

# TECHNICAL NOTE      NUMBER 220

FOREST PRODUCTS LABORATORY . U. S. FOREST SERVICE - MADISON, WISCONSIN

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## USE OF FIBROUS PLANTS FOR PAPER MANUFACTURE

Information regarding the possible use of plant fibers, such as sugarcane bagasse, cornstalks, castor-bean stalks, bamboo, and the various straws and grasses, for pulp and paper manufacture is often requested from the Forest Products Laboratory. Although the Laboratory's investigations of these fibers have not been extensive, some study was made on flax and hemp a few years ago. Other bureaus of the U. S. Department of Agriculture have, however, investigated the pulping of a number of such plant fibers.

The indications are that, except in specific instances, the use of crop plants for paper manufacture is somewhat impractical under present conditions in the United States. Exceptions are the successful developments of building boards from sugarcane bagasse and cornstalks, and corrugating board and egg case fillers from straw.

There is a widely held view that our pulpwood supplies are inadequate to meet national needs and that some other source must be found. This assumption has little basis in fact. It is true that a few widely used pulpwoods, such as spruce and balsam are diminishing in quantity and becoming more expensive. The place of these preferred species is, however, being taken by other trees, as, for example, the southern pines and certain hardwoods, and technologic advances continually open up new sources of pulpwood which more than make up for those which have been or are being lost. Such developments make wood a very cheap source of fiber and tend to render the economic position of crop plants in this field increasingly difficult.

One of the chief difficulties standing in the way of economic utilization of fibrous plants and waste crop products as pulp materials is the fact that many of them contain large quantities of pith, parenchymatous tissue, and other nonfibrous or noncellulosic substances. The cellulose suitable for pulp in such materials is often low in amount and difficult to purify, so that the cost is almost prohibitive. The pulp produced from many of them is of limited use.

In the experiments made by the Forest Products Laboratory and other bureaus of the U. S. Department of Agriculture, none of the plant materials examined were found very suitable for newsprint. Under favorable economic circumstances, some of them could be pulped to a fairly good grade of book, magazine, lithograph, and writing paper which might be able to compete with papers made from standard pulp materials.

**STRAWS.** By ordinary pulping processes, two types of pulp can be made from the common varieties of straw, one a bleachable material

suitable for book and magazine papers, and the other a fairly tough product adapted to the manufacture of wrapping papers and corrugating boards. The standard straw used for board is wheat straw, although oat, rice, rye, and flax straw can be similarly used. Flax straw can be converted into a number of papers ranging from tough wrapping to tissue, but the cost of the raw material is high and the processing expensive in comparison with similar products prepared from wood pulp.

**STALKS.** Hemp stalks may be converted by the kraft process into a pulp suitable for wrapping, bag, and other papers, but such use has not been found practicable in regions favored with a suitable wood supply. Hemp hurds, which are obtained from waste in the production of hemp fiber, while suitable for making book paper, are not so utilized because of the relatively small amount produced in any one place and the excessive cost of collection. Cornstalks can be pulped by a slightly modified caustic soda process so that not only the fibrous casing but also the pith can be converted into a fair grade of book paper. The same use can be made of broomcorn stalks and of sugarcane bagasse, and recently successful experiments have been reported using castor-bean stalks. Sugarcane bagasse is being used commercially in the manufacture of wallboard. Cotton stalks contain very short fibers that are difficult and expensive to isolate and purify. Their use is therefore limited to low-strength, unbleached paper and boards.

**PLANT FIBERS.** Jute fiber is used extensively in the manufacture of wrapping and tag paper. The product is of excellent strength and durability, second only to hemp. As jute is not a pure cellulose fiber but is a lignocellulose, papers made from it can only be bleached to a bright yellow color which places certain limitations on its use. Jute fiber usually comes to the paper maker in the form of waste twine and burlap. The cost of converting the raw fiber into a suitable form of paper would be excessive.

Cotton fiber in the form of staple fiber, rags, or linters may be used for the production of high-grade "all rag" paper. It is also mixed with wood pulp to improve the quality of "woodpulp" papers.

Hemp fiber (*Cannabis sativa*) in the form of either rags or spinning mill waste possesses pre-eminent properties for the production of thin, pliable, opaque papers, such as are used in bibles and encyclopedias. It is also used in the manufacture of cigarette papers. Manila hemp fiber (*Musa textilis*) in the form of discarded rope and twine is used for tag papers and wrapping tissue for fine electrical wires.

Flax fiber in the form of linen rags is used for high-grade writing, currency, and bond paper. Flax spinning mill waste and a tow prepared from seed flax straw are suitable for a variety of papers, some of which are competitive with wood pulp. The use of seed flax tow in cigarette paper is a recent commercial development in this country.

**BAMBOO, PALMETTO, YUCCA, AND THE GRASSES.** Bamboo is not used for paper in the United States, but in India four or five of the several hundred species have been found suitable for paper making. Bamboo is

suitable for both white printing and lower-grade unbleached papers. In experiments at the Forest Products Laboratory, a paper which compared favorably in some respects with kraft was produced.

Cabbage palmetto can be used for sulfate pulp and possibly for magazine or book papers when mixed with small quantities of sulfite pulp for strength. Among the grasses that can be pulped by the soda process are saw, esparto, Japanese, and zacaton. The fibers in these plants are usually very short, so that the pulp would be more useful as a filler with longer-fibered pulps. Esparto grass is used extensively in Europe for book papers. Spanish bayonet or yucca can be pulped by the milk-of-lime process into a strong paper resembling kraft. Soap weed can be pulped and made into cheap wrapping or packing paper.