

Nonwood Fiber: Growth and Opportunity

This once-niche market is growing, thanks to new products and new materials that offer properties traditional wood fibers can't match. We interviewed members of TAPPI's Nonwood Fiber Committee to learn more.

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Ask most people what paper is made from and they'll tell you "trees." Yet, while wood fiber is certainly the dominant furnish for today's global pulp and paper industry, it's not the only option. New environmental pressures and market opportunities are fueling interest in nonwood fibers for pulp and paper production.

According to engineer Bob Hurter of HurterConsult Inc., papermaking from nonwood fibers generally uses the same unit operations as wood fibers. "Nonwood fibers are harvested, transported to the pulp and

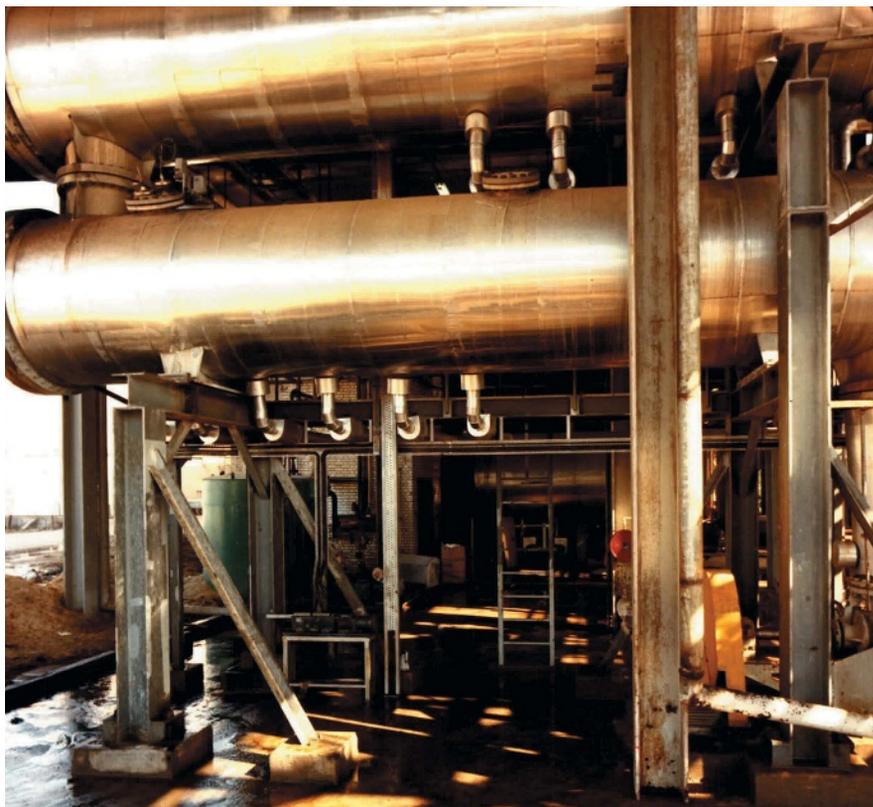
paper mill, stored for a period of time, prepared for cooking, cooked, then brown stock is washed, pulp is screened and cleaned, followed by bleaching and then papermaking," he says. "Though depending on the nonwood fiber, there can be significant differences."

In fact, papermakers have depended on nonwood fibers since paper was invented in first-century AD China, notes Frank Riccio, president of the Danforth Group LLC and past chair of TAPPI's Nonwood Fiber Committee. "By the late 19th century, wood had become the dominant furnish for all but very special

papers; and during the 20th century, nonwood fibers continued to be used," he says. "Today there are a number of papers that require specific mechanical properties and characteristics: some dielectric and electrolytic papers, meat casing papers, liquid filtration media, and many others that demand a certain appearance and/or organoleptic properties that incorporate pulps from fibers such as abaca, flax and sisal to achieve the sought-after objectives.

"Furthermore, with the advent and growth of wet-laid (and other) nonwovens technologies beginning in the 1950s and 1960s, fibers

All photos courtesy of Bob Hurter.



A tube digester, which is often used in nonwood fiber pulping.



A combine harvesting hemp in the Netherlands.



Bagasse pile in Florida.



An established sisal field in Tanzania.



Cutting sisal in Tanzania.

such as abaca, flax, jute, sisal, and others such as ‘true hemp’ and kenaf have been considered and used,” Riccio adds.

NONWOODS: A WIDE RANGE

Broadly, nonwood fibers are any plant material that is not classified as a tree and that can be used for pulp and paper, explains Hurter. There is a wide range in the physical nature of different nonwood fiber raw materials delivered to the pulp mill and in the fiber characteristics of the pulp produced; these differences between fibers can affect mill design, equipment selection and pulp quality.

He offers wheat straw as an example. “Wheat straw is usually harvested once per year during a 6-8 week period, so baled straw needs to be stored for the entire year’s requirements. Preparation systems differ significantly from wood chipping. Horizontal tube digesters are typical, versus the Kamyr-type digesters for wood; straw cooking times are shorter and lower chemical usage is normal. The soda process is standard. Chemical recovery is more difficult due to silica, and the straw pulp is slower draining, so a longer paper machine wet end is needed.

“On the other hand, bamboo and giant reed can be chipped just like wood and processed in the same mill that processes wood,” he adds. “Specialty nonwoods have yet another set of issues and needs that also will vary depending on the specific fiber.”

Hurter says that, when discussing nonwood fibers, “Exceptions are the norm. A process configuration may work with certain nonwoods, but there are always others for which it will not work.”

There are three generally recognized sources for nonwood fibers: agro-industrial

residue, dedicated fiber crops, and naturally occurring fibers.

Corn stalks and cobs, wheat and cereal straws, sugar cane bagasse, and other fibers remaining from agricultural production have economic value for larger-scale production of commodity pulps, as well as for bio-energy fuels, fiberboard, and other uses. “The emergence of crop residue as a valuable resource has evolved to the point where there are competing uses for it—this must be understood when considering the medium- to long-term viability of a given resource for the paper industry,” Riccio says.

Fiber crops—including abaca, bamboo, sunn hemp, kenaf, ramie, false yucca, and switchgrass, to name a few—offer the potential to develop materials to meet specific requirements, says Riccio. “Some of these crops, such as bamboo, may be abundant and naturally occurring; however, due to their growing importance for industrial applications, they are now being cultivated as alternative agricultural crops. But there are issues to consider regarding environmental impacts of the introduction of large-scale monocultures.”

Naturally occurring fibers that could be used for papermaking have region-specific availability, and there are many variables depending on local conditions. “The large-scale use of any of the materials obtained from these sources implies the need for development of an infrastructure, from field or processing facility forward,” adds Riccio.

NEW INTEREST: NEW MARKETS

Although the environmental impact of wood fiber paper production has vastly improved over the past 40 years, concerns about climate change and sustainability have

spurred interest for nonwood fiber products. “Some entrepreneurial companies saw an opportunity about 20 years ago and started importing nonwood fiber paper and molded products into North America,” Hurter says. “Over time, a few major companies joined the bandwagon to serve what once was a niche market. Today, millennials are pushing the market for nonwood fiber products even further.”

Molded fiber products—plates, bowls, cups, and clam shells—represent the fastest-growing market for nonwoods. “While most is still being imported, some is now being made in the US using nonwood fibers, and I believe that more is on the near horizon,” Hurter explains. “This is likely because of smaller mill capacities and lower capital requirements. Still, it is only a matter of time before someone builds a larger scale nonwood fiber market pulp mill or integrated mill to satisfy the growing demand.”

Hurter does not see nonwoods replacing trees as the primary material for global production of pulp and paper, but he does predict they will play an increasing role in the fiber mix over the next 10 or 20 years.

“Initially, the growth in nonwoods usage will be in the fiber molded products industry. Pulp mills likely will be 100-150 tpd or less and will need to be creatively designed to be cost-effective and environmentally sound. It is already happening in the US; for example, Aloterra is already producing miscanthus pulp and molded products in Ohio. Others are looking at sugarcane bagasse, wheat straw, corn stover, industrial hemp and other nonwood fibers.

“Over time, I can see a few nonwood market pulp mills dotted across the US and Canada in locations where the nonwood raw materials are plentiful, either crop residues or purposely



A sugarcane field in Upper Egypt.

grown fiber crops. These mills likely will be in the 300-500 tpd range, producing high yield unbleached pulp suitable for packaging paper and paperboard grades, molded products and possibly some tissue products—for example, Columbia Pulp’s proposed 400 tpd wheat straw project in Washington State.”

According to Hurter, “woody” nonwoods such as bamboo and *Arundo donax* (giant reed) offer interesting opportunities for the US Southeast since these can be chipped and processed using existing mill infrastructures. “With more than 1,200 bamboo species identified worldwide, you can tailor the farm to provide a range of fiber types—softwood substitutes, hardwood substitutes or somewhere in between—depending on what you want to accomplish,” he says. “Also, it is possible to co-cook bamboo or *Arundo* with certain species of wood. This is where I believe the first large scale use of nonwoods in the industry will occur; in fact, I recently heard that someone is scouting land in Florida for bamboo farms.”

SPECIAL PROPERTIES OF NONWOODS

Of particular interest to papermakers is the fact that nonwood fibers can deliver special properties not available from wood-based fiber, notes Med Byrd, director of applied research, NCSU Department of Forest Biomaterials Pulp & Paper Labs and chair of the Nonwood Fiber Committee. “For example, bamboos have fiber properties that range from short, hardwood-type fibers to longer, softwood-type fibers. For tissue manufacturers, some species of bamboo in between these two extremes may be able to produce both superior softness (normally obtained from imported eucalyptus pulp) and strength (normally obtained from Canadian

softwoods). This would simplify the papermaking process and allow the manufacture of premium tissue without relying on a 100 percent imported fiber supply.”

Fiber length is another important property. “Some nonwoods—most particularly hemp and flax—have incredibly long fiber length, in some cases up to 10 times greater than that for wood fibers,” says Byrd. “While such length makes traditional papermaking problematic, these fibers could act as sustainable, biodegradable reinforcing fibers for paperboard composites and other structures.”

Hurter says he is particularly interested in how biorefinery technologies being developed for wood might also be adapted for nonwoods: “For example, will American Process’ Greenbox technology also work on bamboo?”

Hurter suggests that manufacturers using wood fibers exclusively should learn now which nonwood fibers are the best fit for their mill and end products—then begin exploring fiber sourcing, so that they are well-positioned when they’re ready to start production using nonwood content.

“In most cases, adding 10 percent or 20 percent nonwood pulp to the furnish will have no impact on machine runnability, but even this seemingly small portion in the furnish will open new marketing opportunities,” says Hurter. “With the wide range of nonwoods and the many tree species, the possible combinations are virtually endless. In the end, it will be all about providing a competitive product with the right specifications and fiber components that meet consumer demand.” ⁵⁶

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TAPPI’S NONWOOD COMMITTEE

As a technical committee within TAPPI’s Pulp Manufacturing Division, the Nonwood Fiber Committee (NFC) works to further understanding of nonwood fibers and how they’re used. This includes “the study, development, and utilization of all nonwood plant fibers such as bagasse, cereal straws, rice straw, flax straws, cotton linters, bamboo, reeds, esparto grass, sabai grass, and other grasses, bast fibers such as kenaf, jute, and crotalaria, and leaf fibers such as abaca, henequen, and sisal.” But the committee actually does much more, says Bob Hurter, a consulting engineer and three-time past chair.

“This committee is unique within TAPPI in that we cover all aspects of using nonwood fibers,” he says. “Our activities touch on all aspects of the industry for nonwoods, thus the committee has synergies with all TAPPI divisions.”

Since its formation in 1970, the NFC’s main activity has been developing technical sessions on nonwood fibers, first for TAPPI’s Pulping Conference and now for the PEERS conference. The group has also worked on TAPPI Technical Information Papers (TIPs) related to nonwoods. “We are also available to assist other TAPPI divisions and committees as they develop their respective conference programs, which may include nonwood fiber sessions,” says Hurter.

Today, the NFC’s purpose is to facilitate the exchange of information and advance the technologies relevant to the use of nonwood plant fibers in the pulp, paper, and related industries. “This includes all aspects of the process, from the nature and production of raw materials through handling and storage, pulping, bleaching, papermaking, and end uses,” Hurter says, although he adds that even this statement is not as comprehensive as it should be. “The resources of the Nonwood Fiber Committee are underutilized because not enough people know the breadth of our activities.”

To learn more about the NFC, or to join the committee, visit tappi.org or contact committee chair Med Byrd at med_byrd@ncsu.edu.