Paper From Flax

by ARTHUR C. DILLMAN

TEN YEARS AGO cigarette paper, made chiefly from linen rags, was imported from Europe. Now it is made from American flax straw. On the day that the Second World War broke out, the first commercial roll of cigarette paper made entirely from flax straw came off a machine at Pisgah National Forest in North Carolina. Now it is turned out at the rate of 50 or 60 tons a day, more than enough to make the 250 billion cigarettes smoked each year in the United States. Besides supplying domestic requirements, American cigarette paper is shipped to nearly every tobacco-consuming country in the world.

The successful development of this new industry was almost entirely the work of private industry. For more than 50 years, beginning in the eighteen nineties, experiments had been conducted by Federal, State, and commercial organizations to use the fiber in flax straw. In the experiments, work was done on the production of thread for spinning, sacking cord, binder twine, counter board, boxboard, writing paper, and other products. The research gave valuable information but generally the processes developed were expensive or not adapted to commercial use. Before we started making fine paper from it, the main industrial uses of fiber from flax straw were upholstery tow, insulating board, boxboard, counter board, rugs, and coarse cloth. Probably not more than 25,000 tons of flax tow were used annually for those products—equivalent to about 125,000 tons of flax straw.

L. F. Dixon, of Pisgah forest, estimated that the quantity of processed flax straw converted to industrial use, chiefly for making cigarette paper, was 5,200 tons in 1937; 147,200 tons in 1940; and 360,000 tons in 1945.

The principal types of paper made from the fiber of flax straw include cigarette paper, carbon paper, condenser paper used in electrical con-

densers, high-grade letter paper for air-mail correspondence, and thin book paper. For all these uses, a thin, strong paper is required. Flax fiber is reported to be one of the strongest and most durable fibers known. As for durability, consider the linen wrappings of ancient Egyptian mummies. Currency and bank-note paper is made from the better grades of fiber-flax tow; it contains about 80 percent flax fiber and 20 percent cotton.

Flax straw is a variable product. The yield and quality of its fiber appears to depend on seasonal growing conditions, the variety of flax grown, the rate of seeding, the time and method of harvesting, and on the amount of exposure or weathering of the straw after harvest.

The fiber content of flax stems ranges from about 14 to 20 percent in different varieties. Moreover, there is a marked difference in the amount of fiber that can be recovered by mechanical methods from different varieties. This varies also with the weather, or growing conditions of the crop. The dry, overripe straw produced under conditions of drought is of little value for fiber.

The yield of flax straw as usually harvested and threshed on farms in Minnesota is 1,000 to 1,500 pounds an acre. In experimental plots, where flax is pulled and all of the straw is recovered, yields at the rate of 1,200 to 3,000 pounds an acre are obtained. The possible or potential yield of straw from seed flax, therefore, compares rather favorably with that of fiber flax. As usually harvested, one-fourth or more of the straw is left in the field as stubble.

About 80 percent of the flax tow used in the manufacture of cigarette paper is produced in Minnesota, some 10 percent in California, and the remainder in North Dakota, South Dakota, and Iowa. Tow mills are located at Red Lake Falls, Crookston, Marshall, Minneapolis, Le Roy, and Winona, Minn., and at El Centro, Calif. Besides the fiber produced in tow mills, much straw is processed by means of portable decorticating machines which move from farm to farm.

These decorticating machines are in fact tow mills on wheels. The straw is carried between fluted steel rollers under pressure by coil springs. The rollers, meshing like gear teeth, break the inner woody portion of the stems, separating it more or less from the outer bark or fiber tissue. Beaters and other devices help to separate the wood or shives, while controlled air suction removes chaff, leaves, shives, and dirt. This operation reduces the bulk or weight of the original straw about one-half. This effects a considerable saving in the cost of baling, trucking, and freight.

The making of cigarette paper begins in the pulp mill, a huge, spherical, revolving cooker or digester, where steam and chemical reagents separate the usable fiber from the remaining shives or woody material of the tow. The pulp is washed thoroughly to remove the woody material, bleached with chlorine, and then beaten and cut into a finely divided

mass of fiber. In the final beating process, powdered chalk is added to control the speed of burning in the final product. In a cigarette the paper must burn at the same rate as the tobacco.

To a novice, the Fourdrinier paper machine, which makes paper in an endless web and was developed in England at the beginning of the nineteenth century, is something strange and wonderful. The liquid pulp material for cigarette paper flows, like milk, from the headbox onto a moving fine-mesh screen. The excess water drips through the screen; the wet paper film is picked up on a roller, passed over heated rolls, then through drying chambers, and finally it comes out as a continuous sheet of paper. In this journey from screen to roll, the paper travels some 100 feet in about 5 minutes. All moving parts of the machine must work with clock-like accuracy or the paper would be either torn or crumpled. The large rolls are finally cut in strips and wound on bobbins.

At present there is a well-established market for flax-straw fiber for the manufacture of special papers. It seems likely that the demand for flax straw will continue as long as suitable straw is available at a price the industry can afford to pay. Since 1939 the price of flax straw on the farm has gone up from about $1 to $2.50 a ton. The cost of baling, trucking, and shipment brings the cost up to $10 to $15 a ton at the tow mill. If the farmer is equipped to bale his straw and truck it to the tow mill or shipping point, he can get this additional income for his labor.

There are still many problems to be solved in the economical production and handling of flax straw as a source of fiber for paper making. The technical problems of paper manufacture have been overcome. The future of the industrial use of flax straw is likely to depend on the supply and quality of the raw material.

THE AUTHOR

Arthur C. Dillman, Minnesota-born, grew up on a farm in South Dakota and took his college work at State College in Brookings, S. Dak. He entered the Department of Agriculture in 1908, and carried on research work in plant physiology and the breeding of drought-resistant forage crops for the northern Great Plains until 1921, when he was transferred to the Division of Cereal Crops and Diseases, in charge of flax investigations. In his work on the improvement of seed flax (linseed) he has worked closely with the several State and Canadian experiment stations and with the linseed industry and the manufacturers of cigarette papers. At the beginning of the cigarette-paper industry, he suggested the use of a portable "flax break" or decorticating machine to process flax straw on the farm, thus effecting savings in the cost of shipping the bulky straw to tow mills. On October 1, 1946, Mr. Dillman took up new work as an agronomist with the Flax Development Committee, of the Flax Institute of the United States, with headquarters in Minneapolis.

FOR FURTHER READING

Emley, Warren E., Compiler: *Flax and Its Products, Production and Utilization,* U. S. National Bureau of Standards, 1942.

Robinson, B. B.: *Flax-Fiber Production,* U. S. D. A. Farmers' Bulletin 1728, 1940.