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Nonwood fibers offer potential opportunity for papermakers

Editor's Note: TAPPI would like to thank Brian Brogdon and Peter Hart of the TAPPI Journal (TJ) Editorial Board for selecting papers from the 2013 PEERS Conference and overseeing their peer review for the special Nonwood Pulping content in this issue. Also, thanks to Art Ragauskas of the Editorial Board and Tom Lindström for organizing additional Nanocellulose content associated with the May issue. Thank you to the authors and peer reviewers who participated in this process as well.

– Monica Shaw, Editorial Director

As a third generation consulting engineer, I grew up in the pulp and paper industry. In 1961 at age 10, I first learned that trees were not the only fiber raw material that could be used to make pulp and paper when my grandfather (Fred) and father (Freddy) were awarded a contract to build the largest rice straw pulp and paper mill in the world — RAKTA in Alexandria, Egypt. After that, they worked on many nonwood projects based on sugarcane bagasse, bamboo, cereal straws, cotton, and many more nonwood fibers. Fast forward to 1980 when I joined the family firm, my first project was the rehabilitation of another rice straw pulp mill.

Over the years, I have learned that nonwood fibers offer papermakers a rich variety of physical and optical properties that could be used to enhance their products. There are short fiber hardwood substitutes such as cereal straws, corn stalks, reeds and grasses, sugarcane bagasse, and some bamboos. And, there are nonwood fibers such as flax, hemp, jute, and kenaf bast; cotton; sisal; abaca; and some bamboos with properties as good as or much better than softwoods.

Diverse fibers with unique benefits

Paper and paperboard can be made from 100% of a specific nonwood fiber pulp, a blend of 2 or more nonwood fiber pulps, a blend of nonwood and wood pulps, and a blend of nonwood and recycled fiber pulps. The potential blends are endless. In some instances, blending as little as 10%-15% nonwood pulp with wood pulp and/or recycled fiber pulp can improve end product properties without any disruption to papermaking the process. For example, blending high yield wheat straw pulp into recycled fiber packaging board will improve stiffness.

The wide diversity of nonwood plant fiber raw materials presents many challenges, but most of these challenges have been solved over the past 40-50 years. Many of these solutions have been presented in Nonwood Fiber sessions at various TAPPI conferences.

Systems have been developed and commercially used for the long term storage of annual plants, such as cereal straws and bagasse. Straw and bagasse fiber preparation systems are operating in mills around the world, as are horizontal tube digesters. Specially designed wet ends accommodate high straw and bagasse pulp content in the sheet. And, specially designed chemical recovery systems address most of the silica related issues. Nevertheless, development in all of these areas continues and new technologies and processes, such as a recently patented straw preparation process that desilicates the straw prior to cooking, are continuing to improve straw and bagasse pulping and papermaking.

Bamboo and giant reeds such as *Arundo donax* offer a unique opportunity to the industry in that they can be chipped and pulped in existing wood pulp mills with little or no capital investment other than perhaps a chipper designed for hollow bamboos and with modest changes to the process conditions. In fact, as addressed in one of the papers in this *TAPPI Journal* issue, it is entirely possible to co-cook bamboo chips with wood chips. Also, a number of years ago, a successful mill-scale trial was carried out at the old Samoa pulp mill in California using *Arundo donax*.

There are over 1250 identified bamboo species worldwide, of which about 100 are being used commercially for products including pulp and paper, construction materials, bamboo flooring, and furniture. Some species produce short fiber pulp, some long fiber pulp, and others fiber lengths between hardwoods and softwoods. This leads to some exciting possibilities for establishing bamboo farms that could include species tailored to specific papermaking requirements. Many species, depending on location and growing conditions, can produce 40-50 dry metric tons per hectare per year. And, just like trees, if you do not need them, the bamboo can be left on the farm until needed. But maybe one of the best attributes of bamboo versus trees is that the bamboo will regrow after cutting, thus eliminating the need to replant after every cut.

Nonwood pulp: Past, present and future

As little as 150 years ago, nonwood fibers — primarily cotton and linen (flax) rags and cereal straw — accounted for 90% or more of the world's pulp production. By 1985 when I joined TAPPI and TAPPI's Nonwood Fiber Committee, this had dropped to about 12%, and today it is about 7%. Most of the nonwood pulp production is located in countries that do not have trees for pulp and paper production, such as China, India, Pakistan, Egypt, and Columbia.

However, over the past two decades, nonwood fiber pulp and paper products have been hitting the shelves of U.S., Canadian, and European retailers. Walk into any Staples and you will find copy paper made from wheat straw and sugarcane bagasse. Molded pulp products made from nonwood pulps (bagasse, oil palm empty fruit bunch, bamboo) are also in these retail markets. Currently, these products are either being imported as finished product or, in some European cases, made in Europe from imported pulp, but this appears to be changing. There are several molded fiber product projects underway in the U.S. that are based on nonwood fibers

such as wheat straw. A 200 ton/day wheat straw market pulp mill has been announced for the U.S. Northwest. Kimberly Clark is investigating a range of nonwoods, including bamboo, wheat straw, kenaf and *Arundo donax* with the long term view to replace 750,000 tons of wood pulp with nonwood pulp annually.

Will nonwood fibers ever replace wood as the fiber raw material of choice? In my opinion, the answer is *no*, but nonwoods can complement wood in many cases. This combination is where I see the future and growing use of nonwoods.

At the upcoming 2014 PEERS Conference in Tacoma, WA, USA, this September 14-17, TAPPI's Nonwood Fibers Committee will have two technical sessions and a panel discussion on state-of-the-art nonwood fiber pulping and bleaching. The committee will meet on Sunday, September 14, and all are welcome. Join us to learn about the latest from Kimberly-Clark, a new enzymatic pulping process, and much more. **TJ**

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