Why CEO's Don't Want to Hear about Nonwoods - or SHOULD THEY?

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INTRODUCTION

When we agreed to present this keynote paper at the 1998 North American Nonwood Fiber Symposium, we had decided to approach the topic from the perspective of what CEO's want from nonwood plant fibers for pulp and paper production; the original title for our presentation was "What the Pulp and Paper Industry Wants from Nonwood Fibers".

During the course of preparing the paper, however, we found that although there is growing interest in nonwood fibers, the pulp and paper industry as a whole is reluctant to embrace the use of nonwood fibers for a variety of reasons. Given this realization, we decided to address some of the key concerns expressed by the industry in relation to the potential use of nonwood plant fibers by North American pulp and paper mills.

CEO's today are faced with very much the same problems as may have been faced by industry leaders two centuries ago, regarding long-term fiber supply. The consumption of paper during the 18th century had increased dramatically, with books in wider circulation, the establishment of newspapers, the publication of weekly and monthly magazines, and the introduction of paper as a packaging material, not to mention its use in the wrapping of lead balls and powder for muskets.

Paper at the time was produced almost exclusively from textile waste and the rag shortage was so acute that in 1799 one Massachusetts mill produced writing paper which bore the watermark, "SAVE RAGS". Prior to wood being recognized as a viable alternative, every imaginable material was considered, from asbestos to potatoes.

Possibly the most incredible incident in the quest for alternative fiber resources in the 19th century was the use of mummy wrappings. I. Augustus Stanwood operated a mill in Gardiner, Maine and when the shortage of rag threatened his operations he imported several shiploads of mummies and threw the woven wrapping and papyrus filling into the beaters. The result was a coarse brown paper used by grocers, butchers and other merchants. (The only competition he encountered in purchasing the mummies came from the Egyptian National Railroad, as they used the well wrapped, compact mummies as their sole source of fuel for a decade!!)

An historic perspective on the problems with which we are faced today may give us some insights, as well as some comfort in knowing that our predecessors encountered similar circumstances and overcame them. Problems are, after all, opportunities in disguise.

The purpose of this presentation is to set the tone for these proceedings and in this paper we will try to provide responses to some of the major issues and assumptions associated with nonwood fiber use and, hopefully set the stage for the more in-depth papers which will be presented during this symposium.

THE ISSUES

- We have lots of wood and wastepaper in North America so why consider nonwoods.
- The quality of nonwood fibers is inferior to wood fibers.
- Furnish and Runnability
- Using nonwoods means capital expenditures.
- Using nonwoods will increase operating costs.
- Silica in nonwood fibers will impair or prohibit chemical recovery.

WE HAVE LOTS OF WOOD AND WASTEPAPER!!

It's commonly thought that the U.S. and Canada have lots of relatively low cost wood and a seemingly endless supply of wastepaper. It may be true that there are more trees in the U.S. today than fifty years ago and that, as the largest per capita consumer of paper in the world, the U.S. generates more wastepaper than any other country. However, will these fiber resources be sufficient over the long term?

Projected Global Fiber Consumption

During 1963 world consumption of paper and board was 165 million tonnes; in 1993 it had risen to approximately 253 million tonnes and current forecasts indicate that by 2010 consumption will rise to above 400 million tonnes per year.

Jaako Poyry (1) predicts that the total global consumption of papermaking fibers will increase from the current level of about 300 million tonnes in 1996/97 to approximately 425 million tonnes by the year 2010, an increase of 125 million tonnes. They project that the bulk of the new fiber requirement will be sourced from recovered paper. Is this realistic, or possible?

According to the American Forest & Paper Association, U.S. wastepaper recovery rates for corrugated and newsprint are already high at 73.5% and 62.8% respectively. The only area where significant increases in recovery rates may be achieved is in printing/writing papers which are being recovered at a rate of only about 25%. While an increase in the recovery rate for these grades may be possible through more effective office waste recovery systems, a significant amount of this paper is consumed in the home and is discarded with regular trash.

Furthermore, it is well established that recycling fiber weakens the fiber each time it is reprocessed. Increasing recovered paper content may place limitations on paper grades over time.

So, the big question is, where will the estimated 125 million tonnes of fiber needed by the years 2010 come from?

Wood Supply in the U. S. and Canada

At the 1995 TAPPI Global Fiber Symposium, Les Reed of FLC Reed & Associates (2) predicted a "probable downward course of timber availability in the next 25 years". Factors which will influence this downward trend include:

a) sharp curtailment of public timber sales in British Columbia and the US Pacific Northwest and Rocky Mountain regions

b) real price increases due to the cumulative impact of more costly harvesting and silviculture, regulatory compliance, stumpage increases and other factors.

c) lower quality timber from the average stand as the shift to less attractive stands and lower diameter wood continues into the foreseeable future.

The most significant feature of the projected supply figures for industrial roundwood is the decline in the coniferous wood supply. This decline is due mainly to reduced cuts in the U.S. Pacific Northwest and Rocky Mountain regions.

The implications of reduced coniferous wood supply will be significant if Jaako Poyry's prediction that the bulk of the increased fiber demand of 125 million tonnes by the year 2010 is met with increased recovered fiber, as it is coniferous wood fiber which provides strength to recycled paper.

Since the 1995 Global Fiber Supply Symposium it does not appear that the outlook has changed significantly. Robert Hagler (3) of Wood Resources International, Ltd. quoted at the recent Monitoring the Global Woodfiber Equation conference held in October 1997 in Washington, D.C. stated "The days of cheap, incremental increases in supply are over. Our outlook over the next two years includes a 5% to 10% increase in global wood fiber prices." Over the long-term he predicted that prices will rise significantly above historic levels.

Other issues may cause further limitations in the allowable cuts in U.S. National Forests. In 1995, U.S. National Forest Land totaled some 191 million acres(4). Timber harvest currently is permitted on 49 million acres. However, by the year 2000, forest-based recreation is expected to pump 100 billion dollars into the U.S. economy, compared with 3.5 million dollars from timber sales. The shear size of the recreation –based economy may provide more incentive to further restrict cutting in National Forests. Although these forests only represent about 17% of the U.S.'s timberlands, a dramatic reduction in cutting will have an impact on the pulp and paper industry.

The recent Kyoto Summit on global warming raised the issue that forests traditionally have been considered as carbon sinks which remove harmful carbon dioxide from the atmosphere. However, this may not be the case for Canadian forests according to Michael Apps, a senior research scientist for carbon and climate change response with the Canadian Forest Service (5). According to Mr. Apps, until 1970, Canadian forests were considered a net collector of carbon dioxide, but due to fire and insect damage by the late 1980's Canadian forests had become a source of carbon dioxide. Is the same happening in the U.S. and will this increase pressures for reduced timber cutting on federal lands?

The foregoing illustrates that North America can expect a decline in virgin wood fiber supply during the coming decades, which leads us to the topic of this symposium.

WHAT ABOUT NONWOOD FIBER SUPPLY?

Nonwood fibers can be classified in several manners. For supply side issues we have classified them into three categories:

- natural stands such as reeds and grasses
- fiber crops such as kenaf, hemp, bamboo and switch grass
- agricultural residues such as cereal straws, corn stalks, sugarcane bagasse and flax straw.

(This paper will not address natural stands.)

Agricultural Residues

The U.S. and Canada have an abundance of agricultural residues which could be used for pulp and paper production.

At the 1997 Nonwood Fiber Short Course, Bob Hurter (6) presented tables which provide the estimated availability of agricultural residue in the U.S. and Canada.

The difference between the U.S. estimates result from the methods of estimation used:

- Atchison's estimates are based on average field yields of collectable fibrous raw material and areas harvested

- White & Cook's estimates are based on grain production statistics and estimates of harvest indexes (ratio of grain to total above ground biomass).

Agricultural residues offer great potential as a fiber source for the pulp and paper industry, for example:

a) All of the wheat straw in the U.S. would produce about 25 million tonnes of hardwood substitute pulp assuming a 33% yield to account for storage, preparation, pulping and bleaching losses.

b) The residues offer different types of fibers which could be used for different applications.

However, the availability of agricultural residues must be carefully assessed for each project to account for:

a) regional distribution

b) raw material concentrations within regions

c) farming practices

Fiber Crops

Fiber crops offer the pulp and paper industry the potential to develop specific crops to meet their fiber quality requirements.

Fiber crops which could be considered in the U.S. include crotalaria, kenaf, bamboo, ramie, hesperaloe, and switch grass, to name a few.

Crops which could be considered in Canada are, among others, switch grass and industrial hemp.

The issues surrounding the use of agricultural residues and/or fiber crops are many and include both technical and economic matters. Most of the technical issues have been addressed and it is largely economic factors which may inhibit the broader use of nonwood fibers in North America. With a decrease in wood availability and wood cost increases, however, in increasing use of nonwood fibers may prove economically viable.

NONWOOD FIBERS ARE INFERIOR TO WOOD

There is a common misconception in the industry today that wood fiber somehow has intrinsic properties and characteristics which are superior to those of nonwood fibers. Needless to say, an examination of the chemical and physical properties of the fibers will elucidate the facts.

Directing our attention once again to the 18th and 19th century, when wood was only beginning to be considered for broad application within the industry, the same opinion prevailed regarding wood in the use of so significant an item as paper.

An issue of the *Boston News Letter,* of 1769, proclaimed –

Rags are as beauties which concealed lie,
But when in paper, how it charms the eye!
Pray save your rags, new beauties to discover,
For of paper, truly every one's a lover;
By pen and press such knowledge is displayed
As wouldn't exist if paper was not made.
Wisdom of things, mysterious, divine,
Illustriously on paper shine.

The first use of wood-pulp paper for newspaper printing in this country was the January 14th, 1863 issue of the *Boston Weekly Journal;* the *Daily Journal* of this date was printed on the regulation all-rag paper. Remaining copies of these papers bear evidence to the considerable difference in quality, the rag being much finer than the wood.

The first commercial use of groundwood pulp in the United States was in 1867, by the Smith Paper Company of Lee, Massachusetts. The product was considered "shoddy" and an inferior stock and although initially deemed unfit the prejudice was eventually overcome and, it was discovered that it had good printing qualities and that it lowered the cost of paper.

It appears that the earliest use of wood in regular newspaper editions was in the *New York Staats-Zeitung,* in January of 1868; this newspaper was using all wood paper entirely by 1870.

While groundwood offered an inexpensive product which could be employed in a vast range of uses, the need for a high quality, durable product at an intermediate cost between rag and wood, continued.

Early work on chemical wood pulp began in England ca. 1851 and a U.S. patent was secured in 1854. Chemical wood pulp met with the same prejudices as groundwood and only after a long battle was it possible to establish a mill of **large-scale** capacity, at 20 tonnes per day, with the formation of the American Wood Paper Co. The company became the leading producer of soda pulp, but eventually met with financial failure.

The continued efforts of men such as Tilghman, Ekman, Fry and Dahl eventually led to developments of chemical processes which were able to produce pulps which were both economically

viable and which had the properties and characteristics considered necessary for general use.

Following a long and turbulent struggle for recognition, wood ultimately made possible the incredible growth of the paper industry.

A writer on the subject of papers observed in 1869; "Endeavouring to make contrasts between the grades of papers from forty years ago and those of today is very difficult for the reason that the requirements of the publishers of today are so much greater than formerly, and it is very doubtful if the all-rag papers made long ago could now take the place acceptably filled by the all-wood papers of the present."

The paradigm shifted! Necessity resulted in the development and acceptance of an initially unacceptable concept through the continued effort to satisfy the demand for both quantity and quality. Wood, which was considered to be intrinsically inferior to linen and cotton rag as a furnish, was ultimately recognized as possessing the potential to satisfy the needs of the industry and of society at-large.

Our industrial history and the ongoing use of nonwood in the specialty paper sector should be indicative of the potential which exists for the use of non-woods in virtually every application. A review of the literature will disclose, as we shall see here today, that the range of nonwoods, their physical and chemical properties and the various technologies which may be applied, can be considered as offering qualities comparable to and surpassing those of the wood pulps to which we have grown accustomed.

The industry's relatively recent history discloses that southern pine was considered to be too resinous and therefore unacceptable to permit its pulping without encountering great difficulties. Dr. Charles Holmes Herty commented in 1931 that within five years the production of newsprint from southern pine would be entirely feasible; in 1933 nine Georgia newspapers were printing their regular editions on newsprint made from southern pine and in 1940 the Southland Mill at Lufkin, Texas was producing the first newsprint for continuous commercial consumption from this previously unacceptable wood source.

The producers of the range of specialty papers being manufactured today from nonwood fibers may attest to the levels of quality which are possible and when we consider the blending of nonwoods with recycled fibers, wood and other nonwood species we can begin to see a vast range of opportunities in which to effectively use these fibers.

FURNISH AND RUNNABILITY

Ultimately, it's the papermaker who must deal with the pulp provided to the headbox and the machine. What are the considerations which must be made when we have finally produced the pulp and conveyed it to the machine room?

These factors will vary from fiber to fiber and from application to application. If we are to use a nonwood pulp as a filler, or enhancer, there are likely to be few changes, if any, required in the headbox or in machine configurations, speeds and clothing.

If considering high percentages of relatively short fiber straw pulps we may be faced with a number of problems in dispersion, formation and drying which must be addressed in advance, with great specificity. In his presentation entitled *Agricultural Residues* at our Nonwood Fibers Short Course in October, 1997 Bob Hurter (6) covered many of the issues related to furnish and runnability of straw pulps succinctly and very effectively.

If we are planning the development of specific fiber crops, or; when we have access to a range of agricultural residues within the geographic range which permits economic feasibility, and/or we are using nonwoods in combination with virgin wood pulps or recycled pulps, the need for significant modification in either technology or equipment will be limited.

There is substantial enough evidence available today, from the use of the specialty, nonwood pulps as enhancers, to support the contention that the term ***nonwood fiber*** should not be alarming to the papermaker. Certainly, there is a learning curve through which one must move to fully understand the properties, characteristics and response to refining for each of the fibers to achieve the optimum results, however, with the capabilities of today's papermakers, coupled with the technology and equipment available, this will be limited.

The technology of papermaking has changed dramatically in recent years. Our preoccupation with machine speed has started to give way to a broader concept of efficiency and quality, with the advent of machine and mill quality control systems. The nonwood fibers not only present an additional source of material but offer the ability to more effectively differentiate products for the achievement of higher value-added product mixes.

USING NONWOODS MEANS CAPITAL EXPENDITURES

Generally, nonwood fiber raw materials cannot be processed into pulp using existing equipment designed to produce pulp from wood. Also, the design of a nonwood fiber pulping line will differ from raw material to raw material - for example, the requirements for processing cereal straw into pulp will be different from those for cotton linters or those for flax etc.

In assessing the merits of using a particular nonwood fiber, consideration must be given to:

a) raw material storage and handling as most nonwoods typically are bulkier than wood and do not come in the form of chips

b) preparation systems which will vary for various raw materials - for example, cereal straws will require cutting

and dry and/or wet cleaning versus kenaf which may be used as chopped whole stalk or decorticated bast fiber

c) stationary and continuous digesters used for wood do not work with nonwoods - either a continuous horizontal tube digester or batch rotary digesters will be required

d) brown stock washer sizing will differ significantly from washers used for woodpulp - conventional drop-leg vacuum washers would have three time the surface area for washing cereal straw or may be smaller for high freeness pulps such as flax

e) bleaching of nonwood pulps, however, typically is easier than woodpulp and requires fewer bleaching stages and lower chemical consumptions.

So, the answer is yes, capital expenditures will be required to process nonwood plant fibers at existing wood-based pulp and paper mills. In fact, a separate line likely will be required to provide the optimum pulp characteristics.

An exception which would require minimum capital investment is bamboo. Bamboo will produce chips similar to wood chips and can be pulped in existing stationary or continuous digesters used for pulping wood. In fact, it is possible to pulp bamboo chips in combination with wood chips. In this instance, a separate bamboo chip pile would be required, chip washing and a blending station to arrive at the required bamboo/wood blend.

USING NONWOODS WILL INCREASE OPERATING COSTS

The answer to this question is maybe yes, maybe no.

The factors which could increase operating costs include:

a) Smaller Mill Size

For various technical and economic reasons, nonwood pulp mills typically are smaller than woodpulp mills. For example, due to drainage rates, a washer which will process 1000 BDMT of woodpulp will only process about 300 BDMT of wheat straw pulp. Also, there are limits on the economic collection radius for nonwood fiber raw materials which will limit the size of the line which could be built. For example, the economic collection radius for cereal straws currently is about 100 - 150 km.

b) Operating Labor

Essentially, it takes the same number of people to operate a 1000 ton/day woodpulp mill as it does to operate a 300 ton per day nonwood pulp mill.

c) Debt Service

As the nonwood mill size is smaller, typically the debt service per ton of pulp produced is higher for a nonwood pulp mill than for a woodpulp mill.

Factors which decrease operating costs include:

a) Energy Consumption

Pulping nonwood fibers requires less energy than wood fibers.

b) Chemical Consumption

Pulping nonwood fibers requires a lower chemical charge than wood fibers.

Bleaching nonwood fibers is easier than wood fibers. Most nonwoods can be bleached to high brightness in short bleach sequences and using lower chemical charges.

Another factor which over time may improve the economics of the use of nonwood fibers will be increasing wood costs as discussed earlier.

The overall effect of using nonwoods on operating costs will have to be studied on a case-by-case basis as it will change depending on the raw materials, processes used, end products and line size.

SILICA IN NONWOODS WILL IMPAIR OR PROHIBIT CHEMICAL RECOVERY

As reported by Bob Hurter (6), nonwood plant fibers all contain varying amounts of silica. The amount of inherent silica which forms part of the plant structure will vary depending on soil conditions, climate and farming practices.

For the most part, nonwood raw materials contain higher amounts of silica than wood. During pulping, the silica is dissolved and enters the black liquor. High silica content in the black liquor results in various problems in the chemical recovery loop including:

a) increased black liquor viscosity at high solids concentrations

b) hard scales in the evaporator and hard deposits at various points in the recovery boiler

c) formation of colloidal gels in the recausticizing system that lower the settling rate

d) formation of glassy material in lime kilns

e) reduced slaking rate

With proper design throughout the pulp mill, all of the above problems can be addressed for most nonwood raw materials with

the exception of rice straw which has an exceptionally high silica content. Nevertheless, as you will learn in session 5, a considerable amount of work is on-going regarding chemical recovery of nonwood black liquor.

From a North American perspective, one should consider the implications of an add-on line to a wood-based pulp mill. If one were to add-on a 100 ton per day wheat straw pulping line to an existing 1000 ton per day woodpulp mill, what would be the implications of the higher silica content of the wheat straw to the black liquor.. Using an average 5.5% silica in the wheat straw and assuming that the wheat straw constitutes about 9% of the fiber input to the pulp mill, then the silica content of the total amount of fiber charged to the pulp mill - wood and wheat straw - would increase by about 0.5%. The question is would this cause any significant problems in the chemical recovery system if the black liquors from wood pulping and wheat straw pulping are combined prior to evaporation. In our opinion, it is unlikely that there would be any significant problems.

CONCLUSIONS

Through the next two days you will hear a great deal regarding the use of nonwood fibers and the potential they may offer in virtually every facet of our industry. We believe you will draw your own conclusions from what you hear, however, there will be substantive information which should support the overall concept that the use of nonwoods can be efficient, that they can enhance and replace wood and recycled furnish and, that these objectives can be achieved without recapitalizing our industry.

It will be incumbent upon you, the members of our industry to make the commitment and take the initiative necessary to bring these concepts to fruition. We must define our targets and begin to organize our efforts. We are, after all, not suggesting revolution, only the reconsideration of the origins of our industry in the use of nonwood fiber and the reintroduction of these fibers as sources of raw material as we move into the 21st century.

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The Issues

- We have lots of wood and wastepaper
- Nonwood fibers are inferior to wood
- Furnish and runnability
- Capital expenditures
- Increased operating costs
- Silica and chemical recovery

Global Papermaking Fiber Consumption - million tons

	Year	Consumption
Actual	1970	135
	1980	180
	1990	250
Projected	1998	300
	2000	330
	2010	425

Canadian Industrial Roundwood Projected Supply - million m^3

	Coniferous	Non-Coniferous
Production		
1990	146.4	17.0
1991	138.9	15.3
1992	142.2	17.0
Allowable Cut	166.7	53.1
Projected Supply		
2010	135.0	30.0
2020	150.0	45.0

U.S. Industrial Roudnwood Projected Supply - million m^3

	Coniferous	Non-Coniferous
Production		
1986	326.0	189.0
1991	304.0	194.0
Projected Supply		
2010	245.0	187.0
2020	265.0	196.0

1995 U.S. National Forests

million acres

Non-forested	51
No timber harvest permitted	91
Timber harvest permitted	49
Total area	191

Year 2000 Economic Gain from U.S. National Forests

Recreational uses	$100 billion
Timber sales	$3.5 billion

Wood Fiber Supply

- declining supply in specific regions - Pacific Northwest & Mountain
- U.S. National Forests only 17% of timber land but recreational use may decrease allowable cuts
- Canadian forests decline as carbon sink
- increasing global fiber shortages
- increasing wood fiber costs

Sources of Nonwood Fibers

- agricultural residues
- fiber crops
- naturally growing plants

U.S. Agricultural Residues

For 1994 (000 BDMT)

	Atchison	White & Cook
Straws		
Wheat	76,000	78,900
Rice	3,000	7,500
Barley	7,000	12,000
Oat	5,000	6,000
Rye	400	400
Grass seed	1,100	900
Flax (oilseed)	500	700
Subtotal straw	93,000	106,000

U.S. Agricultural Residues

For 1994 (000 BDMT)

	Atchison	White & Cook
Straws	93,000	106,000
Corn stalks	150,000	300,800
Sorghum stalks	28,000	33,700
Sugarcane bagasse	4,400	3,000
Cotton stalks	4,600	7,100
Cotton staple	3,500	3,500
Cotton linters	500	500
Cotton mote		200
TOTAL	284,000	455,200

Canadian Agricultural Residues

For 1996 (000 BDMT)

	Minimum	Maximum	Average
Corn stalks	7,944	9,788	8,870
Rye straw	480	672	576
Wheat straw	27,322	37,257	32,289
Barley straw	9,434	13,102	11,268
Oat straw	3,681	5,113	4,397
Flax straw	592	888	740
TOTAL	49,453	66,830	58,140

Nonwood Fiber Potential

- agricultural residues offer a huge potential fiber resource
- U.S. wheat straw alone could produce about 25 million tonnes of hardwood substitute pulp
- agricultural residues offer different types of fibers which could be used for different applications
- fiber crops increase the fiber alternatives

Agricultural Residues

Long fibers	oilseed flax (bast)	- U.S. & Canada
	cotton linters	- U.S.
Short fibers	cereal straws	- U.S. & Canada
	rice straw	- U.S.
	grass seed straw	- U.S.
	bagasse	- U.S.
	corn stalks	- U.S. & Canada
	sorghum stalks	- U.S.

Potential Fiber Crops

Long fibers	kenaf (bast)	- U.S.
	hemp (bast)	- Canada & U.S.
	ramie (bast)	- U.S.
	bamboo	- U.S.
	hesperaloe	- U.S.
Short fibers	kenaf (core)	- U.S.
	hemp (core)	- Canada & U.S.
	ramie (core)	- U.S.
	bamboo	- U.S.
	switch grass	- U.S. & Canada

Rags are as beauties which concealed lie,
But when in paper, how it charms the eye!
Pray save your rags, new beauties to discover,
For of paper, truly every one's a lover;
By pen and press such knowledge is displayed
As wouldn't exist if paper was not made.
Wisdom of things, mysterious, divine,
Illustriously on paper shine.

Boston News Letter, 1769

Capital Expenditures Required

- most nonwoods cannot be pulped using equipment designed for wood
- system design will differ for different nonwoods
- separate system for storage, preparation, pulping and bleaching
- bamboo is the exception

Operating Costs

- factors increasing costs:
  - mill size
  - labor
  - debt service
- factors decreasing costs
  - lower energy consumption
  - lower pulping & bleaching chemical consumption
- future costs of wood versus nonwoods

Silica & Chemical Recovery

- nonwoods contain more silica than wood - cotton linters is the exception
- silica causes problems throughout the recovery system
- 9-14% silica in rice straw makes conventional recovery impossible

Silica & Chemical Recovery

- silica manageable in most other cases
- silica may not be a major problem if the nonwood line is added to a large wood pulp mill
  - a 100 t/d wheat straw pulping line added to a 1000 t/d pulp mill would add about 0.5% silica to the combined black liquor