. To this end an improved portable bandsawmill has been designed at the Laboratory and bids received for the construction of an experimental unit. The principal advantages of the new sawmill are the reduction in waste brought about through the smaller saw kerf and the improvement in the quality of the lumber. More important is the flexibility or portability of the new sawmill that results from moving the saw through the log instead of the log through the saw. This reversal of the usual mechanical procedure results in a reduction in the length of the sawmill by one-half, enabling it to be easily transported and set up for use in farm woodlands or other small timber holdings.

A farmer does not market his rotten apples with his good, but he does market his good and poor forest crop together. Such a system of marketing results in the poor products pulling down the value of the good. To surmount this condition, the Laboratory is working on a system of grading so that logs may be separated in accordance with their quality the same as other agricultural products. Past efforts at establishing log grades have attempted to set up specifications for grades and then to fit the grades to the logs. The method undertaken at the Laboratory is to collect information on the actual defects in representative logs of a species and then to make the rules fit the existing conditions in the logs. So far, under the new method of grading, 90 percent of the top-grade lumber in woods-run logs falls in the No. 1 log grade and practically none in the No. 3 grade, whereas by former methods many so-called No. 1 logs did not cut out as well as some No. 2's or even No. 3's.

In industrial uses, woods are often selected primarily for their working qualities. Adequate information on the strength and physical qualities of most woods have been collected over a period of years, but practically no information of a factual nature is available or has ever been obtained on the working qualities of the various species. Lack of such factual information has resulted in the development of prejudices and in the incorrect selection of species, seriously handicapping the marketing of a number of species and general inefficient use of existing forest resources. To overcome this condition a study of the working qualities of hardwoods in the Southern, New England, and Appalachian regions has been afforded a prominent place in the Laboratory's research program. The study involves not only the collection of information on working qualities, but also the development of instruments and the devising of units of measurement that have heretofore not existed. During the year the planing properties of the southern hardwoods were determined and recommendations made of the conditions required for best results.

One of the problems of forest management is to make all the trees produce high quality wood. A comprehensive study of the relation of growth conditions to wood quality indicates that the warping and twisting occasionally found in southern pine lumber is caused by excessive longitudinal shrinkage as the result of irregularities in the rate of growth of the trees. The basic cause of this trouble has heretofore been unknown. Now that the cause has been established, the possibilities of constructive steps to eliminate the trouble through cultural practices may be undertaken.

Decay is the principal cause of the replacement on American farms of approximately 500 million fence posts a year -- equivalent to a quarter of a mile of fence posts for every farm in the country. Methods of treating fence posts for protection against decay have been known for many years, but they are in the main too expensive for the average farmer. The need has been for a simple, inexpensive method. The Laboratory's simple tire-tube method of treating posts for protection against decay by means of zinc chloride placed in a discarded inner-tube and attached to the butt end of the freshly cut post appears to be the answer to this need. During the year the Nation's agricultural press and radio systems have prominently brought this inexpensive, home-operated method of greatly prolonging the life of nondurable farm timber to the attention of rural America, with the result that thousands of requests have been received at the Laboratory for the detailed instructions as to its operation.

Forest Fire and Planting Investigations

Aside from the regular activities, the Laboratory contributed services to the technical profession of forestry in the forest-fire field and in planting.

Studies on the use of chemical solutions for forest fire suppression indicated that ammonium phosphate solution, can under some conditions, accomplish a great deal more than water in suppressing fires. When plenty of water and pumps for using it are available, there is little opportunity for chemicals to be helpful, but where the supply of water is limited, or where fire trucks are used that carry only a few hundred gallons of liquid, ammonium phosphate solution may be able to double the effectiveness of the water. Chemical solutions were found much more effective than water for preparing a line from which to back fire. Chemical foams, which are highly recommended for oil fires, failed to show any superiority over water for extinguishing forest fires.

The kiln designed at the Laboratory for extracting seed from cones of forest trees to meet the present planting programs of Federal and State nurseries continued to yield more viable seeds per bushel of cones in less time and at a lower cost per pound of seed than any method

used heretofore. The proper seed-extraction schedules for use in this type of kiln were extended to two additional species, red pine and longleaf pine. The seeds of longleaf pine were found surprisingly sensitive to even comparatively moderate temperatures.

Related Investigations

Aside from the foregoing types of work the Laboratory was active with many others, such as improving air-seasoning and kiln-drying techniques, logging and milling practices, fiberboard shipping containers, and painting practices for wood; determining the water resistance of resin glues; impregnating wood under pressure with preservatives for protection against decay; devising chemical treatments for fire-proofing wood; formulating design details for modern timber connectors and other joints and fastenings in wood; evaluating the strength of little-used species; dissecting wood fibers by means of chemicals; characterizing the total cellulose in wood; adapting woodpulp to the varied requirements of paper making; classifying high-yielding trees for naval stores production, and identifying various commercial woods.

Public Relations

A constant and increasing demand was made on the Laboratory during the year for the results of its work. More than 10,000 visitors, representing every State in the Union and 23 foreign countries, called personally at the Laboratory. Of this number, 850 visitors, an increase of 26 percent over that of last year, had special problems that required consultation with senior staff members. The requests for information through correspondence has also greatly increased. In addition more than 100,000 pieces of printed matter (mimeographs, technical notes, bulletins, circulars, leaflets, etc.), which do not require the preparation of a letter were requested. This increasing use of the Laboratory by the general public is highly desirable.