
The Environmental Paper Listening Study

Chapter Four: Tree Free Paper

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September 26, 2004

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Conservatree is a nonprofit catalyst and advocate for ecologically sustainable paper markets, combining environmental expertise with paper industry and technical proficiency. It provides practical tools and realistic strategies for successful conversion to environmentally sound and sustainable papers.

Conservatree began in 1976 as the for-profit Conservatree Paper Company, specializing in identifying, developing and supplying commercial quantities and qualities of cutting edge recycled printing and writing papers. After the company closed in 1997, Susan Kinsella and Gerard Gleason converted its information and advocacy mission to an independent nonprofit project of The Tides Center. It does not sell paper, does not represent any paper company or distributor, and networks with people with all types of perspectives on environmental paper issues.

As director of the Listening Study, Conservatree creates partnerships, conducts interviews, researches reports and tests, oversees the comprehensiveness of the information, writes the synopses, and compiles and publishes the reports.

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Promoting Innovative Fibers from Alternative and Non-wood Sources

Fiber Futures is a dedicated advocacy and consulting group that focuses on catalyzing the use of agricultural residues and fibers from non-wood plants for building materials, pulp & paper, textiles and other industries.

As an advocacy group, Fiber Futures has built bridges with industry to convey the benefits, opportunities and challenges of using non-wood fiber resources.

To promote enterprise development of such opportunities, Fiber Futures provides a variety of technical assistance services such as engineering assessments, market research, business plan refinement, educational forums and financing expertise.

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EXECUTIVE SUMMARY

Many environmentalists have a vision: One that includes amber waves of grain and fields of plenty instead of chainsaws in forests. They hope that plant fibers can take the place in paper mills of today's forest fibers. But there are many questions about whether this shift is appropriate and feasible and how it could best be accomplished. Despite disagreement on many of the specifics, virtually all non-wood fiber experts agree there is much research still to do.

This report includes some of the data produced by nonwood fiber researchers, but it is not by any means an exhaustive collection. We intend to continue adding links and references to data sources. But the Listening Study is focused especially on the thinking that shapes these issues, interprets the data and chooses what to explore – or not to explore. Some of this thinking is informed by data – which may or may not be readily accepted by others – and some is not. Our purpose is to sort out the arguments on these issues to find ways of moving through them to more progress in advancing environmentally sustainable paper production.

Plant Fibers vs. Tree Fibers

How do alternative plant fibers compare to using tree fibers for paper production? This is not a simple question with a simple answer. Many different systems and sub-systems mesh to produce either paper source, and each system influences the environmental, social, technological, geographic, and production evaluations necessary. In fact, the most important point that our respondents made over and over is that there can be no general answer to this question. Indeed, there was also some debate about whether this even is a valid question. John Mechem of the American Forest and Paper Association was quoted in a magazine article as saying, "We think finding a replacement for wood fiber is a problem that does not need to be solved."

But Maureen Smith, author of an extensive environmental evaluation of the U.S. paper industry, thinks that assertion is premature: "Overall, the dominance of the wood-based industry perspective and the associated research corpus has strongly tended to overwhelm the debate as it has emerged and to claim the benefit of the doubt. . . . an important example of how a conventional wood-based perspective could undermine the nonwoods idea before it could even be argued."

For almost all respondents, however, there are so very *many* questions about nonwood fibers, in part because every potential nonwood fiber source has a different profile from the others. As Jeanne Trombly of Fiber Futures told us, "Considering that nonwood plant fibers and ag-residues were pulped and used for paper going as far back as [105] AD, there are hundreds of sources of non-woods for paper, each with a rich and diverse history that can be explored depending on where one needs the fiber and what the final product needs to be."

The Listening Study responses identified four different categories of sources for these plants:

1. "On-purpose," or dedicated, crops grown specifically for paper fiber, such as hemp, kenaf, jute and flax,
2. Agricultural residues left over from food production, such as cereal, rice straw and bagasse (sugar cane),
3. Industrial residues (sometimes included with agricultural residues) such as cotton linters snipped from cottonseed after ginning for textiles but before pressing for oils; cotton or linen scraps from clothing production; and flax residue from oilseed, and
4. Naturally occurring uncultivated crops such as wild grasses, sisal, and bamboo.

Virtually all the respondents would agree that each type of plant fiber must be evaluated individually for its advantages and disadvantages for use in paper production. Many of the arguments surrounding different nonwood options involve environmental comparisons. These are critical to deciding whether it is worthwhile to pour resources into developing one type of fiber over another, as well as whether any nonwood fibers offer sufficient advantages over the use of wood fibers to warrant the investment. But environmental comparisons are not the only consideration. A list of critical factors developed through the

discussions of each question in the tree free section of the Listening Study shows a wide range of hurdles a nonwood option has to meet:

- How does the plant fiber compare environmentally to tree fibers and to other plant fibers? Is its sourcing more benign than from natural forests? Is it more benign than from tree plantations? Does its life-cycle require pesticides, herbicides, excessive energy or water? Does its sourcing or use benefit the environment, such as kenaf rebuilding depleted soil or grain crop residues providing a means for changing waste into a beneficial product?
- Does using the fiber for paper provide social benefits, such as income for family farmers which in turn might strengthen communities? Or does it lead to social detriments, such as encouraging landowners to sell off or cut down their forests or farmers to neglect sufficient return of organic material to their soil?
- Is it easily available in large quantities and compatible with its environment? For example, the reed *Arundo donax* was considered to have great potential for papermaking in California until farmers objected that its invasive qualities threatened their production and others became concerned about its potential to block salmon streams. But it may be an excellent candidate in a different location.
- Can it be grown in sufficient quantities near a mill that can pulp it? Can it easily be transported to a pulp mill?
- How easily can it be pulped and does its pulping produce problems that must be addressed? Plant fibers drain water at different rates than wood fibers and than each other, yet almost all the pulp mills in North America are engineered for wood. The problem of large amounts of silica produced when pulping agricultural residues remains to be solved.
- Do the fibers make good paper? Some are too short for the strength required for some products, others are too long.
- Is the non-wood paper compatible with recycling? Some nonwood fibers have already been proven to be recyclable. There are concerns that others, particularly agricultural residues, might break down more than wood fibers in the strong mechanical action in a deinking pulp mill, slowing drainage, reducing yield, and making weaker products. Is that true or simply a negative myth that needs to be debunked?

Some of the attractiveness of one option over another has to do with the currently uneven development of different possibilities. For example, Jeff Mendelsohn, president of the environmental paper merchant New Leaf Paper, pointed out, "It's easier to get low impact agricultural fiber than FSC offcuts. However, it's easier to take advantage of FSC certified woods because the systems are already set up for pulping wood."

International Paper, primarily a wood-based paper manufacturer, argued for its predominant fiber source when it stated, "While managed forests are entirely hospitable to biodiversity, wildlife and endangered species, alternative fibers are agricultural crops, which means they're monocultures requiring the near eradication of any competing plant or animal species."

Peter Hopkins, a spokesperson for Crane Paper Company, summed up the dilemma over comparisons by saying, "There are too many variables to do anything close to a life-cycle analysis between 'ag fibers' and 'tree fibers.' Now, if you take two specific cases and directly compare them, you could complete a good study. Something that would compare a specific fiber grown in a specific place with specific conditions, processed in a specific way for a specific paper. Then you could compare accurately and with certainty."

Yield

Still, there are many bases for comparison. Some argue on the basis of yield, which varies widely for different plants, at different times, in different places, and by different methods. As Jeanne Trombly from

Fiber Futures told us, "Even in comparing the same fiber, such as wheat straw, one may have drastic variations in fiber yield. The density of wheat grown in eastern Washington is four times that in Kansas, for instance. This is due to climate conditions and soil quality. With bamboo, there are over 1000 varieties that will have a different yield per acre. Flax grown for linen grows much higher than the seed kind, yet the seed kind yields a beautiful fiber."

There are also different ways to calculate yield. Is it most important to measure the volume in the field per acre? Or should we look at how much land is necessary to grow the equivalent amount of pulp? Maybe the most important comparison is how much pulp the fiber produces after going through a pulping process. Some of the reason for sometimes contradictory claims may be that "yields" are being measured based on different assumptions.

Tom Rymysza of Vision Paper even argues that some of the yield tables in the Paper Task Force report on nonwood fibers are calculated using incorrect conversion factors, yet they are used by many as the source for arguments about the preference of agricultural residue fibers over on-purpose crops. He asks, "How can we have a science-based discussion attempting to arrive at a well-thought-out comparison of the merits of different types of fiber if the basic data – and even the basic conversion factors – are wrong?"

Environmental Impacts

How do nonwood fibers compare to tree fibers in their papermaking impacts on water, energy and pollution? Answers to these questions seem to be tied up in systemic differences that factor into the whole picture. The International Institute for Environment and Development (IIED) points out that, "Small mills are preferable for nonwoods because of limited fiber supply, therefore capital costs are lower. However, small mills by nature will be more polluting because chemical recovery does not make economical sense. The higher proportion of silica in most nonwood fibers makes traditional chemical recovery processes ineffective."

Silica, present at high levels in some agricultural residues such as straw and corn stalks, is a serious problem. Tom Rymysza of Vision Paper describes that it "accumulates and hardens on machinery, creating the need to frequently stop production and clean with caustic chemicals. Regularly shutting down machinery in a pulp mill decreases any chance of creating an economically viable product." Research is ongoing to resolve this problem. Meanwhile, production with agricultural crops that do not create this silica problem has moved ahead.

On other environmental factors, nonwood fibers shine. Tom Rymysza also reports, "Most annual crops, when compared with trees, contain lower levels of lignin. Since chemical pulping methods remove non-cellulose components, many annuals can be pulped using milder chemistry and less energy." Robert Hurter, in a TAPPI publication, notes, "Bleaching of nonwood pulps . . . typically is easier than woodpulp and requires fewer bleaching stages and lower chemical consumptions." Ernett Altherimer of Nile Fiber calls *Arundo donax* "a carbon sequestration giant. It takes in carbon and effluents and stores them in the leaves, stems, etc. . . . Compared with wood it is 90% more efficient at sequestering carbon. *Arundo donax* enhances the soil by processing toxic chemicals to an inert form." Steve Shaffer of California's Department of Food and Agriculture makes a similar point: "Kenaf's long roots remove salt deposits in the soil and can be used as an excellent rotation crop for improving the soil . . . and can pull up lost nitrogen leached farther down in the soil."

Peter A. Nelson of AgroTech Communications sums it up by saying, "In theory, the wear and tear on the land (topsoil) over ten years growing trees would be less than an annual crop, while the production of pulp from trees would require more energy and water based on lignin content, etc."

International Paper would beg to differ, though, saying, "Annual agricultural crops are more energy intensive than sustainably managed forests. Much of the additional raw material cost stems from the additional work and energy required to deliver the material. In addition, it is necessary to invest additional money in facilities to convert them to produce paper made from agricultural fibers. Reducing the cost of agricultural fiber crops would not eliminate the fundamental biodiversity and energy use problems associated with these crops."

Pesticides and Fertilizers

One of the key points made in debates about the environmental value of fibers from agricultural crops vs. forests revolves around the use of pesticides and fertilizers. Richard Denison at Environmental Defense puts it this way: "The available data indicate that pesticide and fertilizer usage even for plantation-grown trees is generally lower than it is for kenaf and hemp. The main reason for this is that trees are grown on multi-year rotations with chemicals applied at most every few years, in contrast to annual crops, where such chemicals are applied annually." Yet perhaps there is room for improvement, as IIED states that, "Most farmers use pesticides and fertilisers on their non-wood fiber crops, although it is possible to grow most types of fibre without those inputs."

The consideration is skewed, as well, by the fact that agricultural residues, by definition, derive from crops that would have been planted and grown whether or not their residues are used for paper. Therefore, their use of pesticides and fertilizers is considered irrelevant to the paper fiber question, while on-purpose crops must account for inputs from the very beginning. Yet Peter Nelson at AgroTech is concerned about the effect of financial incentives for residues, commenting, "I discourage the idea of using crop residues. . . . Farmers are an efficient bunch and if there were a 'commodity price' for residues it would be too tempting to take off too much residue. You have never heard of a farmer intentionally leaving beans, cotton, or corn in the field at harvest; the same farmer would not leave enough residue for ground cover if he already took the time to bale and move the residues."

There are additional points that put a different spin on the pesticide question. For example, some respondents pointed out that sorghum is a fast grower and therefore has less weed competition and less cultivation requirements; kenaf is host to beneficial insects; a farmer harvesting for fiber rather than for fruit or grain needs less herbicide and no insecticide.

Social Realities

There are social realities, as well. IIED states, "There are two main advantages for farmers in growing fibre crops rather than trees. Firstly, the area under the crop can be changed every year depending on the relative benefits from the crop. Secondly, income is generated every year, avoiding the need for credit to support tree growing costs over many years." At the same time, perception may play a role, according to Russ Clark, of the U.S. EPA's Environmentally Preferable Purchasing Program, who points out, "[Nonwoods] may not have an advantage because people may not see trees as toxic. Whereas consumers might believe that agricultural products were grown with pesticides, they could believe trees just grew in a forest and must be natural."

Agricultural Residues vs. On-Purpose Crops

The question of whether nonwood fibers would be better for papermaking than tree fibers is tied up with the question of exactly which nonwood fibers would be used. There is a strong camp arguing for only the use of agricultural residues, since they already exist and would otherwise be waste products (beyond the volume that is turned back into the soil for amendments). Maureen Smith points out that, "By one estimate, depending on growing practice and soil type, an average of more than 50 percent of harvested cereal straw is available as surplus." Jeanne Trombly put it well by saying, "The biggest opportunity for using non-wood fibers with little land impact is simply to use the residues of the millions of tons of crops that are already being grown for food and oilseed."

The Paper Task Force report argued, "Using agricultural residues to make paper helps solve a waste management problem for farmers and provides an additional source of fiber for papermaking. Chemical use throughout the fiber acquisition process is also low. Paper industry experts think that agricultural residues will be more competitive than annual crops because no additional land is required and the agronomic practice has already been developed. Harvesting straw for pulping eliminates the burning of straw and the resulting air pollution." But it also recognized some downsides: "Harvesting the straw can lead to a loss of nutrients in the soil. Farmers must then balance the cost of a smaller straw harvest with the application of fertilizer to compensate for the nutrient loss."

There are also many supporters of on-purpose crops. Tom Rymysza, in arguing for kenaf, states, "In the US, almost 80% of all annual row crop land is used to produce three main crops – corn, soybeans and wheat. That does not represent diversity or sustainability. The intensive agricultural practices currently used require high levels of fertilizer and chemicals on those crops. Adding new crops that are rotated with conventional crops will reduce overall pesticide and other chemical use, will contribute to maintaining soil fertility, and will help to reduce surpluses. . . . When prices are low [because of surpluses], the government steps in with deficiency payments to farmers (subsidies), which cost you, the taxpayer, money, and which create an un-level playing field in the world trade picture."

The Association for the Advancement of Industrial Crops agrees, reminding us that, ". . . overconcentration and overproduction in a relatively small number of food and feed crops have created global problems. Clearly, diversification in agriculture is of high priority." Russ Clark, at EPA's Environmentally Preferable Purchasing Program, suggests that, "As sustainable forestry issues become more defined, we have to also look at sustainable agriculture." To the nonwood papermakers at Living Tree Paper Company, that means using on-purpose crops for rotation crop farming, which they say "is far less damaging than current industrial chemical agricultural practices."

Often advocates for ag residues voice a worry that markets for on-purpose crops would encourage landowners to cut down their forests for farming. EPA's Russ Clark demurs, "I don't think anyone is thinking of cutting down existing tree farms or forests to plant crops. With a life cycle analysis, we would understand the implications of such a replacement," and Tom Rymysza points out, "There are over 75 million idle agricultural acres in the U.S. If only a portion of this went to growing kenaf, the supply would be adequate."

Still, Richard Denison at Environmental Defense believes that, "It is hard to imagine that the biological value of even the most intensive of tree plantations would ever be lower than that of an agricultural field of comparable size. Indeed, I would argue that, acre for acre, from an ecological perspective, habitat value, biodiversity and water quality protection and soil carbon storage would all be higher for silviculture relative to agriculture because harvesting, replanting, fertilization and pesticide application only occur on a multi-year basis rather than annually."

But Nicole Rycroft, of Canada's Markets Initiative, points out that these arguments can be situational: "From a Canadian perspective, it makes a lot of sense to further explore annual crops as viable fibre options. I understand there have been some lifecycle studies that point to Southeastern U.S. tree farms as more benign than on-purpose crops. In the Canadian context, wood fibre and pulps primarily originate from old-growth or intact forest eco-systems. . . . Because the biodiversity values, ecological functions and services of old growth forests are very different from Southeastern U.S. tree farms, it may well be that many on-purpose crops actually are preferable from a life-cycle analysis perspective to pulp and fibre from intact old growth forests."

Kelly Sheehan, at North Carolina's Dogwood Alliance, questions whether tree plantations can be seen in a positive light: "It is important to follow and support research into on-purpose crops. I think we should be careful not to refer to pine plantations as benign in most any context. Giving the impression that plantations support biodiversity is inaccurate. (Unless of course we're talking about deer populations!) The conversion of natural forests in the Southeast to pine plantations, requiring an intensive use of herbicides and fertilizers, is one of our greatest challenges to forest protection in this region."

For the late environmental luminary David Brower, there was no contest. In an article called "Kenaf: A Tree-Free Alternative," he wrote, "The forest plantations that cover ancient forest soils are not the answer. These plantations tie up useful land, and after only a few rounds, leave the soil decimated. We cannot pretend that we will turn these areas back into forests. Kenaf offers us a viable alternative."

Susan Kinsella at Conservatree questions the premise underlying the debate: "I think there is way too much focus on comparisons only to forests. . . . [T]his question is more complex than that. It crosses over to also include agricultural sustainability issues, where there is a whole different set of thinkers and activists working to re-orient the agricultural status quo to be more sustainable both for farmers and the land. So the question of ag residues vs. on-purpose crops cannot be analyzed only from a forest

paradigm. We have to bring in an additional set of experts with sustainable agriculture expertise and perspectives to add to the forest considerations."

Arguing for "the practical and implementable, not just the theoretical," Conservatree maintains that "the only U.S. or Canadian nonwood fibers that have gotten to consistent marketplace printing and writing paper products, other than cotton and a very small amount of bagasse, are on-purpose crops. The companies that produce them . . . have taken enormous financial risks, put in decades of phenomenal dedication, built complex sourcing systems from the ground up, responded to environmental issues, and turned out extremely high quality products in a highly technical and demanding industry." While clearly encouraging more work on developing ag residue paper fiber potentials, Conservatree urges that nonwood fiber supporters not "turn our backs on the people who have actually already made nonwood papers in the U.S. a reality."

Research and Infrastructure

In creating that reality, there has been a good deal of in-depth research and experimentation with both on-purpose crops and agricultural residues. The U.S. federal government reports, "Since the 1930's, the U.S. Department of Agriculture has devoted some attention to possible use of nonwoody plant fibers (especially crop residues such as sugarcane bagasse and grain straw) in pulp and paper. . . . As a first step in identifying new sources of fibers for pulp, a botanical-analytical screening system was established. . . . Among 387 species that were subjected to the entire screening evaluation, kenaf and sunn hemp were most promising. The later decision to concentrate on kenaf rather than sunn hemp was based largely on the ability of kenaf to produce consistently higher yields with much better standability."

Al Wong, an innovative papermaker who works with straw and grain crop residues, recommends that researchers "re-examine the supply of papermaking fibres from a zero-base viewpoint, without technical prejudice. The obvious sensible approach is the reinforcement of the basic tenet: Reduce, Reuse and Recycle, and with the addition of a '4th R.' The fourth 'R' is replacement of traditional virgin wood fibres with other fibres. Replacement with agricultural cropping residues in paper manufacture, in conjunction with 'reduce, reuse and recycle' practices, would have a significant impact on 'saving trees.'"

Both the Agricultural Research Service of the USDA and the Alberta Research Council in Canada are researching new crops that can be used for industrial – in this case papermaking – purposes. Purdue University has an Internet New Crop Online Resource Program. The USDA's Forest Products Laboratory as well as several university paper and/or forestry schools conduct studies into agricultural options.

And yet, most of the comments by leading experts in the field are laced with acknowledgements that more study and more development is needed. Peter Hopkins of Crane Paper Company points out, "Tradition is a major holdup. Since just after the Civil War, paper has been made from trees. Every piece of papermaking machinery has been designed for trees. You can't just dump a bale of kenaf into a pulper, because the pulper was designed specifically for trees. The tree paper industry has built economies of scale from research to distribution. On the other hand, how much is spent on ag-fiber paper research in the last couple of years? Pretty close to \$0 has been spent for kenaf, hemp, bagasse, sisal, jute, straw, flax, you name it. Meanwhile, millions are spent each year to develop higher-yielding, shorter-rotation tree-crops. We're really just starting to figure out how to get ag fibers grown and processed efficiently."

Another basic requirement is infrastructure. Other than about a dozen cotton pulping mills and three or four mills that pulp flax for specialty items such as filters, cigarette papers and teabags, there is virtually no non-wood pulping in the U.S. and Canada. Al Wong's small experimental pulper in western Canada has advanced the knowledge and technology for pulping ag residues, and there is some pulping of bagasse (sugar cane residue) in Mexico.

The nonwoods expert Michael Jackson says, "Most agricultural fibers will not process in the raw material handling and pulping stages of existing wood pulp mills," and, as AgroTech's Peter Nelson points out, "Conversion [to nonwood fibers] is more complex than just the pulp; the existing infrastructure is a part of the larger wood products industry. . . . A pulping mill conversion would affect the far-reaching markets of wood products," and therefore presumably be contradictory to interests of paper companies that rely on virgin wood fibers. However, Andrew Kaldor, in a TAPPI Journal article, notes a

contradiction: "[A] commonly held view today among the pulp industry experts of developed countries is that the production of nonwood fibers is not viable or competitive in their economic environment. The same industries, on the other hand, are prepared to accept a heavy long-term reliance on wood fibers due to a perceived lack of alternatives."

Even despite the lack of infrastructure, though, there are a surprising number of high quality printing and writing papers that already contain nonwood fibers. Conservatree's website Guide to Environmental Printing and Writing Papers lists nearly 80, with almost half of those containing nonwood fibers other than cotton, including hemp, flax, bagasse, kenaf, banana stalk fiber, coffee and tobacco plant residue, seaweed, old currency and blue jeans.

Towards the Future

What does the future hold for nonwood fibers? That depends on many factors, including financial. Jeanne Trombly describes the fiscal realities: "The price of raw material wood chips is maintained artificially low because of many resource tax breaks and other give-aways of public agencies that own large swaths of forestland, not only in North America but all over the world. Only when wood increases in price do the paper companies get interested in non-woods. . . . One of the biggest factors in the costs of non-woods is the price of pollution control technologies to recover the pulping chemicals. The wood pulping chemical recovery systems have not worked for non-woods and new inventions have been introduced, but the entrepreneurs providing lab-scale alternatives have not been able to raise the capital needed to get these new technologies into pilot scale. Yet this may change as one major development is about to break due to the demand for non-wood pulping in China."

Plans are underway for a kenaf pulp mill in the U.S. Southeast and research is going into the feasibility of an agricultural residue pulp mill in Alberta, Canada. But, as with recycled content and other environmental paper characteristics, the deciding factor will be demand. Peter Nelson says, "Many of the efforts in the past have focused on beating out other crops such as corn or soybean and promoting one specific fiber. A more effective technique is to win the consumer's heart for natural ingredients from the ground as better than synthetics. Then the individual fibers can develop their own niches. The nonwood industry would be better off to market nonwood fibers as a diversified sustainable opportunity." Paper industry consultant Peter Hopkins agrees, "Industry is not going to change just because we want them to start using ag fibers to make paper. Consumer demand has to change in the absence of other motivating factors for the paper industry. . . . [If] there are enough consumers out there saying they won't buy virgin wood paper, the industry will find the economic advantage and take heed."

Which comes first, the demand or the capacity, the chicken or the egg? James S. Han, a research chemist at USDA's Forest Service Forest Products Laboratory, suggests, "A perfect scenario would be establishment of small pulp mills at the heart of the wheat belt, corn belt, etc., compact the straw and send it to the mills, then pulp during the off-season, hiring the farmers. Pulps can then be shipped to the paper mills. Thus, combine farming and pulping. It is no different than sending grains to the mills to be processed as flour." Maureen Smith expands the vision, saying, "Generally, the transport issues associated with nonwoods, the corollary emphasis on smaller-scale pulping formats, and the issues of heterogeneity in fiber types, sources, and applications, are the basis of an increasingly strong regional theme that runs through the debate."

Indeed, over and over again, comments in the Listening Study show that environmental issues and desirable nonwood fiber profiles vary considerably between geographic areas. Answers in one region may actually create problems in another. While the paper produced may be sold nationally or even internationally, the appropriate fiber sources and processing systems may be very different from one part of the country to another. Perhaps some of the controversies around nonwood fibers have developed from attempts to impose one answer on such a variety of situations. Peter Hopkins, representing Crane Paper Company, explains, "Supply for ag residues is a regional issue: A mill in Maine might want to use rice straw. It doesn't matter if there are millions of tons in California, the cost of transportation might mean that there is effectively no supply for that mill in Maine."

So are there enough tree free fibers to produce paper? In theory, yes, of course, says Peter Nelson, "However, it is hard to know when to stop counting — in theory, we could pulp tree clippings from

town, but the land management, collection, and transportation is complicated. Pound for pound, hauling trees is generally far more efficient than hauling baled hay. In practicality, all the existing residue cannot and should not be harvested." Of course, regional variations provide the potential for many different successful scenarios.

Whatever types of nonwood fibers are pursued, there is a daunting amount of work ahead to develop competitive systems. "Just think of all the effort that has gone into developing the collection, processing and use of recycled fibers," says Michael Jackson. "A similar effort and capital investment would have to go into systems for agricultural fiber use." Fortunately, there are a number of entrepreneurs and advocates already tackling developing those systems.

Future Directions

Clearly, the nonwood fiber portion of environmental paper development is fraught with a number of knotty problems:

- What data can we rely on to evaluate whether nonwood papermaking fibers are environmentally worthwhile to pursue in comparison to wood fiber?
- What fibers are worth pouring research and development resources into advancing?
- Should we support the use of both agricultural residues and on-purpose crops or only one or the other?
- How do we solve production problems such as silica burdens?
- How do producers juggle attracting investment financing to build nonwood fiber mills while at the same time developing customer demand that will motivate and justify it?
- How do we develop that customer demand in the first place?
- Can the prices of nonwood products be competitive with wood fiber products produced in long-established, highly stable and well-capitalized manufacturing systems, or can they create niches that allow them time to build the necessary economies of scale?

Russ Clark at EPA sees practical requirements: "The [nonwood paper manufacturing] industry needs to do a better job at putting their nonwood materials side by side with trees to understand as a country which papers are preferable. There is a lot of support on 'the Hill' for agriculture-based products. On the other hand, the forestry industry has a lot of lobbyists. Without good information, the [nonwood] industry is not going to get far."

New Leaf Paper's Jeff Mendelsohn continues that point, "To address the technical barriers, there needs to be a combined effort from private industry and public research. When fighting an entrenched industry with significant barriers to entry, public support is critical." Peter Nelson clarifies, "The inherently impossible question seems to be: Overall, how do we minimize impact of industries that by existing destroy the earth? There is a clear role for the public dollar in nonwood research. There is already a ton of federal research money going into tree genetics, lower energy, and water use. We have to tap into this research."

Tyson Miller, program director for the Recycled Products Purchasing Cooperative, which makes environmental office papers available at competitive prices, spells out some of what he thinks is needed:

- There should be more public funding for R&D to develop new hybrids and varieties that are resistant to pests. Cooperative extensions would be good entities to accomplish such research.
- Additionally, cooperatives that pool fiber producers together to reduce transportation and production costs would be ideal.
- There should also be government participation in the fiber production. The government could use public lands to set cheap rates or grow it themselves.
- The industry should identify the potential users to determine their price point and what preference they would give to alternative fibers, if any. Then they should balance the demand against the costs of production to see how much the price can be pushed down.
- The collection infrastructure should be targeted. The industry could reduce the overall costs of getting pulp to industry by developing regional collection programs to get high volumes shipped. With this model, the pulp purchasers can reduce their fiber unit costs.

- Promoters would also need to target producers to show that there would be a demand for tree-free papers. With demand numbers they could get the “big four” to invest in capital equipment and conversion costs.

Some of this is already happening. Peter Nelson of AgroTech relates, "To help develop the marketing end, AgroTech Communications, Inc. is participating with 40+ biobased companies to develop the Biobased Manufacturers Association (BMA) to help in marketing biobased products based on their inherent attributes. . . . One aspect of the program is setting up cooperative purchasing. . . .The nonwood industry would be better off to market nonwood fibers as a diversified sustainable opportunity. Particularly after September 11, the industry needs to market to Washington. They also need to heal wounds with the wood industry to come up with the best balance."

Russ Clark sees more, "As sustainable forestry issues become more defined, we have to also look at sustainable agriculture. To compare how an acre of trees versus an acre of agriculture is managed, we need a clear standard for comparison. The criteria for organics are primarily related to human health, how much residue is on the fruit or vegetable. It might be appropriate to develop a non-food standard. It would have to be beyond the organic requirements and focus on the life cycle issues: runoff, irrigation, transportation limits of inputs, etc."

James Han at USDA's Forest Products Laboratory sees an even larger agenda, "Future outlook seems to me is based more on the control of imports and national policy rather than availability of agricultural pulping facilities. Without a national policy, cheap imported chips, pulps, and papers will flood the U.S. market."

With so much basic work still needed, why is there nevertheless so much motivation to develop nonwood papermaking fibers? After all, as Maureen Smith so aptly puts it, "If the question is one of fitting a heterogeneous and disbursed alternative fiber supply into a geographically concentrated, technologically rigid, vertically integrated, capital-intensive industry, one begins to better understand the modern history of nonwood paper commercialization efforts. The question becomes less why the commercialization of nonwood fiber pulping has yet to succeed, than why anyone in his or her right mind would still be trying."

But there are two sides to this picture. On one hand, Maureen comments, "When one views the issue from a broad perspective of social and environmental opportunity . . . one sees nothing short of abject failure and gross irresponsibility reflected in the modern industrial status quo." Yet on the other hand, "One also sees an area of potential remarkable for its reach, its regional variability, and its human and ecological significance."

It is that second view that inspires this report on tree free paper questions.

Recommendations for Next Steps

As we point out in this summary, and as is obvious in reading the full comments, there are a number of difficulties in the nonwood paper fibers field that hamper its development. The obstacles cover all the different kinds we initially contemplated in developing the Listening Study:

- **Developmental** – The North American infrastructure for nonwood fiber sources other than cotton is mostly either fledgling or nonexistent, with agricultural sources, transportation, pulping and distribution systems all needing development. The fibers now available are often pulped as special cases in mills built for other types of fibers.
- **Economic** – Successful development requires a great deal of investment and capitalization in order to achieve economies of scale that can mainstream the products.
- **Technical** – New pulping processes need to be developed to overcome the silica problem with agricultural residues. All kinds of research and testing are needed for all the potential fiber choices.

- **Cognitive** – Studies and debates need to be presented with much more clarity about exactly what fibers are being discussed, in what geographic regions with what kinds of contexts. Readers will notice in reading through the comments in this report that many discuss "nonwood fibers" as one entity, yet the comments are clearly applicable to only on-purpose crops, or only agricultural residues, or only a particular fiber and not another. We have reached a point in this field's development where it is essential to be specific about the statements made so that others will be able to accurately apply them.

There also clearly is a need to enlarge the knowledge-base for nonwood paper issues by bringing in expertise about sustainable agriculture. Much of the discussion so far has been framed by those with expertise in forest issues, primarily because the product we are discussing – paper – has been so overwhelmingly produced from wood fibers. Nonwood fibers require equal expertise in agriculture.

- **Value-driven** – Of course, the traditional wood-based paper industry has a great deal invested in maintaining its tree-fiber-based systems, and this informs their viewpoints and considerations. Environmental advocates bring in-depth knowledge of ecosystem issues to the questions, but generally do not have business backgrounds. Some are even suspicious of business needs that are in the forefront for entrepreneurs trying to bring nonwood products to the marketplace. Rather than always seeing these values in competition, those involved in these discussions have many opportunities to enlarge their understandings enough to incorporate many competing needs, in order to encourage development of the prototypes and systems necessary to build towards success.
- **Political** – U.S. economic values and capital systems that encompass only the most overt financial costs while disregarding environmental, social, infrastructure, and other non-monetary costs (often labeled "indirect costs") are encouraging the traditional paper industry to make almost all new investments outside of North America in order to be "competitive." This global focus by large companies could possibly increase opportunities for entrepreneurs who think locally and regionally, but they will likely be faced with the same sort of investment critiques and expectations that undermine domestic investments by large companies.

Subsidies to forestry and wood-based papermaking, as well as generous subsidies to paper companies in a number of other countries, discourage development of new types of papermaking facilities in the U.S. However, there are also bio-based research funds available through the U.S. Department of Agriculture (although these are often interpreted to apply to wood-based products) and other federal sources that could support some of the necessary nonwood research.

In addition, the current comments in the Listening Study suggest some specific steps that would help move these issues forward:

Research Evaluations

Much of the specific technical research necessary will be identified by those developing specific nonwood fiber sources. But there are some points that will make it easier for others to evaluate the data available, as well as which studies are sound foundations for choosing directions.

- **Address research study criticisms.** There are many reasons why studies of similar issues might show quite different results, or why researchers might arrive at very different opinions. But advocates, policymakers, purchasers, and other researchers deserve explanations so that they can effectively evaluate which studies to rely on. If calculations or conclusions are criticized, they should be actively addressed and substantiated. If there are errors, the data should be recalculated or withdrawn.
- **Provide transparency for opinion articles.** This field needs a solid footing in order to move forward. Some opinion pieces have substantiated their conclusions with compilations of statistics but not cited the background data that would let readers assess whether they agree that the statistics chosen for the compilations were appropriate.
- **Bring sustainable agriculture perspectives into the discussion.** Network with agricultural experts on paper issues, both to bring more of their knowledge into illuminating fiber sourcing

discussions and also to bring more of a paper perspective into their sustainable agriculture considerations.

Research Studies

- **Translate applicable studies**, particularly life cycle and environmental analyses, from other languages. Researchers in Japan, China, India, Thailand and other countries that have established expertise in nonwood papermaking have valuable information to add to North American evaluations of nonwood fibers.
- **Pursue life cycle analyses** of the nonwood fibers most likely to be used for papermaking in the U.S. and Canada. This will require also developing accepted frameworks for analysis. It may also require life cycle analyses of tree fibers in different contexts (e.g. old growth forests, sustainably certified forests, second- and third-growth forests, plantations) for comparison.
- **Explore incentives, disincentives and laws** that could alleviate concerns about converting forests to crops.
- **Determine whether potential nonwood pulps can be recycled.**

Processing

- **Develop solutions to the silica problem** that hampers pulping many types of nonwood fibers and bring them to production-scale applications.
- **Develop and build pulping mills** appropriate for specific nonwood fibers that will be used for papermaking.
- **Experiment with creative options** to the traditional large-scale mills developed by wood-based paper companies, particularly small-scale, regional and cooperative models.

Market Development

- **Support entrepreneurs' efforts** in developing specific nonwood papers, unless there are serious and proven environmental problems involved. Environmental obstacles should be solidly substantiated, not simply theorized.
The nonwood fiber pulp and paper markets are currently so miniscule that mixed messages or opposition from environmental groups can dissuade paper purchasers and undermine market development. Especially because nonwood fibers appear to be most successfully approached as regional sources, the more options allowed to develop, the better the possibility of developing thriving nonwood alternatives to wood-based pulps.
- **Develop a consensus** among environmental groups on which nonwood fibers they can support in a unified way. The process for reaching consensus should include a wide range of expertise, including agriculture and papermaking as well as forestry.