STRATEGIC MARKET MANAGEMENT SYSTEM
PULP AND PAPER

June 25, 2002

by

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Preface

In February 2002, the author was contracted by Prairie Research Associates (PRA) Inc., of Winnipeg, Manitoba to prepare an overview document of the Canadian Pulp and Paper industry and the opportunities and problems of using nonwood plant fibres within the industry.

This report would be one of 15 companion documents to an Agriculture and Agri-Food Canada (AAFC) funded study, **Non-food/Non-feed Industrial Uses for Agricultural Products**, for which PRA was the prime contractor.

This report can also be viewed in the Special Crops section of the AAFC web site at the following URL:

http://www.agr.gc.ca/misb/spcrops/sc-cs_e.php?page=pulpandpaper-patesetpapiers#s1_1

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1. Pulp & Paper - A Global Industry

Historically, nonwood plant fibres were the only fibre raw materials used for producing pulp and paper. During the 18th century, paper consumption 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. Paper at the time was produced almost exclusively from textile waste (linen and cotton) and the rag shortage became so acute that in 1799 one Massachusetts mill produced writing paper with the watermark, "SAVE RAGS". Prior to wood being recognized as a viable alternative, every imaginable material was considered, from asbestos to potatoes. In the mid 1800's cereal straws, primarily wheat straw, began to emerge as a major fibre resource which was suitable for papermaking, the pulp being processed using the soda process. During the same time frame, the fibre raw material shortage became so acute that extensive work was being carried out on developing processes for the use of wood fibres in pulp and papermaking. In Germany, Carl Dahl invented the kraft process in 1884 and it was first used to produce paper from sugar cane bagasse. However it was 1909 before the first kraft paper was produced in North America from wood fibres. During the 1920's work on improving the kraft process for producing good quality woodpulps started the trend which has resulted in the dominance of wood as the primary fibre raw material globally used for pulp and paper production.

Thus, in a period of about 100 - 150 years, the global pulp and paper industry made two significant and dramatic shifts to meet rising demand for paper products:

1) from an industry based almost entirely on nonwood plant fibres as the fibre raw material supply to one based primarily on wood as the main fibre raw material, and

2) from an industry based on small scale local and regional mills in which papermaking was more of an art than a science to an industry based on very large scale mills in which papermaking science and chemistry plays a significant role and which serve global markets

Today, the pulp and paper industry is a global industry producing mainly commodity products in large scale facilities using wood as the primary fibre raw material. It is a diverse industry which produces a wide range of pulp, paper and paperboard products to meet specific end user requirements. Of course, given the diversity of the industry, smaller specialty mills producing high end specialty paper products still remain within the industry; however, in terms of total global output these mills only amount to a very small segment of the global market.

Of total global papermaking capacity, Atchison[1] estimated that about 89% of all papermaking is done using wood fibres leaving only about 11% produced using a variety of nonwood fibres. The largest users of nonwood fibres for papermaking are China (about 74% of world nonwood pulping capacity), India (8%), Pakistan (2%) and the US (1.6%) with all remaining countries at less than 1.1% of available capacity.

Per Table 1, in 1997, Paavilainen[2] predicted that total global consumption of papermaking fibers would increase from about 300 million tonnes for 1998 to about 425 million tonnes by the year 2010, an increase of 125 million tonnes and that the bulk of the new fiber requirement would come from recovered paper. One may ask is "How good were Paavilainen's predictions?"

1 Atchison, Joseph E., "Update on Global use of Non-Wood Plant Fibres and Some Prospects for their Greater Use in the United States", 1988 TAPPI North American Nonwood Fibre Symposium Proceedings, p. 13-42.

2 Paavilainen, Leena, "Non-Wood Fibres In Paper and Board grades - European Perspective", 1997 TAPPI Nonwood Fibres Short Course Notes.

Table 1 Global papermaking fiber raw material consumption

	Year	Consumption (million bone dry metric tonnes)
Actual	1970	135
	1980	180
	1990	250
Projected	1998	300
	2000	330
	2010	425

The Pulp & Paper International Annual Review 2001[3] established that the world's paper and paperboard producers achieved a total output of 323 million metric tonnes during the year 2000. However, this tonnage of paper and board includes not only the pulp produced from papermaking fibre raw materials but also moisture and various additives. Table 2 provides the total global pulp production in the year 2000 from the Annual Review and an estimate of the papermaking fibre raw materials required to produce this pulp.

Table 2 2000 global pulp production & estimated papermaking fiber raw material consumption

Pulp Grade	Year 2000 Production (million metric tonnes)	Estimated Papermaking Fibre Raw Material Consumption (million bone dry metric tonnes)
Chemical pulp	129.8	259.6
Mechanical pulp	37.1	39
Other pulp	21.7	43.4
Total pulp	188.6	342

Notes:
1. Chemical pulp includes semi-chemical pulp
2. Deinked Pulp (DIP) included with "Other pulp"
3. "Other pulps" also include total pulp production in countries which did not specify a grade breakdown.
3. Pulp yields on papermaking fibre raw materials used to estimate consumption were estimated as 50% for "Chemical pulps" which include bleached and unbleached full chemical and semi-chemical pulps, 95% for "Mechanical pulps", and 50% for "Other pulps".

The Estimated Papermaking Fibre Raw Material Consumption given in the above table is a rough estimate and the scope of this study does not permit a more accurate estimate. Given the margin of error, it would appear the Paavilainen's prediction for papermaking fibre raw material consumption was a reasonable prediction for the year 2000 and that it is conceivable that the demand for fibre could increase to 425 million bone dry metric tonnes by the year 2010.

3 Pulp & Paper International, Annual Review, July 2001

Paavilainen's other prediction - that most of the new fibre demand would come from recovered paper - however may not be as close as that for fibre demand. The single largest global source of recovered paper is the United States. According to the American Forest & Paper Association, US wastepaper recovery rates for corrugated and newsprint are about 75% and 65%, respectively. The only other area where significant gains may be achieved appears to be printing and writing papers, currently recovered at a rate of about 25%. Some improvement in recovering these grades may be possible through more effective office waste recovery, but a large amount is consumed in the home and discarded in regular trash.

Given current paper recovery rates, it is unlikely that recovered fiber will be able to meet all of the projected growing fibre demand so, the question is, "Where will we find an additional 100 - 125 million tonnes of fiber needed by 2010?"

The likely answer is that all fiber resources will be required to meet future demand including fast growth wood plantations, increased paper recovery and nonwood plant fibers from crop residues as well as fiber crops.

2. Nonwood Plant Fibres - Availability, End-Uses, Technology

When assessing nonwood plant fibres, it is important to understand that there is a huge diversity of plant materials available which could be used to produce pulp and paper. It is also important to understand that this diversity of plant fibre raw materials offers a wide range of fibre characteristics and that paper makers can use specific nonwood plant fibres to impart desirable properties to their finished products.

2.1 Availability in Canada and the US

From a supply side perspective, nonwood plant fibre raw materials can be broadly classified into three categories:

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

2.1.1 Agricultural Residues

Within the Canadian and US context, agricultural residues provide the bulk of the nonwood plant fibre raw material currently available.

Table 3 provides Hurter's[4] estimates for agricultural residues available in Canada which could be used for pulp and paper production.

4 Hurter, Robert W., "Agricultural Residues", 1997 TAPPI Nonwood Fibers Short Course Notes.

Table 3 Estimated availability of agricultural residues in Canada

Raw Material	Estimated Annual Availability (bdmt)		
	Minimum	Maximum	Average
Corn stalks	7,944,000	9,798,000	8,870,000
Wheat straw	27,322,000	37,257,000	32,289,000
Barley straw	9,434,000	13,102,000	11,268,000
Oat straw	3,681,000	5,113,000	4,397,000
Seed flax straw	592,000	888,000	740,000
Rye straw	480,000	672,000	576,000
Note: bdmt means bone dry metric tones			

The amount available will vary from year to year depending on many factors such as what framers decide to plant each year, climate conditions etc.

If all of the wheat straw were available for pulp production, the average amount available in Canada each year could produce about 11 million bone dry metric tons of bleached chemical straw pulp suitable for papermaking.
However there are other considerations which need to be addressed when considering the use of agricultural residues for pulp and paper such as:

- competing uses for the nonwood material - i.e. in Alberta, a considerable amount of the available straw is used as fodder for the cattle industry
- the economic collection radius of the nonwood material - typically the economic collection radius is limited to about 100 - 150 kilometres for bulky materials such as straw
- field trash especially plastics which may make collection from fields close to well travelled roads and to towns and cities unacceptable

The US also has an abundance of agricultural residues which could be used for pulp and paper production. Given that the continental US offers a wider range of climates, it also offers a wider range of potential agricultural residues which can be used for pulp and paper. Table 4 offers two estimates of the total annual amount of agricultural residues produced in the US The difference between the estimates result from the methods of estimation used: Atchison's[5] estimates are based on average field yields of collectable fibrous raw material and areas harvested, and the USDA estimates by Rowell & Cook[6] are based on grain production statistics and estimates of harvest indexes (ratio of grain to total above ground biomass).

Although the US has about twice as much cereal straw as is available Canada, corn stalks may provide a higher potential both in terms of availability and also a higher biomass yield per hectare which will help to reduce the collection radius for a given project.

5 Atchison, Joseph E., "Update on Global use of Non-Wood Plant Fibers and Some Prospects for their Greater Use in the United States", 1998 TAPPI North American Nonwood Fiber Symposium Proceedings, p. 13-42.

6 Rowell, R.M. and Cook, C., Types and Amounts of Nonwood Fibers Available in the US", 1998 TAPPI North American Nonwood Fiber Symposium, p. 43-47.

Table 4 Estimated US availability of agricultural residues (bone dry metric tons)

Raw Material	Atchison	USDA
Straws		
Wheat	76,000,000	78,900,000
Rice	3,000,000	7,500,000
Barley	7,000,000	12,000,000
Oat	5,000,000	6,000,000
Rye	400,000	400,000
Grass seed	1,100,000	900,000
Flax (oilseed)	500,000	700,000
Subtotal Straw	93,000,000	106,400,000
Corn stalks	150,000,000	300,800,000
Sorghum stalks	28,000,000	33,700,000
Sugarcane bagasse	4,400,000	3,000,000
Cotton stalks	4,600,000	7,100,000
Cotton staple	3,500,000	3,500,000
Cotton linters	500,000	500,000
TOTAL RESIDUES	284,000,000	455,000,000

2.1.2 Fibre Crops

By comparison to agricultural residues, fibre crops globally have traditionally been planted for other purposes such as ropes, twine and carpet backing. These crops however also produce fibres which have exceptional papermaking properties and which are used in high value paper products. Table 5 provides Atchison's [7] estimates for global fibre crop production.

Table 5 Estimated global fiber crops

Raw Material	bdmt
Stem Fibers (jute, kenaf, hemp, textile flax etc.)	
whole stalk	13,700,000
bast fiber	3,000,000
Leaf Fibers	
sisal, henequen, maguey	500,000
abaca (Manila hemp)	80,000

7 Atchison, Joseph E., "Update on Global use of Non-Wood Plant Fibers and Some Prospects for their Greater Use in the United States", 1998 TAPPI North American Nonwood Fiber Symposium Proceedings, p. 13-42.

In the US work on fibre crops especially kenaf has been ongoing since the early 1950's. This was the result of World War II which saw the US cut off from its sources of rope and twine and a desire to develop a domestic source of fibre for these products. Despite massive funding over the past 50 years into the research and development of kenaf for multiple uses including pulp and paper, the kenaf industry has never really gotten off the ground and no commercial pulp and paper operations are in place in the US today. More recently, interest in farming other nonwood plants including bamboo (temperate species) in North Carolina and *Arundo donax* in the southern and some western states has developed.

On the Canadian scene, the introduction of legislation to permit growing industrial hemp has seen the development of a fledgling but struggling industry in southern Ontario as well as hemp farming in the Prairie Provinces. The economics of hemp for pulp and paper production still needs to be determined. Also, efforts have been made to reintroduce textile flax in Quebec with limited success (the flax tow is used for specialty papermaking).

2.1.3 Summary

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 the resulting increase in wood cost, use of nonwood fibers may prove economically viable.

Agricultural residues offer a huge potential fiber resource for the pulp and paper industry. For example, as mentioned previously, all of the wheat straw in Canada would produce about 11 million tonnes of hardwood substitute pulp assuming a 35% yield to account for storage, preparation, pulping and bleaching losses. And, residues offer different types of fibers which could be used for different applications. Adding fiber crops such as hemp further increase the potential to develop specific pulps to meet specific quality requirements.

2.2 Nonwood Plant Fibre Classification by Potential End Use

Generally, nonwood plant fiber raw materials also can be grouped into two broad categories depending on the type of pulp which can be produced:

- “common” nonwoods or hardwood substitutes such as cereal straws, sugarcane bagasse, bamboo, reeds and grasses etc.

- “specialty” nonwoods or softwood substitutes such as cotton staple and linters, flax, hemp and kenaf bast fibers, sisal, abaca, bamboo etc.

As with wood, there are differing chemical and physical properties within the two groups depending on the nonwood fiber raw material. Additional information regarding physical and chemical properties of various nonwood plant fibres can be found at http://www.hurterconsult.com/nonwood_characteristics.htm

Generally, while the physical properties of the common nonwoods are similar to hardwoods, the common nonwoods have a lower alpha cellulose and higher hemicellulose content as compared to hardwoods. The implication is that the common nonwoods will have a lower pulp yield than hardwoods which has economic implications. The other issue which must be considered is that the common nonwoods have an inherent silica content which is higher than that of wood and this silica can cause operational problems as discussed later.

Also, typically the specialty nonwoods have physical properties superior to softwoods and can be used in lower amounts in the furnish when used as a softwood substitute.

Table 6[8] lists some currently available agricultural residues and potential fiber crops for Canada and the US and their potential as substitutes for either softwood or hardwood.

Table 6 Nonwood fiber classification by potential end-use

Currently available agricultural residues		
Long fiber softwood substitute	cotton linters	US
	oilseed flax (bast)	US & Canada
Short fiber hardwood substitute	sugarcane bagasse	US
	cereal straws	US & Canada
	corn stalks	US & Canada
	grass seed straw	US
	rice straw	US
	sorghum stalks	US
Potential fiber crops		
Long fiber softwood substitute	bamboo	US
	hesperaloe	US
	hemp (bast)	Canada
	kenaf (bast)	US
	ramie (bast)	US
	textile flax (tow)	US & Canada
Short fiber hardwood substitute	bamboo	US
	hemp (core)	Canada
	kenaf (core)	US
	ramie (core)	US
	switch grass	US & Canada

8 Hurter, Robert W., "Will Nonwoods Become an Important Fiber Resource for North America?", 1998 World Wood Summit, Aug. 31 - Sept. 2, 1998 Chicago, Illinois

The current uses of nonwood pulps[9] include virtually every grade of paper produced including, but not limited to:

- printing and writing papers
- linerboard
- corrugating medium
- newsprint
- tissue
- specialty papers

For a more extensive list of the potential uses of nonwood fibers in paper production, please refer to http://www.hurterconsult.com/nonwood_uses.htm

Typically, common nonwood pulps or hardwood substitutes are produced in integrated pulp and paper mills located fairly close to the available fibre supply as the bulky nature and low bulk density of most of the common nonwoods such as cereal straws and corn stalks prevents long distance trade. Softwood kraft is added to provide the strength requirements to the paper. In some cases, wastepaper pulp is blended in the furnish. The nonwood portion can vary from 50 to 90% and even up to 100% depending on the grade and required quality. The possible combinations are endless and can be adjusted to meet market requirements.

Specialty papers such as currency, cigarette papers, tea bags, dialectric paper etc. may be made from a furnish of 100% nonwood specialty pulps. These pulps may be produced on-site in an integrated pulp and paper mill or in a stand-alone paper mill using purchased pulp supplied by one of a very few specialty pulp mills. Unlike the common nonwoods, high value bast and leaf fibers such as flax and hemp bast fiber, abaca and sisal are traded globally and are being used to produce high quality specialty market pulps. Although these fiber raw materials are costly, as they are used in specialty pulp and paper production, the cost is absorbed in the end-product price.

Combinations of common and specialty nonwood pulps will permit the production of virtually any grade of paper to meet any quality requirements demanded in the global market. Adding possible combinations which include wood pulp, nonwood pulp and recycled wastepaper pulp increases the possibilities for developing paper with specific sheet properties designed to meet specific customers needs.

Furthermore, nonwood pulps can be used as an additive to wood-based papers for a variety of reasons such as:

- to provide the papers with certain specific desired properties - i.e. production of ultra lightweight papers, or papers with increased opacity or better bulk etc.
- to offset higher wood costs
- to provide an incremental increase in mill capacity in a region where woods resources are finite.

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9 Hurter, Robert W., "Nonwood Plant Fiber Uses in Papermaking", September 2001, http://www.hurterconsult.com/nonwood_uses.htm

2.3 Technology & Economic Considerations

The issues surrounding the production of pulp and paper using agricultural residues and/or fiber crops are many and include both technical and economic matters. A vast body of knowledge has already been developed on the use of nonwood plant fibers. Many of the technical questions raised below have been addressed many times in many countries throughout the world by engineering consultants and equipment suppliers with expertise in the use of nonwood plant fibers. As this expertise can be brought to projects in North America, it is not necessary to completely reinvent the technology for use in North America. And, with a decrease in wood availability and the resulting increase in wood costs, using nonwood fibers may prove economically viable.

Although nonwood plant fibers can be used to produce a wide range of pulp and paper products, there are a number of issues relating to their use which must be considered by the North American pulp and paper industry.

2.3.1 Nonwood plant fiber raw material supply

Assuring a sustained long term nonwood fiber supply is critical. Some issues which must be considered are:

- What is the regional distribution of the nonwood raw material? For example, although there is an estimated 32 million bone dry metric tons of wheat straw in Canada, in which Provinces are there concentrations of wheat straw which could support a project?
- What is the local distribution of the nonwood raw material - i.e. in which counties are there sufficient quantities of the selected raw material within a reasonable collection radius of the mill site?
- What are average amount of the raw material produced in a given year and the amounts produced when there is drought or other crop failures - i.e. if there is a drought or flooding, will there be enough raw material to continue operating the mill?
- If there is a crop failure of the primary nonwood fibre raw material, are there other nonwood raw materials within a reasonable collection radius which could be used?
- What are typical farming practices used in the project area regarding tillage and erosion control which may reduce availability?
- What are other uses for the raw material such as animal feed and bedding or other industrial uses which could impact on fiber supply?

As the bulky nature of most common nonwoods restricts the economic collection radius to about 80 to 150 kilometres, the key is to determine various locations with sufficient nonwood raw material at a reasonable cost to support a mill over the long term even under the most severe conditions of partial crop failures. Also, one must consider what alternatives may be available if there is a total crop failure of the selected nonwood raw material.

2.3.2 Nonwood fiber harvesting, transportation & storage

Most nonwoods are annual crops which must be harvested in a 6 to 8 week period and then stored for an entire year. Some issues which must be considered include:

- Is there sufficient existing baling equipment of the type required to provide for the pulp mill's raw material requirements, or will the mill have to provide additional equipment?
- Will all of the raw material requirement for a full year be delivered to the mill and stored on-site or will farm storage be used for much of the raw material? The response to this has a significant impact on the land requirements for the proposed mill, and the capital and the working capital requirements.
- If farm storage is used, will the location of the storage piles be accessible year round? In a Canadian climate, consideration must be given to snow storms and to potential flooding in some locations.

- Can the local infrastructure support the truck traffic if all of the raw material is delivered to the mill during harvesting?
- Will covered storage be required both on-site and in remote locations? Covered storage can be expensive and in some cases where wind is an issue impractical.
- What are typical transportation and storage losses? Transportation and storage losses are often overlooked and can have a significant impact on the amount of raw material required and the economics of the project.

Responses to the above and other questions affect issues such as the on-site storage area requirements, on-site material handling, quality control, capital expenditures and working capital requirements.

2.3.3 Nonwood plant fiber raw material preparation

Debarking, chipping and chip screening and washing are well established for wood pulping. However, wood chip preparation systems do not work for nonwoods with the exception of bamboo which can be processed in modified wood chippers.

Similarly, there are well established systems for preparing nonwood plant fiber raw materials prior to cooking. As there is a wide range of nonwood plant fiber raw material types which are delivered in various forms and which contain various amounts of non-fibrous material, there is a wide selection of nonwood fiber raw material preparation systems. For example,

- cereal straws must be chopped and then dry cleaned or wet cleaned or dry and wet cleaned.
- sugarcane bagasse is moist depithed, wet cleaned, put in storage and then wet cleaned again before pulping
- bast fiber plants such as flax, kenaf and hemp may be decorticated to extract the bast fiber for pulping, or kenaf or hemp may simply be chopped and pulped whole.

Selection of the most appropriate preparation system will depend on the nonwood fiber raw material and the end-product to be produced.

Also, it is critical to be aware of the losses which occur in storage and in the nonwood raw material preparation system. Incorrect assessment of these losses typically has been one of the main reasons for the economic failure of nonwood plant fiber pulp and paper mills.

2.3.4 Pulping technology

Pulping equipment used to produce woodpulp typically is not suitable for pulping nonwoods. Again, bamboo chips are the exception. Nevertheless, pulping technology for nonwoods is well established.

The kraft, soda and sulfite processes are used throughout the world to produce a range of semi-chemical and chemical pulps from a wide range of nonwood raw materials. Unlike wood, the characteristics of pulps produced using the kraft and soda process are similar and the process selection is based mainly on make-up chemical cost and availability. Most nonwoods currently are pulped using the soda process, but there is no reason why the kraft process could not be used.

Nonwoods may be pulped using either batch rotary digesters or continuous horizontal tube digesters. It is likely that any significant project built in Canada which uses common nonwoods such as cereal straw would use continuous horizontal tube digesters that will produce cereal straw chemical pulps in 15 to 20 minutes.

In addition to commercially established technologies, there are a many new “emerging” pulping technologies which may be applied to pulping nonwood raw materials. Most of these technologies have been tested in the laboratory, a few have reached the pilot plant stage and a very few have been used in commercial installations. Emerging pulping technologies include but are not limited:

- Straw Pulping Technology (STP)[10] process which is an atmospheric cooking process using proprietary equipment that was installed at the SAICA mill in Spain to produce high yield semi-chemical wheat straw pulp for corrugating medium and linerboard. The straw pulp was mixed with wastepaper pulp in a 25:75 ratio. The mill which had four operating 100 ton/day wheat straw pulping lines has closed the pulping lines due to straw procurement problems and the lines have been sold to China. It should be noted that the same semi-chemical pulp can be produced using a traditional soda process in a continuous horizontal tube digester.

- Extrusion pulpers[11] contain twin intermeshed screws with reversed sections to create zones of compression and decompression. The combined unit operations of fiber separation, fiber shortening, washing and bleaching can be carried out in a single pass. Units can come in small sizes suited to mini-mills (less than 100 tpd). There are commercial operations producing cotton linters pulps for specialty applications such as currency but nine are operating on the common nonwoods.

- The NACO process[12] was first installed at Foggia, Italy in 1982 to process wheat straw and recycled fibre pulps. This mill and one other owned by the same group remain the only commercial installations. The process includes specially designed turbopulpers and cooking is carried out using a sodium carbonate/sodium hydroxide liquor under a pressurized oxygen atmosphere. The mill only includes a two stage hypochlorite bleach plant which produces 70-72 %ISO brightness pulps. Laboratory testing on other bleaching sequences including chlorine free bleaching indicate that higher brightness is possible. Questions have been raised regarding the effect of the intense mechanical action on drainage characteristics of straw pulps and the system used to charge and discharge the turbopulper raises questions concerning pulp uniformity. Tests on wheat straw pulp from the Foggia mill conducted by Domtar in the early 1990's indicated that the pulp was unsuitable for high quality communications grade papers due to low brightness and high dirt content but these issues may be correctable with a capital investment in the mill.[13]

- Solvent pulping has been applied to nonwood plant fibers in laboratory test work. There are several solvent pulping processes such as the Organosolv process developed in Germany, the Alcell process developed in Canada and the Krotov process developed in the Ukraine. To date, none of theses processes has been used commercially.

  ALCELL[14] is an ethanol-based process which not only produces pulp but also has several other products including pure lignin, acetic acid, furfural and xylose. The process has been demonstrated on hardwoods in a 30 t/d commercial-size test plant located at Miramichi, NB, Canada. Laboratory tests have shown that the process is well suited to batchwise pulping of nonwood plant fibers and it is estimated that a mill processing 100 tpd of straw (15% moisture) would produce about 2,500 kg of acetic acid, 1,700 kg of furfural, 6,750 kg of hemicellulose sugars, 11,000 kg of lignin, and 49 admt pulp fiber. The process is mildly acidic and most of the silica remains with the pulp and the

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10 Hurter, Robert W., "Agricultural Residues", 1997 TAPPI Nonwood Fibers Short Course Notes.

11 Hurter, Robert W., "Agricultural Residues", 1997 TAPPI Nonwood Fibers Short Course Notes.

12 Hurter, Robert W., "Agricultural Residues", 1997 TAPPI Nonwood Fibers Short Course Notes.

13 Personal communication.

14 Hurter, Robert W., "Agricultural Residues", 1997 TAPPI Nonwood Fibers Short Course Notes

dissolved silica leaves the system with the other co-products of the unbleached pulp. Possible problems relating to the process include: stringent engineering requirements necessary for an explosion proof system, economics of the process are dependent on co-products, batch digesting of straw cannot be carried out in stationary digesters as is the case with wood chips because the wetted/wilted straw will pack in the digester in a manner which will either block liquor flow or will cause channelling, a question remains as to whether or not the process could be adapted to rotary batch digesters or to horizontal tube digesters. The other solvent pulping processes also have the same possible problems.

- Potassium-based pulping liquors were developed in Germany over 70 years ago. In recent times, a potassium-based pulping process was patented by Wong, and a 20 tpd pilot plant has been built in Vulcan, Alberta by ARBOKEM.[15, 16] Process details have not been disclosed; however, based on published information, it appears that a mixture of potassium sulphite, potassium hydroxide and anthraquinone is used as the cooking liquor for batch pulping in a globe rotary digester followed by TCF bleaching. The process produces both pulp and a potassium-sulphur liquid fertilizer supplement solution. Detailed information has not bee made available and various issues remain outstanding including among others:

  - the effect of the fertilizer supplement on soil characteristics at various locations
  - the storage of liquid fertilizer on a large scale
  - the economics of the process

- Steam explosion pulping technology[17] from StakeTech which was installed at a pilot facility at the Weyerhaeuser Springfield Oregon mill to produce pulp for corrugating medium from rye grass straw - the pilot trial showed that the pulp could be used but due to current economic considerations this pilot plant has been closed.

- The nitric acid chemimechanical pulping process[18] in which straw is first treated with a mild nitric acid charge at atmospheric pressure in a continuous digester and then with caustic soda in a second continuous digester followed by bleaching. Even after bleaching, the chemimechanical (CMP) straw pulps produced have opacities and strengths close to groundwood, and satisfactory newsprint has been produced on a pilot plant scale from 80% nitric acid CMP straw pulp; however, the process has not been applied commercially.

- Research work on using the alkaline peroxide mechanical pulp (APMP) process for wheat straw has been carried out in China and in Alberta; however, it remains in the very preliminary stages. Some unpublished results indicate difficulties in achieving acceptable brightness.[19]

- Research work to produce a blended industrial hemp / hardwood bleached chemimechanical pulp (BCTMP) has been carried out at the Alberta Research Council in collaboration with Tembec. This work, reported at the 2002 PAPTAC Annual Meeting in Montreal on January 29, 2002, shows that

15 Hurter, Robert W., “Agricultural Residues”, 1997 TAPPI Nonwood Fibers Short Course Notes.

16 http://www.agripulp.com

17 Hurter, Robert W., “Will Nonwoods Become an Important Fiber Resource for North America?”, 1998 World Wood Summit, Aug. 31 - Sept. 2, 1998 Chicago, Illinois

18 Hurter, Robert W., “Agricultural Residues”, 1997 TAPPI Nonwood Fibers Short Course Notes.

19 Hurter, Robert W., “Agricultural Residues”, 1997 TAPPI Nonwood Fibers Short Course Notes.

the hemp addition can provide some interesting value-added properties to the Tembec's BCTMP. The next step will be a commercial trial.

- The Universal Pulping (UP) process[20] is a two-stage acid/alkaline pulping process which claims to separate lignocellulosic materials into the three basic components - lignin, cellulose and hemicellulose. The nitric acid first stage uses low acid concentrations at 80-100^{0}C. After the acid stage, alkali is added and the pulp is cooked in the second stage. Spent liquor from both stages may be recycled several times with only modest make-up chemicals. Bleed-offs from both spent liquor systems may be combined and the combined spent liquors may be used as a fertilizer supplement or treated before discharge form the mill. Laboratory and pilot plant test work was carried out during the 1970's in Germany and Egypt and verification work on the process was carried out in the late1990's at North Carolina State University. There are no commercial operations at this time.

- The Williams & Jelks process is another two-stage nitric acid/alkaline process. The key difference with the UP process is that the Williams & Jelks process uses higher temperatures on both stages (115^{0}C in the acid stage and 160^{0}C in the alkaline stage) and higher acid concentrations. Most of the laboratory/pilot scale work relating to this process has been carried out on kenaf; however, claims are that it should work with cereal straws. There are no commercial operations at this time.

- The Natural Pulping[21] process is a new process which uses formic acid as the pulping chemical. Laboratory and pilot plant work indicate that it is well suited the nonwood plant fibers; however, the issue of recovering the formic acid from the spent liquor still needs to be resolved. This process offers interesting possibilities for the future.

- The newly patented low energy EAZy[22] process which uses a mild alkaline extraction stage followed by a unique ozone application stage (previously ozone had been thought to cause severe damage to nonwood pulps) and then either ECF or TCF bleaching. The process concept is to use currently available equipment and machinery as well as concepts from existing process technology but reconfigured in a new manner and with new process conditions that will allow good quality pulp production from nonwood plant fibres. The process has been tested in the laboratory and pilot plant but no commercial facilities are in operation. The first mill which will use the process is currently being planned for the US Mid-West and will use corn stalks as the nonwood fibre raw material.

In addition to the foregoing, other processes which have been tested to some extent in the laboratory include the batch Milox process, biopulping and the dilute ammonia process.

In summary, there are many methods in which nonwood plant fibres can be pulped using both the traditional soda, sulphite and kraft technologies as well as any number of the emerging technologies. The bottom line for process selection will be the particular circumstances of a specific project. A few examples could be:

a) If the project is the addition of a straw pulping line to an existing integrated kraft pulp and paper mill, then the likely process selected for pulping the wheat straw will be the kraft process.

b) If the project is a new stand-alone flax or hemp market pulp mill, then the process selection is open to many considerations but it likely would be either a kraft or soda process and most likely a soda or soda-anthraquinone process.

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20 Hurter, Robert W., "Agricultural Residues", 1997 TAPPI Nonwood Fibers Short Course Notes.

21 Siegle, Sven, "Natural Pulping - Update and Progress", PAPTAC 88th Annual Meeting Preprint A, January 29, 2002, pp A237 - A249.

22 http://www.hurterconsult.com/us_patent_6_302_997.htm

c) If the project is an integrated nonwood based pulp and paper mill in which the raw material is cereal straw or corn stalks, again then the process selection is open to many considerations but it likely would be either a kraft or soda process and most likely a soda or soda-anthraquinone process. Perhaps, the low energy EAZy process which uses soda extraction would be a possibility.

2.3.5 Washing technology

Pulps from nonwoods such as cereal straws and bagasse are slower draining than wood pulps thus requiring larger brown stock washer areas than woodpulps, and the same applies to bleach plant washers. On the other hand, pulps produced from materials such as flax, hemp and kenaf bast are faster draining and require smaller surface areas than wood pulps, and the same applies to bleach plant washers.

Errors in washer sizing in nonwood pulp mills are common when the mills are designed by persons who are more familiar with the design of woodpulp mills that with the requirements of nonwood plant fibres.

In the woodpulp industry, recent developments have included a new generation of press washing systems commercially operating in a number of the larger woodpulp mills. These new compact press washers offer many advantages; however, they have not been commercially tested on nonwood plant fibre pulps. There may be problems with applying press washing to nonwood pulps as nonwood fibres are more fragile than wood fibres and the nonwood fibres may be damaged during press washing.

Given the many potential advantages of press washing, further research and development should be carried out on the impact of press washing on nonwood fibre pulps, especially pulps produced from the common nonwood plant fibres.

Until the efficacy of press washing can be proven, it would be better to use vacuum drum washers or horizontal belt washers in nonwood pulp mills.

2.3.6 Bleaching technology

Nonwood pulps are easier to bleach than wood pulps. Shorter bleaching sequences and lower chemical charges are used to bleach nonwoods.

Globally, most nonwoods are still bleached using chlorine in a typical CEH or CEHH bleaching sequence. There are however a few exceptions such as the CELESA mill in Spain which produces flax, hemp, sisal and abaca specialty pulps using either elemental free chlorine (ECF) or totally free chlorine (TCF) bleaching and RF Ecusta in North Carolina which produces flax pulps using either chlorine based bleaching or ECF or TCF bleaching.

There has been a considerable amount of research work carried out in North America, Europe and around the world on ECF and TCF bleaching of various nonwood plant fibres. There is absolutely no reason why this technology which was developed for woodpulp bleaching cannot be applied to nonwood pulps. However, the transfer of this technology to commercial nonwood pulp and paper mills has been slow only because most nonwood mills are located in developing countries which cannot afford to adopt the newer bleaching technologies in replacement of chlorine bleaching already in place. Certainly, this trend is changing as evidenced in China which installed several bamboo based pulp and paper mills during the 1990's with ECF bleaching technology. **In North America, any nonwood pulping facility will include either ECF or TCF bleaching technology.**

For cereal straws, bagasse and other similar common nonwoods, a critical feature of bleach plant design will be to avoid mechanical action on the pulp. These types of pulps are highly susceptible to mechanical action which will reduce the pulp freeness and high shear mixers used in the woodpulp industry should be avoided.

2.3.7 Silica and chemical recovery

Nonwoods, especially the common nonwoods, typically contain more silica than wood and the silica is contained in the black liquor after pulping. Silica can cause a number of problems including scaling in the evaporators and recovery boil, reduction in settling rate in the recausticizing system and impairs operation of the lime kiln.

Efforts have been made to commercialize black liquor desilication systems of various types but none are operating commercially on a large scale. Examples of desilication systems include:

- The submersed bubble reactor[23] (developed by Wagner-Biro of Austria) to bubble flue gas into the black liquor to effect a pH adjustment which causes silica precipitation. Control over the pH is critical however as pH at which lignin precipitates is very close to that of the silica.

- The Conox[24] desilication system which saturates the black liquor with almost pure or pure carbon dioxide causing the pH adjustment which causes silica precipitation. There is no control of the pH and tests have shown that only a small amount of the lignin precipitates out with the silica.

In addition to desilication technology, there are “emerging” black liquor recovery technologies which may be well suited to handle the silica related issues resulting from pulping nonwoods. Examples include:

- The Conox[25] Thermal Oxidation process which can be used in tandem with their deslication process or as a stand-alone unit. This process involves the use of pure oxygen in a gaseous matrix at elevated temperatures and pressures to totally destruct all organic compounds. The first commercial installation is currently being installed at a cotton linters pulp mill in Spain.

- Gassification technologies[26] such as Stone-Chem which also convert the organic compounds into useable energy. Stone-Chem is of particular interest in that the bed of their fluidized reactor is a silica bed which appears to retain the silica. This system was successfully pilot tested on a commercial scale at a woodpulp mill in North Carolina; however, tit has not been tested commercially at a nonwood mill.

Careful design of the fiber raw material preparation system will remove most of the tramp silica (dirt) which comes in the bales and careful design of the recovery island can overcome most of the silica problems if the inherent silica content of the nonwood raw material is not too high. One exception is rice straw which has a silica content of 9 to 14% and for which there is no recovery system available to date.

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

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23 Hurter, Robert W., “Agricultural Residues”, 1997 TAPPI Nonwood Fibers Short Course Notes.

24 http://www.conox.com/

25 http://www.conox.com/

26 Tucker, Paul, “Changing the Balance of Power”, TAPPI & PIMA Solutions, February 2002, pp 34 - 38.

significant problems in the chemical recovery system if the black liquors from wood pulping and wheat straw pulping are combined prior to evaporation - it is unlikely that there would be any significant problems.

The entire area of black liquor recovery from nonwood plant fibre pulping is an area which still requires additional research and development.

2.3.8 Paper Machine Operation

The design of paper machines will differ for furnishes with a high nonwood content. For example, a longer wet end with more drainage elements will be required for papers with a high cereal straw or bagasse content. Press loading will be lower to avoid sheet crushing and the dryer section will require more sections to account for the higher shrinkage of the mainly nonwood sheet. Also, machine speeds for high nonwood content sheets typically are lower than for woodpulp papers.

However, if the percentage of nonwood pulp in the sheet is in the order of 10 to 30% with the balance being woodpulp and/or recycled pulp, there should be little or no effect on the design and operation of the paper machine. In fact, there may be some quality improvements. For example, 20% cereal straw in the furnish will help to improve opacity and sheet density. On the other hand, 10% flax bast pulp as a replacement for softwood kraft may allow for reduced basis weights or lower overall long fiber usage in the furnish.

2.3.9 Capital costs

As most of the equipment included in a typical wood-based pulp mill cannot be used to process nonwoods, capital expenditures will be required to process nonwood plant fibers at existing wood-based pulp and paper mills. In fact, a completely separate line likely will be required. 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.

For a stand-alone nonwood based pulp and paper mill built today, the capital costs per ton of production likely will be higher than that for a wood based mill as wood based mills can be built to larger scale then nonwood based mills. These economies of scale for wood based mills give them a clear advantage.

2.3.10 Operating costs

The question of whether or not the operating costs of a nonwood pulp mill would be higher than those of a wood pulp mill needs to be resolved on a case-by-case basis.

Some factors which could **increase operating costs** include:

- **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 tons/day of woodpulp will only process about 300 tons/day 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.

- **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/day nonwood pulp mill.

- **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.

- **Chemical Recovery Energy Generation -** In a wood-based kraft pulp mill, the chemical recovery system generates sufficient steam and power to run the entire mill. However, due to the different nature of black liquors from nonwoods, the amount of energy generated is barely enough to run the chemical recovery island.

Factors which **decrease operating costs** include:

- **Pulping and Bleaching Energy Consumption -** Pulping and bleaching nonwood fibers requires less energy than wood fibers.

- **Chemical Consumption -** Pulping nonwood fibers requires a lower chemical charge than wood fibers. Also, 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.

Assuming that the cost of fiber is the same, it is likely that producing nonwood pulps will be more expensive than producing woodpulps. However, over time, the economics of using nonwood fibers may improve as a result of increasing wood costs.

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. Also, the costs of processing nonwoods as compared to woodpulp production will be location specific.

2.4 Summary

In summary, there are many issues which need to be addressed when considering a nonwood fibre pulp and paper mill project. As mentioned, most of the technical issues have been addressed many times in many countries throughout the world by engineering consultants and equipment suppliers with expertise in the use of nonwood plant fibers, and this expertise can be brought to projects in North America so it is not necessary to completely reinvent the technology for use in North America.

What we do know is that:

1. the anticipated demand for papermaking fibre is expected to continue to grow globally into the foreseeable future,

2. this increase in demand could mean a global need for as much as 100 million tonnes per year of new papermaking fibre by the end of this decade,

3. existing wood resources likely will be unable to meet the growing demand for papermaking fibre over the long term,

4. increasing pressure on wood resources will increase wood costs which, at some point, will make the use of nonwood fibres attractive alternatives,

5. Canada and the US both have large resources of agricultural residues which can be used for pulp and paper production as well as the potential to grow fibre crops, and

6. the technology exists today to produce pulp and paper from the available nonwood fibre raw materials.

What we do not know is which pulp and paper projects, if any, may offer the best economic utilization of these nonwood fibre resources, or if the nonwood fibre resources should be used by other industries.

3. The Market Pulp Industry

3.1 Introduction

Most of the pulp produced globally is produced in integrated pulp and paper mills and consumed to a large extent for paper production within the same facility. There are however market pulp mills which produce pulp for sale to other paper producers or for transport to another paper mill within the same company. This section deals with these market pulp mills and considers what if any opportunities there are for establishing a nonwood fibre based market pulp mill in Canada.

3.2 A Global Market Pulp Industry

Market woodpulp is a commodity produced primarily in large scale wood-based pulp mills and sold globally. Table 7 extracted from the Pulp & Paper International Annual Review 2001[27] provides the global consumption and production of all types of pulp in the years 1999 and 2000.

Table 7 Estimated global market pulp production in 1999 and 2000 (1,000 tonnes)

Location		Apparent Consumption		Production	
		1999	2000	1999	2000
Europe		49,060	52,233	44,517	47,386
Asia		46,881	48,474	36,810	38,655
Australasia		3,388	3,647	3,690	4,043
North America	Canada	14,504	15,765	25,132	26,411
	United States	58,173	58,153	57,074	57,002
	Total	72,677	73,918	82,206	83,413
Latin America		7,541	8,517	11,407	12,334
Africa		2,083	2,218	2,739	2,853
Total World		181,630	189,007	181,369	188,684

On the surface it would appear to be easy to estimate the global trade in market pulp based on the above figures. However, it is not an easy task because many countries including Canada not only produce market pulp for domestic use by other paper mills in the country and for export but they also import market pulp from other countries, pulps produced from fibre raw materials not available in their country.

Canada has 48 pulp mills which as shown in Table 8[28] produced a variety of pulps for in-plant use (pulp used to produce paper in the same mill) and for sale to domestic and export markets. Although 60% of the pulp

27 Pulp & Paper International, Annual Review, July 2001

28 Pulp & Paper International, Annual Review, July 2001

produced in Canada is used to produce paper at Canadian mills, the amount exported makes Canada the largest market woodpulp exporter in the world. In 2000, Canadian market pulp mills had a capacity of 11,828,000 tonnes and, with market pulp production of 11,123,000 tonnes, this means that they operated at an average rate of 94% of capacity during the year. Although Canadian mills export pulp around the world, the US is Canada's largest single buyer of market pulp.

Table 8 Canadian pulp production, imports & exports (1,000 tonnes)

Grade	Production		Imports		Exports	
	1999	2000	1999	2000	1999	2000
Bleached sulphate	11,423	11,694	151	162	8,799	8,692
Unbleached sulphate	1,399	1,324	1	1	79	41
Bleached sulphite	537	535	1	0	176	182
Semi-chemical pulp	551	571	0	0	0	0
Mechanical pulp	11,222	12,287	15	20	1,747	1,932
Nonwood pulp	0	0	5	18	0	0
Total pulp	25,132	26,411	173	201	10,801	10,847
Market pulp	10,640	11,123	168	183	9,858	10,026

The year 2000 was a good year for the Canadian pulp and paper industry including the market pulp industry. The market pulp industry in Canada experienced a strong start to 2000, shipping at over 100% of capacity in the first quarter. The second quarter was also quite strong, although shipments to Asia were hurt by competition from Russian pulp in the Chinese market. World pulp demand began to weaken in the middle of the year. The Asian paper industry took downtime to deal with excess paper stocks and US demand for paper weakened. Destocking by consumers in North America, Europe and Asia followed, which further depressed demand, particularly in the fourth quarter. Most affected were the chemical paper grades. Overall, world market pulp demand fell 2.0% compared to 1999, which had been a record year. Demand for the chemical grades declined 3.0%. On a more positive note, demand for the high yield pulps (CTMP and mechanical pulps) held up well, rising 10%.

For 2001, Pulp & Paper International Annual Review 2001[29] forecasted that Canadian market pulp shipments to the North American market were expected to decline due to production cuts in the US printing/writing sector and the permanent shutdown of some non-integrated operations in the US. However, shipments to Europe would be up again since paper demand in that region remains quite healthy. On top of that, the absence of further destocking by customers in Asia, coupled with their need for softwood pulp, should mean that shipments to Asia would begin to recover later this year. However, industry experts forecast that pulp exports would fall by a further 1.3% over the full year. The average operating rate was expected to slip to 90%.

Events of September 11, 2001 had a big impact on the above predictions and caused significant erosion in market pulp demand for the rest of the year. The following slow down in the US economy as well as other global economies reduced demand for paper as well as market pulp. A large amount of downtime was scheduled throughout the North American market pulp industry in an effort to stablize prices but price erosion

29 Pulp & Paper International, Annual Review, July 2001

did occur with current market pulp prices being at very low levels and many companies showing poor third quarter and fourth quarter results.

The US has 183 pulp mills with a total installed pulping capacity of 62,927,000 tonnes. Table 9[30] shows that the US pulp mills produced a little over 57 million tonnes in 2000 which means that they operated at a rate of about 90%. Part of this lower operating rate is due to mill closures or downtime taken to keep the pulp prices from falling. Although the US mills produce market pulp, the amount is lower than that produced in Canada and they export less than half of the amount of market pulp exported from Canada. The US is also a large importer of market pulp, primarily from Canada.

Table 9 United States pulp production, imports & exports (1,000 tonnes)

Grade	Production		Imports		Exports	
	1999	2000	1999	2000	1999	2000
Chemical pulp	48,321	48,176	5,619	6,107	4,618	5,027
Semi-chemical pulp	3,643	3,682	0	0	0	0
Mechanical pulp	5,110	5,144	413	437	315	366
Total pulp	57,074	57,002	6,032	6,544	4,933	5,393
Market pulp	7,431	7,758	4,047	4,353	4,552	4,614

Other major and emerging players in the global market pulp industry include:

- Brazil which has extensive fast growing eucalyptus plantations and world class large scale market pulp mills,
- Indonesia and Malaysia which have been developing a world class market pulp industry based on fast growing woods such as eucalyptus and acacia, and
- Scandinavian countries which are traditional suppliers of northern softwood and hardwood market pulps.

Another country which has the potential to become a major player in the market pulp industry is Chile which has extensive softwood and hardwood forests planted years ago. Chile currently supplies wood chips around the world and it is only a matter of time before they move up the value-added chain to pulp production and eventually to fully integrated mills.

The fast growth rate of trees in warmer climates (and where costs tend to be lower) as compared to Canada where it takes 30 years to grow a tree offers a significant long term threat to the Canadian pulp and paper industry. Although wood from fast growing tress produces pulps of differing quality to Canada's northern wood species, technological developments in paper machine design are allowing increasing use of woodpulp from fast growing trees.

30 Pulp & Paper International, Annual Review, July 2001

3.3 Canadian & US Economic Performance

From an economic perspective, in 1998, the Canadian market pulp industry employed about 18,000 people and generated $7.2 billion in revenues. Table 10 provides Industrial Statistics for the Canadian and US Market Pulp Industry[31].

Table 10 Industrial statistics for Canadian & US market pulp industry (billion Canadian dollars)

Year	1990	1991	1992	1993	1994	1995	1996	1997	19981
Canada									
Manufacturing shipments	6.3	5	4.8	4.5	6.5	10.4	6.7	7	7.2
Total costs	3.3	3.3	3.2	3.2	3.8	5.2	4.5	4.4	4.5
Material costs	2.8	2.8	2.7	2.7	3.3	4.6	3.9	3.8	3.9
Fuel & electricity costs *(millions of dollars)*	445.8	482.5	453.6	465	521.9	548.9	545	603.6	630.3
Manufacturing value added	3.1	1.7	1.7	1.2	2.7	5.5	2.2	2.7	2.6
Employment	19,505	19,704	17,956	17,599	18,264	18,573	18,156	19,199	18,149
United States									
Manufacturing shipments	8.5	7	8	7.1	9	13	10.2	10.7	11.2
Total costs	3.8	4.6	4	3.6	4	5.2	5	4.7	4.9
Material costs	3.4	4.2	3.6	3.2	3.7	4.8	4.5	4.2	4.3
Fuel & electricity costs *(millions of dollars)*	390.4	383.4	399.2	370.6	342.6	465.4	498.2	528.2	551
Manufacturing value added	4	2.8	3.1	2.2	2.9	5.4	3	2.9	2.7
Employment	16,100	16,800	15,900	14,200	13,300	13,400	15,000	15,077	14,936
Notes: 1. Values for 1998 are Industry Canada estimates.									

The foregoing industrial statistics illustrate several key features of the market pulp industry:

- The industry is characterized by income volatility due to cyclical selling prices. In 1990, Canadian manufacturing shipments were $6.3 billion followed by several declining years to $4.5 billion in 1993. The primary cause of the declining value in shipments was due to price erosion resulting from global overcapacity. In 1994 the value of shipments began increasing peaking at $10.4 billion in 1995 as a result of increasing prices in tighter supply markets serving strong and growing global economies. Then from 1996 onwards, worsening economies reduced demand which in turn resulted in declining prices as well as shipping volumes.

- Of the total operational costs, the costs of raw materials (primarily wood) follows virtually the same cycle as selling prices. Wood costs form the major portion of the total operational costs so as wood prices increase, alternative lower cost fibre raw materials such as nonwood fibre become more attractive.

31 Strategis Industry Canada Database, SIC-E 2711, *Pulp Industry*, http://strategis.ic.gc.ca/SSG/io27113e.html

- Based on the value of shipments versus employment levels, the US industry appears to employ less people than the Canadian industry for a given production level. This may be because some US mills are more modern and more automated than Canadian mills and/or because the US industry has more in-roads in retrofitted older mills with more automation to reduce employment. Regardless of the reason, if all other costs are the same, this gives the US industry a competitive advantage.

- Energy costs have been increasing annually regardless whether or not manufacturing shipments are up or down. The pulp industry is very efficient in its energy use but it still remains an energy intensive industry. Consistently increasing energy costs do not bode well for the future and more cost effective alternative energy sources need to be developed.

In 1995, Ashmead reported that "The major trends now facing the pulp industry are the use of new technology to reduce costs of production (ie. via new chemical, mechanical or combination chemical/mechanical pulping techniques) and more important, the substitution of other raw materials such as recycled materials and agricultural fibers for the more expensive wood fibre."

As it stands today, the major trend for the market pulp industry still continues to be the introduction of cost reductions through the use of new technology. Regarding the use of recovered wastepaper, this has reached the point where many integrated pulp and paper mills have added processing lines to produce pulp from post consumer recovered wastepaper. As well, several de-inked pulp (DIP) mills have been built in the US to provide DIP market pulps. The broader use of nonwood plant fibres as alternatives to wood, however, has not developed in Canada or the US.

3.4 Canadian & US Nonwood Fibre Market Pulps

3.4.1 Pulps Available

For technical and economic reasons, the "common" nonwoods such as cereal straws, bagasse and corn stalks are not produced as market pulps including, but not limited to:

- On the technical side, drying a cereal straw pulp affects the pulp in several ways, i.e. the pulp strength on re-wetting at the paper mill is reduced, the pulp experiences hornification which impedes the ability to reslush the pulp at the paper mill etc. These issues can be addressed to some extent but are still a concern.

- On the economic side, the largest single-line cereal straw market pulp mill which could be built would be at best about one third of the capacity of the largest single-line woodpulp mill which could be built. The reason is that the drainage rate of the cereal straw pulp is much lower than that of woodpulps and this reduces the amount of pulp which can be processed over the pulp brown stock and bleach plant washers to about one third that of wood pulp on the same washer. This dramatically impacts on the economics of producing cereal straw market pulp as either multiple lines need to be added to achieve an "economical" cereal straw pulp capacity which adds to the capital costs or the production rate will simply be lower which means that the debt service per ton of production will be higher for the cereal straw pulp mill.

- These economic issues were addressed in a paper presented by Shrinath et al[32]. The paper summarized the results of a prefeasibility study for a 250 tpd wheat straw bleached market pulp mill to be located in Minnesota. They estimated the total installed cost of the facility would be in the

32 Shrinath, A., Tschirner, U., Ramaswamy, S., "Economics and Feasibility of a Greenfield Cereal Straw Market Pulp Mill", PAPTAC 88th Annual Meeting Preprint A, January 29, 2002, pp A79 - A83.

order of US$ 326 million for a complete stand-alone market pulp mill including the primary fibre line for preparing the straw, pulping and bleaching; a pulp dryer; a chemical recovery system; and all necessary auxiliary systems. Given the costs of production and an assumed selling price of US$ 600 per ton, the suggested project had an IRR of 0% to 2.6% depending on the type of dryer used to dry the pulp. Since the pulp and paper industry expects an IRR of at least 15% before even considering a project, they then reduced the capital cost by eliminating various sections of the mill until the reduced capital cost would give an IRR of at least 15%. To achieve this, they had to eliminate the pulp dryer, the chemical recovery system and most of the auxiliary system. Essentially, all that remained was the primary fibre line for preparing the straw, pulping and bleaching or, in other words, the portion which could be viewed as an add-on line to an existing pulp and paper mill.

Virtually all of the nonwood fibre market pulps are specialty pulps produced at high cost and typically for specialty paper applications which can absorb the high pulp cost. Cost data for the raw fibre and the finished pulps for the main specialty fibres is provided in Table 11[33].

33 Hurter, R. W., "Sisal Fibre: Market Opportunities in the Pulp & Paper Industry", presented at Alternative Applications for Sisal and Henequen, A joint FAO/CFC seminar, Rome, Italy, 13 December 2000 and published in CFC Technical Paper No. 14, pp 61 - 74.

Table 11 Specialty fibres for specialty papermaking

		Units	Abaca	Flax Bast		Hemp Bast	Sisal
				textile tow	oilseed straw		
Primary sources			Phillippines, Ecuador	EU, Egypt	Canada, US	EU	Brazil, East Africa
Specialty pulp uses			• tea bags • porous plug wrap • filtration papers • laminate substrates • abrasion resistant • high value tape base • meat casing • currency	• cigarette burning tube • currency • ultra lightweight printing (bible) • lightweight printing	• cigarette burning tube • lightweight printing	• cigarette burning tube • currency • ultra lightweight printing (bible) • lightweight printing	• tea bags • condenser paper • porous plug wrap • filtration papers • laminate substrates • abrasion resistant • high value tape base • meat casing
Raw fibre used							
	total	tonnes/year	50,000 - 55,000	45,000 - 55,000	30,000 - 40,000	20,000 - 25,000	16,000 - 20,000
	for in-house pulp	tonnes/year	22,000 - 25,000	30,000 - 35,000	30,000 - 40,000	15,000 - 18,000	14,000 - 15,000
	for market pulp	tonnes/year	28,000 - 30,000	15,000 - 20,000	0	5,000 - 7,000	2,000 - 5,000
Raw fibre cost		US$/tonne	US$ 770 - 1,300	US$ 500 - 700	US$ 325	US$ 550 - 650	US$ 700 - 800 (EA)
Raw fibre cost		US$/admt pulp	US$ 1,185 - 2,000	US$ 1,040 - 1,460		US$ 1,040 - 1,230	US$ 1,100 - 1,250
Market pulp cost		US$/admt	US$ 2,800 - 3,100	US$ 1,900 - 2,000	n/a	US$ 1,900 - 2,000	US$ 2,000 - 2,100

NOTES: 1. This table excludes China.
2. Sources: Internal information from Danforth International Trade Associates, Inc. and HurterConsult Incorporated (3)

Table 11 also includes the estimated global demand for the fibre raw materials used in specialty pulp production, and it is a very limited amount. The main constraint on the wider use of these fibre raw materials and the pulps within the larger wood-based pulp and paper industry is the high cost of specialty pulps even though these pulps offer superior properties to softwood and hardwood pulps.

3.4.2 Potential New Markets for Specialty Fibre Pulps

The findings of three market studies[34, 35, 36] carried out since 1989 show that there are potential new markets which could be developed for pulps produced from specialty fibres.

The 1989 market global survey for bleached sisal pulp showed that there was a potential annual demand for 104,000 - 114,000 air dry metric tons (admt) at prices mostly in the range of US$ 1,660 - 1,680 per admt. This market survey was focussed on specialty papermaking applications.

The 1992/93 global market survey also for bleached sisal pulp was broadened to include other potential applications for the pulp, especially for use as a reinforcing fibre in wood-based papers based on the superior properties of the sisal pulp. The results of this survey are summarized in Table 12

Table 12 1992/93 global market survey for bleached sisal pulp

Potential Demand		**Minimum** (admt/y)	**Maximum** (admt/y)
specialty pulp users		15,712	24,662
specialty pulp & reinforcing fibre users		92,550	102,650
reinforcing fibre users		177,990	235,510
unknown		100	100
Total		**286,352**	**362,922**
Selling Prices		**Range** (US$/admt)	**Majority** (US$/admt)
Specialty uses	unbleached	520 - 1,750	1,000 - 1,100
	bleached	600 - 3,000	1,200 - 1,500
Reinforcing fibre	unbleached	500 - 800	n/a
	bleached	500 - 1,600	1,000 - 1,300
Note: Delivered to purchasers' port basis			

Even though sisal cannot be grown in Canada, the purpose of providing the above information is to show that what have traditionally been considered as "specialty pulps" can find new market opportunities as a reinforcing fibre in wood-based papers provided that the price is right. Also, these markets would be open to other types of "specialty pulps" such as flax and hemp pulps at the right price.

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34 "Feasibility Study for a Sisal Market Pulp Mill in the Dominica Republic", unpublished report, HurterConsult Incorporated, 1989.

35 "Study Report Tanzania Integrated Sisal and Sisal Pulp Project", unpublished report, HurterConsult Incorporated, 1993.

36 "Prefeasibility Study - Nonwood Pulp and/or Paper Mill, Manitoba, Canada" unpublished report, HurterConsult Incorporated, 2000 - to be made public in mid 2002.

The more recent Canadian market survey was based on producing bleached flax market pulps in Manitoba. It was established that there were potential markets in 1999/2000 for 50,000 admt/y. More details regarding this study cannot be provided until it is made public later this year.

Virtually any commodity paper that uses softwood kraft as a reinforcing fibre to provide strength properties to the paper could use flax, hemp or sisal pulp instead of, or as a supplement to, softwood kraft.

As early as 1971, an unpublished study[37] showed that sisal pulp could be used economically in papers with high mechanical wood content. In a commercial trial, newsprint that was being produced with 65% stone groundwood and 35% softwood kraft was replaced with 81% stone groundwood, 10% softwood kraft and 9% sisal pulp. Fairbanks and Detrick[38] report that *Hesperaloe funifera*, another member of the Agavaceae family, provides an excellent reinforcing fibre for mechanical paper grades. And, Dixit and Hair[39] addressed how flax pulp could be used as an additive to many paper grades.

The potential list of commodity papers which could use specialty pulps as a reinforcing fibre in substitution with softwood kraft pulps is endless and generally can be categorized as:

- high recycle fibre content paper
- uncoated papers which are produced using various mixes of hardwood and softwood pulps
- higher-valued mechanical paper grades such as supercalendered grade A (SCA) and lightweight coated (LWC) papers both of which require a high content of reinforcement pulp (typically softwood kraft) due to high contents of non-fibre fillings or coating materials
- coated "free sheet" paper which contains about 1/3 hardwood pulp, 1/3 softwood pulp and 1/3 coating material
- high nonwood fibre content papers where the bulk of the nonwood fibres comes from agricultural residues such as cereal straws

Another possible application as a reinforcement fibre would be to allow basis weight reductions in commodity papers. Although paper is sold by the tonne, the basis weight of a tonne determines the printing area available. If the basis weight can be reduced while maintaining the other properties of the paper, this would provide more printing surface and could be an incentive for using specialty pulps.

37 "Sisal pulp utilization", unpublished report, Stadler Hurter International Ltd., Montreal, 1971.

38 Fairbanks, M. and Detrick, R., "Hesperaloe funifera - an excellent reinforcement fiber for mechanical paper grades", TAPPI Journal, November, 2000, Vol. 83, No. 11.

39 Dixit, A. S. and Hair, T. E., "Flax Pulp Applications: More Than Just Specialty Products", PAPTAC 88th Annual Meeting Preprint A, January 29, 2002, pp A277 - A283.

3.5 Potential Canadian Projects Using Nonwood Fibres in Market Pulps

There are three potential projects which appear to offer potential for the production of nonwood fibre market pulps or for the use of nonwood fibres in market pulps:

1. A stand-alone market pulp mill which would have the capability of producing flax and hemp bleached market pulps. As found during the Canadian study mentioned previously, the key to the success of this project will be to develop a more cost effective method for separating the bast and core fibres than the currently used dry decortication system. Development work on a new separation system was done during the study with partial success, but lack of funding did not allow completion of this work to a successful conclusion.
2. The addition of a flax/hemp pulping line (from raw material preparation to pulping, bleaching and pulp drying and baling) to an existing chemical woodpulp mill so that the two pulping lines can share the auxiliary systems such as chemical recovery, steam and power, effluent treatment etc. This would greatly improve the economics of the flax/hemp pulp production.

3. The blending of flax or hemp fibre with wood fibre as suggested by the research work at the Alberta Research Council and Tembec to produce bleached hardwood chemimechanical pulp (BCTMP) with value-added properties.

4. The Paper Industry

4.1 Introduction

Paper is produced in two types of facilities: fully integrated mills which produce the pulp that is consumed in the attached paper mill and stand-alone paper mills which purchase the necessary pulps to provide their fibre requirements.

4.2 A Global Paper Industry

As is the case with the market pulp industry, the paper industry is primarily a global industry which is tarded thgouhout the world. Table 13 extracted from the Pulp & Paper International Annual Review 2001[40] provides the global consumption and production by region for all types of papers and paperboards in the years 1999 and 2000.

40 Pulp & Paper International, Annual Review, July 2001

Table 13 Estimated global paper and paperboard production in 1999 and 2000

Location		Population (1,000)	Apparent Consumption Per Capita (kg)	Apparent Consumption (1,000 tonnes) 1999	Apparent Consumption (1,000 tonnes) 2000	Production (1,000 tonnes) 1999	Production (1,000 tonnes) 2000
Europe	EU countries	377,316	210.5	74,654	79,409	80,089	84,540
	West - other	12,692	228.3	2,678	2,898	4,060	4,153
	East	343,633	29.1	8,740	10,010	9,948	11,218
	Total	733,641	124.5	86,072	92,317	94,097	99,911
Asia		3,648,225	28.3	99,802	103,568	91,848	95,658
Australasia		28,907	152.5	4,163	4,407	3,349	3,524
North America	Canada	30,750	243.1	7,509	7,476	20,195	20,689
	United States	278,400	331.7	94,359	92,355	88,061	85,495
	Total	309,150	322.9	101,868	99,831	108,256	106,184
Latin America		519,293	35.8	17,855	18,577	14,506	14,813
Africa		768,497	6.1	4,457	4,678	3,023	3,205
Total World		6,007,713	53.8	314,217	323,378	315,079	323,295

Analysis of the information presented in Table 14 offers several key indicators of the likely future trends for global paper and paperboard production and consumption:

- the industrialized West including North America and Western Europe have the highest per capita paper consumption
- the industrialized West including North America and Western Europe which has a total population of 699 million, only 11.6% of the total global population, consumed 182 million tonnes in 2000 which is 56% of total global consumption
- the lesser developed countries in Asia, Latin America, Africa and to some extent Australasia contain the bulk of the world's population (about 5.3 billion) and have the lowest per capita paper and board consumption
- increasing industrial development fosters increasing use of paper and paperboard products so the largest increases in consumption will be seen in the lesser developed countries of Asia, Latin America, Africa and to some extent Australasia
- a one kilogram increase in the average per capita consumption in lesser developed countries means an increased demand of 5.3 million tonnes
- as consumption increases in the lesser developed countries, paper and paperboard production capacity also likely will increase in these countries and this may impact on the export capability of Canadian and US paper and paperboard producers
- lesser developed countries also typically have lower cost structures than developed countries and as their paper and paperboard production capacity increases, these countries may begin exporting product to North America

Some of the above trends for global paper and paperboard production already began during the last decade with the construction of world class pulp and paper mills in countries such as Brazil, Indonesia and Malaysia where wood and labour costs are low. These mills were built with export markets as their primary target markets and have been shipping paper products to North America and Europe in direct competition with North American and European producers. And, during the past few years, imports from lesser developed countries have been increasing in the US.

Global paper and paperboard production can be further subdivided by the major classifications of the paper and paperboard grades produced as shown in Table 14[41]. It must be noted that there are literally hundreds of paper and paperboard grades available in the market including a wide range of basis weights, colours and finishes for some grades.

Table 14 Estimated global paper and paperboard production in 1999 & 2000 by grade (1,000 tonnes)

Location		Newsprint		Printing / Writing		Packaging & Other Paper & Board[1]		Total Paper & Board	
		1999	2000	1999	2000	1999	2000	1999	2000
Europe	EU	9,132	9,277	30,573	32,756	40,383	42,507	80,088	84,540
	West - other	1,202	1,196	1,408	1,440	1,450	1,517	4,060	4,153
	Total West	10,334	10,473	31,981	34,196	41,833	44,024	84,148	88,693
	East	2,027	2,217	1,952	2,100	5,969	6,901	9,948	11,218
	Total Europe	12,361	12,690	33,933	36,296	47,802	50,925	94,096	99,911
North America		15,717	15,898	30,410	30,417	62,129	59,869	108,256	106,184
Asia		7,666	8,440	26,477	27,661	57,705	59,557	91,848	95,658
Australasia		765	782	508	565	2,076	2,177	3,349	3,524
Latin America		882	946	3,514	3,527	10,110	10,340	14,506	14,813
Africa		360	367	676	706	1,987	2,132	3,023	3,205
Total		37,751	39,123	95,518	99,172	181,809	185,000	315,078	323,295

Notes: 1. For countries where breakdown by grade is not possible (ie not specified or not estimated), total output has been listed under "Packaging and Other P&B" category.

Canada has 102 paper mills which as shown in Table 15[42] table produced a variety of paper and paperboard grades for sale to domestic and export markets. About 75% of Canadian production is exported and we import about one third of the paper and paperboard consumed in Canada. In 2000, Canadian paper and board mills had a capacity of 21,692,000 tonnes and they operated at an average rate of 95% of capacity during the year. Although Canadian mills export paper and board around the world, the US is Canada's largest single buyer.

41 Pulp & Paper International, Annual Review, July 2001

42 Pulp & Paper International, Annual Review, July 2001

Table 15 Canadian paper & paperboard production, imports & exports (1,000 tonnes)

Grade		Production		Imports		Exports	
		1999	2000	1999	2000	1999	2000
Newsprint		9,204	9,221	35	40	7,969	8,052
Printing & writing	woodfree uncoated	1,417	1,485	440	453	867	976
	woodfree coated	361	424	391	410	244	310
	mechanical uncoated	3,073	3,454	71	86	2,713	3,120
	mechanical coated	897	949	144	138	730	802
	Total	5,748	6,312	1,046	1,087	4,554	5,208
Corrugating materials	corrugating medium	1,137	1,109	102	86	615	610
	linerboard	1,888	1,896	452	539	937	902
	Total	3,025	3,005	554	625	1,552	1,512
Other wrapping papers		534	531	186	181	396	393
Tissue		664	652	92	105	103	100
Boxboard		1,020	968	467	450	492	436
Total paper & paperboard		20,195	20,689	2,380	2,488	15,066	15,701

According to the Pulp & Paper International Annual Review 2001[43], newsprint was by far the strongest sector in 2000. World demand rose by almost 3.0% but machine shutdowns and conversions in North America and Europe left global capacity flat year-to-year. As a result, the newsprint industry shipped at full capacity in 2000. At Canadian mills, the average operating rate jumped to 97%. During 2000, newsprint consumption in the US market (Canada's primary market) remained strong throughout most of the year, rising 1.2%. In 2001, US consumption was predicted to decline in the first two quarters, but by year end would be roughly the same as 2000 if the US economy picked up in the second half. Regardless, even if US consumption did decline, it was suggested that North American newsprint producers should be able to continue shipping at, or near, full capacity because the supply was expected to decline for a second consecutive year as planned shutdowns and conversions take effect. And, offshore demand was predicted to remain strong, allowing mills to increase their exports if the tonnage is available. The operating rate at Canadian mills should remain at 97% in 2001, which is very close to full capacity.

North American demand for printing/writing papers began to slow in the middle of 2000, mainly due to weaker consumption of uncoated woodfree papers, the largest segment of the North American market, especially demand for business forms, which fell by 14%. Demand for mechanical printing papers for magazines, catalogues, flyers and other advertising material remained quite strong. Since 70%of Canadian capacity comprises coated and uncoated mechanical papers, the Canadian industry performed well in 2000, despite North American printing/writing demand having grown by just 1.0%. Overall, Canadian shipments grew by 12%, exceeding the impressive 10% gain the industry posted in 1999. The average operating rate increased 3.0 points to 96%. North American demand for woodfree papers was predicted to remain sluggish through the first half of 2001 with particularly weak demand for the uncoated grades. Overall, Canadian shipments of printing/writing papers were predicted to increase 1.7% in 2001.
The packaging industry was the first to feel the effects of a slowing US economy during 2000 as manufacturing output began to falter, well ahead of the technology and services sectors which were driving

43 Pulp & Paper International, Annual Review, July 2001

GDP growth in the first half of the year. Canadian shipments of packaging papers and boards started to decline in the second quarter of 2000 ending the year down 3.4% and resulting in the average operating rate to93%. For 2001, it was predicted that a weak first half would result in a small decline in shipments of about 1.0% for the full year.

Events of September 11, 2001 had a big impact on the above predictions and caused significant erosion in the demand for all grades of paper and paperboard for the rest of the year. The following slow down in the US economy as well as other global economies reduced demand for paper. A large amount of downtime was scheduled throughout the North American paper industry in an effort to stablize prices but price erosion did occur with current prices being at very low levels and many companies showing poor third quarter and fourth quarter results.

The US has 512 paper mills which as shown in Table 16[44] table produced a variety of paper and paperboard grades for sale to domestic and export markets. In 2000, US paper and board mills had a capacity of 94,090,000 tonnes and they operated at an average rate of 91% of capacity during the year. About 11% of US production is exported whereas about 17% of US consumption is imported from various sources with Canadian mills being the primary supplier.

Table 16 US paper & paperboard production, imports & exports (1,000 tonnes)

Grade	Production		Imports		Exports	
	1999	2000	1999	2000	1999	2000
Newsprint	6,513	6,677	6,796	6,841	704	777
Printing & writing	24,662	24,105	5,876	6,476	1,539	1,716
Corrugating materials	32,385	30,901	969	1,017	3,548	3,627
Other wrapping papers	4,351	4,027	675	650	752	793
Tissue	6,211	6,248	212	161	93	130
Boxboard	13,939	13,537	808	782	2,402	2,024
Total paper & paperboard	88,061	85,495	15,336	15,927	9,038	9,067

According to the Pulp & Paper International Annual Review 2001[45], the slowdown of the US economy in the fourth quarter of 2000 weakened paper and board production for the full year. Total production reached 85 million tonnes, down 2.9% from the previous year. The domestic slowdown and a strong dollar hurt papermakers during 2000, as US exports became increasingly uncompetitive in offshore market. The same issues continued to damage the US industry in the first half of 2001. And the events of September 11, 2001 had yet another a big impact on US papermakers causing even further erosion in the demand for all grades of paper and paperboard for the rest of the year. The following slow down in the US economy as well as other global economies reduced demand for paper. A large amount of downtime was scheduled throughout the North American paper industry in an effort to stablize prices but price erosion did occur with current prices being at very low levels and many companies showing continued poor results for the third quarter and fourth quarters.

44 Pulp & Paper International, Annual Review, July 2001

45 Pulp & Paper International, Annual Review, July 2001

It should be noted that the strong US dollar versus the weak Canadian dollar is favourable to Canadian exporters of pulp and paper products to the US.

4.3 Canadian & US Economic Performance

4.3.1 Newsprint

Under the "Newsprint" SIC-E 2712 classification, the Strategis[46] Industry Canada Database includes the manufacturing of two paper grades:

- groundwood printing paper
- newsprint paper.

From an economic perspective, in 1998, the Canadian newsprint industry employed about 25,350 people and generated $9.8 billion in revenues. Table 17 provides Industrial Statistics for the Canadian and US Newsprint Industry[47].

46 Strategis Industry Canada Database, SIC-E 2712, *Pulp Industr*y, http://strategis.ic.gc.ca/SSG/io27122e.html

47 Strategis Industry Canada Database, SIC-E 2712, *Pulp Industr*y, http://strategis.ic.gc.ca/SSG/io27122e.html

Table 17 Industrial statistics for Canadian & US newsprint industry (billion Canadian dollars)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998[1]
Canada									
Manufacturing shipments	7.5	6.7	6.2	6.5	7.5	11.5	10.5	9.6	9.8
Total costs	4.2	4.1	3.9	4.0	4.3	5.2	5.2	5.0	5.1
Material costs	3.1	3.0	2.8	2.8	3.1	4.0	3.9	3.6	3.7
Fuel & electricity costs *(millions of dollars)*	1088.1	1165.5	1133.8	1159.8	1206.0	1254.8	1263.8	1345.5	1386.9
Manufacturing value added	3.3	2.6	2.2	2.6	3.1	6.2	5.5	4.5	4.5
Employment	36,985	35,734	31,921	30,264	30,009	30,530	29,150	27,836	25,347
United States									
Manufacturing shipments	35.3	32.6	33.1	37.0	45.0	60.7	52.5	54.6	57.6
Total costs	16.9	16.8	16.6	17.3	20.1	22.8	20.5	20.0	20.4
Material costs	14.5	14.5	14.2	14.9	17.5	20.5	18.1	17.5	18.0
Fuel & electricity costs *(millions of dollars)*	2356.3	2387.9	2381.8	2442.6	2618.7	2324.9	2418.6	2460.3	2476.0
Manufacturing value added	15.2	13.5	12.1	12.8	14.2	22.9	19.4	20.2	21.0
Employment	95,553	97,331	93,510	89,184	87,316	85,532	81,327	79,646	77,601

Notes: 1. Values for 1998 are Industry Canada estimates.

The foregoing industrial statistics illustrate several key features of the newsprint industry, many of which mirror the key features of the market pulp industry discussed in section 3.2 above:

- The industry is characterized by income volatility due to cyclical selling prices. In 1990, Canadian manufacturing shipments were $7.5 billion followed by several declining years to $6.5 billion in 1993. The primary cause of the declining value in shipments was due to price erosion resulting from global overcapacity. In 1994 the value of shipments began increasing peaking at $11.5 billion in 1995 as a result of increasing prices in tighter supply markets serving strong and growing global economies. Then from 1996 onwards, worsening economies reduced demand which in turn resulted in declining prices as well as shipping volumes.

- Of the total operational costs, the costs of raw materials (primarily wood) follows virtually the same cycle as selling prices. Like market pulp, wood costs form the major portion of the total operational costs, over 70% in the case of the newsprint industry. And, as wood prices increase, alternative lower cost fibre raw materials such as recovered wastepaper become more attractive. However, unlike market pulp, nonwood plant fibre alternatives may not be replacements for wood fibre in the newsprint industry for several reasons including both technical and economic issues.

- Based on the value of shipments versus employment levels, the US industry appears to employ less people than the Canadian industry for a given production level. This may be because some US mills are more modern and more automated than Canadian mills and/or because the US industry has more in-roads in retrofitted older mills with more automation to reduce employment. Regardless of the reason, if all other costs are the same, this gives the US industry a competitive advantage.

- Also on the employment front, it is evident that employment in this industry is declining each year in both Canada and the US as the mills are made more efficient.

- Energy costs have been increasing annually regardless whether or not manufacturing shipments are up or down. The newsprint industry is a very energy intensive industry as the processes used to produce mechanical pulps used in newsprint at energy intensive. Consistently increasing energy costs do not bode well for the future and more cost effective alternative energy sources need to be developed.

In 1995, Ashmead had little to say about the newsprint industry. As it stands today, the major trend for the newsprint industry is the introduction of cost reductions through the use of new technology. This also includes the conversion of many mills from standard newsprint grades to value-added mechanical papers including light-weight coated grades and uncoated super-calendered (SC) grades which are in demand by advertisers for use as newspaper inserts due to their better printability and finished product appearance.

4.3.2 Paperboard

Under the "Paperboard" SIC-E 2713 classification, the Strategis[48] Industry Canada Database includes the manufacturing of several paper grades:

- building paper, not impregnated or coated
- chipboard (paperboard)
- corrugating board
- liners, kraft or paperboard
- paperboard, container and boxboard grade
- shoe board
- strawboard for corrugated containers

From an economic perspective, in 1998, the Canadian paperboard industry employed about 5,850 people and generated $2.2 billion in revenues. Table 18 provides Industrial Statistics for the Canadian and US Paperboard Industry[49].

48 Strategis Industry Canada Database, SIC-E 2712, *Pulp Industr*y, http://strategis.ic.gc.ca/SSG/io27122e.html

49 Strategis Industry Canada Database, SIC-E 2712, *Pulp Industr*y, http://strategis.ic.gc.ca/SSG/io27122e.html

Table 18 Industrial statistics for Canadian & US paperboard industry (billion Canadian dollars)

Year	1990	1991	1992	1993	1994	1995	1996	1997	19981
Canada									
Manufacturing shipments	1.8	1.4	1.4	1.5	1.9	2.6	2.0	2.1	2.2
Total costs	0.8	0.8	0.8	0.9	1.1	1.4	1.2	1.2	1.3
Material costs	0.7	0.6	0.6	0.7	0.8	1.2	0.9	1.0	1.0
Fuel & electricity costs *(millions of dollars)*	182.8	186.6	184.9	212.0	222.7	235.8	238.7	254.0	266.3
Manufacturing value added	0.7	0.6	0.6	0.6	0.9	1.3	0.9	0.9	0.9
Employment	6,894	6,737	6,213	6,681	6,344	6,511	6,192	6,278	5,846
United States									
Manufacturing shipments	21.7	19.7	23.6	26.9	34.5	46.2	37.7	39.2	41.4
Total costs	10.7	12.9	11.4	13.2	15.5	18.7	16.8	16.1	17.0
Material costs	9.1	11.3	9.7	11.2	13.3	16.5	14.5	13.6	14.4
Fuel & electricity costs *(millions of dollars)*	1607.3	1578.3	1703.8	2038.0	2209.5	2199.1	2315.8	2426.9	2574.0
Manufacturing value added	9.5	8.3	9.9	9.7	11.8	17.4	13.2	13.9	14.7
Employment	53,100	50,600	51,500	53,300	55,100	56,900	54,800	54,952	55,222

Notes: 1. Values for 1998 are Industry Canada estimates.

The foregoing industrial statistics illustrate several key features of the newsprint industry, many of which mirror the key features of the newsprint industry discussed in section 4.2.1 above:

- The industry is characterized by income volatility due to cyclical selling prices. In 1990, Canadian manufacturing shipments were $1.5 billion followed by several declining years to $1.4 billion in 1992. The primary cause of the declining value in shipments was due to price erosion resulting from global overcapacity. In 1993 the value of shipments began increasing peaking at $2.6 billion in 1995 as a result of increasing prices in tighter supply markets serving strong and growing global economies. Then from 1996 onwards, worsening economies reduced demand which in turn resulted in declining prices as well as shipping volumes.

- Of the total operational costs, the costs of raw materials follows virtually the same cycle as selling prices. However, unlike other paper grades and market pulps for which the primary fibre raw material is wood, today the primary fibre raw material for the paperboard industry is recovered wastepaper. As wastepaper prices increase, alternative lower cost fibre raw materials such as nonwood plant fibres may become more attractive.

- Based on the value of shipments versus employment levels, the US industry appears to employ less people than the Canadian industry for a given production level. This may be because some US mills are more modern and more automated than Canadian mills and/or because the US industry has more in-roads in retrofitted older mills with more automation to reduce employment. Regardless of the reason, if all other costs are the same, this gives the US industry a competitive advantage.

- Energy costs have been increasing annually regardless whether or not manufacturing shipments are up or down. The paperboard industry is an energy intensive industry, and consistently increasing energy costs do not bode well for the future and more cost effective alternative energy sources need to be developed.

In 1995, Ashmead had little to say about the paperboard industry. As it stands today, the major trend for the paperboard industry in recent years has been the introduction "mini-mills" (about 400 tpd of paperboard) located near US urban centres, the major sources of wastepaper. These very efficient mills are designed to process recovered wastepaper into new paperboard products.

4.3.3 Other Paper Industries

Under the "Other Paper Industries" SIC-E 2719 classification, the Strategis[50] Industry Canada Database includes the manufacturing of the following grades grades:

- blotting paper
- book paper (exc. groundwood printing)
- bristol paper
- decalcomania paper
- duplicating paper
- facial tissue stock
- filter paper
- fine paper, miscellaneous
- lightweight paper
- manifold papers
- matrix paper
- onion skin paper
- printing papers (exc. groundwood printing)
- reproduction paper
- serviette stock, paper
- toilet tissue stock
- towelling stock, paper

This classification includes a mixture of semi-specialty and specialty grades such as blotting paper and onion skin, printing & writing grades such as printing paper and reproduction paper, and tissue papers such as serviette stock, toilet tissue and towelling. Normally, the paper industry would not lump these grades together but as this is the manner in which they have been presented by Strategis, it is not possible to further differentiate between these grades in this report.

From an economic perspective, in 1998, the Canadian paperboard industry employed about 11,580 people and generated $4.4 billion in revenues. Table 19 provides Industrial Statistics for the Canadian and US Paperboard Industry[51].

50 Strategis, Industry Canada Database, SIC-E 2719, *Pulp Industr*y, http://strategis.ic.gc.ca/SSG/io27193e.html

51 Strategis Industry Canada Database, SIC-E 2712, *Pulp Industr*y, http://strategis.ic.gc.ca/SSG/io27193e.html

Table 19 Industrial statistics for Canadian & US other paper industries industry (billion Canadian dollars)

Year	1990	1991	1992	1993	1994	1995	1996	1997	19981
Canada									
Manufacturing shipments	2.7	2.3	2.8	2.9	3.4	4.6	4.2	4.1	4.4
Total costs	1.8	1.5	1.7	1.7	1.9	2.5	2.4	2.3	2.4
Material costs	1.6	1.3	1.5	1.5	1.7	2.3	2.2	2.0	2.1
Fuel & electricity costs *(millions of dollars)*	195.1	190.8	219.1	228.0	230.3	234.0	260.1	272.5	285.8
Manufacturing value added	0.9	0.8	1.1	1.2	1.4	2.2	1.8	1.8	1.9
Employment	13,372	12,104	12,661	12,561	11,886	11,839	12,571	12,399	11,582
United States									
Manufacturing shipments	12.8	11.1	14.8	16.4	20.1	24.3	21.1	21.9	23.1
Total costs	7.9	6.5	8.0	8.4	9.8	12.1	10.5	10.0	10.4
Material costs	7.5	6.2	7.5	8.0	9.3	11.6	10.0	9.5	9.9
Fuel & electricity costs *(millions of dollars)*	422.5	390.9	460.2	480.1	500.1	433.5	497.7	517.1	532.0
Manufacturing value added	4.2	4.3	5.8	5.9	6.4	7.9	6.3	6.8	7.3
Employment	34,547	32,969	37,090	37,016	34,584	33,168	35,073	35,174	35,264
Notes: 1. Values for 1998 are Industry Canada estimates.									

The foregoing industrial statistics illustrate several key features of the newsprint industry, many of which mirror the key features of the newsprint industry discussed in section 4.2.1 above:

- The industry is characterized by income volatility due to cyclical selling prices. In 1990, Canadian manufacturing shipments were $2.7 billion followed by a decline to $2.3 billion in 1991. In 1992 the value of shipments began increasing peaking at $4.6 billion in 1995 as a result of increasing prices in tighter supply markets serving strong and growing global economies. Then from 1996 onwards, worsening economies reduced demand which in turn resulted in declining prices as well as shipping volumes.

- Of the total operational costs, the costs of raw materials follows virtually the same cycle as selling prices. Like market pulp, wood costs form the major portion of the total operational costs. And, as wood prices increase, alternative lower cost fibre raw materials such as nonwood plant fibres and recovered wastepaper become more attractive. Nonwood plant fibres are ideally suited from many of the grades included in this classification.

- Based on the value of shipments versus employment levels, the US industry appears to employ less people than the Canadian industry for a given production level. This may be because some US mills are more modern and more automated than Canadian mills and/or because the US industry has more in-roads in retrofitted older mills with more automation to reduce employment. Regardless of the reason, if all other costs are the same, this gives the US industry a competitive advantage.

- Energy costs in Canada have been increasing annually regardless whether or not manufacturing shipments are up or down. This industry segment is energy intensive industry, and consistently increasing energy costs do not bode well for the future and more cost effective alternative energy sources need to be developed.

In 1995, Ashmead had little to say about this industry segment. As it stands today, the major trend for the industry in recent years is the introduction of cost reductions through the use of new technology.

4.3.4 Other Strategis Classifications

The Strategis Industry Canada Database[52] also includes a number of other classifications under the general heading of "Paper and Allied Products Industries" and some of these classifications may include the base paper or paperboard produced in a paper mill and which should be considered as part of the production from the paper and paperboard industry. However, these classifications also include converted products and it is impossible to differentiate between the base sheets/products and the converted products.

Included in these classifications are:

- SIC-E 2721 - Asphalt Roofing
- SIC-E 2731 - Folding Cartons and Set-Up Boxes
- SIC-E 2732 - Corrugated Boxes
- SIC-E 2733 - Paper Bags
- SIC-E 2791 - Coated and Treated Paper
- SIC-E 2792 - Stationery Paper Products
- SIC-E 2793 - Paper Consumer Products
- SIC-E 2799 - Other Converted Paper Products Industries

Of the above, SIC-E 2791 for Coated and Treated Paper should be considered carefully as there has been increasing demand in recent years for light-weight coated (LWC) paper grades. The LWC grades include a range of products from those which include mechanical woodpulps and are used mostly for advertising inserts in newspapers to higher quality paper produced from chemical woodpulp which is used in higher end magazines and financial reports.

52 Strategis Industry Canada Database, http://strategis.ic.gc.ca/SSG/gi00027e.html

4.4 Canadian & US Nonwood Fibre Paper and Paperboard

4.4.1 Currently Available Paper and Paperboard

Currently, there are no paperboard products produced in Canada and the US using nonwood plant fibre raw materials.

There are however a variety of paper and allied products which are produced in Canada and the US using nonwood plant fibre raw materials. For the most part, the paper grades produced using nonwoods plant fibres are printing/writing papers, currency paper, cigarette papers and a variety of miscellaneous specialty papers, all of which are sold in small niche markets.

4.4.1.1 Printing/Writing Papers

Nonwood content printing/writing papers are available in the market from various sources, both traditional well established suppliers and relatively new entrants to the market. The quality of the paper ranges from high quality archival grade papers which typically are produced from 100% cotton fibre pulp (produced from cotton linters or rags) to more run-of-the-mill paper which may be a blend of woodpulp and nonwood pulp or a blend of recycled fibre pulp and nonwood pulp. The nonwood plant fibre raw materials which have been and are being used include cotton linters, cotton rags, linen rags, flax bast fibre, cereal straw, sugarcane bagasse, hemp bast and kenaf. For a brief period, bamboo fibre printing and writing paper produced using imported pulp also was available from a US mill, but this product line has been discontinued.

The Canadian and US markets for nonwood content printing/writing papers, especially the higher end papers, currently is relatively small and is estimated to only be in the range of 50,000 - 70,000 tonnes per year. The primary reason for the small market size is that the retail cost of these nonwood papers is 5 to 8 times that of wood-based papers which reduces the demand for these products. Even the largest retailer in the world, Wal-Mart only ordered 400 tons in 2001 of cotton content resume paper to meet the requirements of all of its stores[53].

Traditional, well established suppliers to this market generally can be characterized as follows:

- typically operate either a paper mill which uses purchased pulps including nonwood pulps to produce paper, or an integrated pulp and paper mill which pulps the nonwood plant fibre raw material for use in their paper mill
- have long term experience in the market
- are well known for the quality of their products
- use 25 - 100 % nonwood fibre in the paper varies depending on the grade with the balance being recycled fibre pulp (both post consumer and pre-consumer)

53 Personal communication.

A few examples of traditional suppliers are:

- Rolland Inc, St. Jerome, Quebec, Canada: 25 - 100% cotton content papers produced using purchased cotton linters pulp with the balance being purchased recycled fibre pulp

- Spexel Inc., Beauhornois, Quebec, Canada: cotton content papers produced using rag pulp produced in-house or purchased cotton linters pulp

- Gilbert Paper, Menasha, WI, USA: 0 - 100% cotton content paper produced using purchased cotton linters or rag pulp with the balance being purchased recycled fibre pulp

- Crane& Co., Dalton, MA, USA: 25 - 100% nonwood fibre (cotton, kenaf, hemp) paper produced using nonwood pulp produced in-house with the balance being purchased recycled fibre pulp

In addition to the above well established traditional suppliers, several of the larger paper companies have introduced nonwood fibre content printing/writing paper products at specific mills, such as:

- Domtar Inc., St. Catharines, Ontario, Canada: 100% nonwood fibre paper produced from purchased sugarcane bagasse pulp (85%) and purchased industrial hemp pulp (15%)

- Neenah Paper, Neenah, WI, USA: 50% nonwood content paper produced from sugarcane bagasse pulp (50%) and recycled fibre pulp (50%)

New entrants to this market generally can be characterized as follows:

- typically do not operate any pulp or paper mill and contract with traditional suppliers and/or other pulp and paper mills to produce the paper under contract

- initially have little market experience and undergo a long learning curve to establish a market position

- use 25 - 100 % nonwood fibre in the paper varies depending on the grade with the balance being recycled fibre pulp (both post consumer and pre-consumer)

A few examples of these suppliers are:

- Arbokem, Vulcan, Alberta, Canada: operates a pilot pulp mill and contracts out for producing 50% nonwood fibre content paper using straw pulp produced in Vulcan with the balance being purchased recycled fibre pulp

- Living Tree Paper Co., Eugene, OR, USA: 25% hemp content paper produced under contract with the balance being recycled fibre pulp

- Vision Paper, Albuquerque, NM, USA: 100% kenaf paper produced under contract

4.4.1.2 Currency Paper

In Canada and the US, there are only two suppliers of currency paper. Spexel Inc., Beauhornois, Quebec, Canada produces currency paper from in-house produced rag pulp and supplies the Canadian Government. Crane& Co., Dalton, MA, USA produces currency paper from in-house produced rag pulp and supplies the US Government.

4.4.1.3 Cigarette Papers

Decorticated flax bast fibre from Manitoba and Saskatchewan is used for the production of cigarette burning tube by two US based pulp and paper mills: Schweitzer-Mauduit International, Spotswood, NJ and RF Ecusta, Pisgah Forest, NC. Due to market conditions, anti-smoking campaigns and high market entrance requirements, it is unlikely that there will be new entrants to this market segment.

4.4.1.4 Other Specialty Papers

In the US, especially the New England States, there are a number of small specialty pulp and paper mills which produce a wide variety of specialty papers using nonwood fibre pulps.

As noted in Table 11, **abaca** is used to produce tea bags, porous plug wrap, filtration papers, laminate substrates, abrasion resistant papers, high value tape base, meat casing and currency; **textile flax tow** to produce cigarette burning tube, currency, ultra lightweight printing (bible) paper and lightweight printing papers; **oilseed flax bast** to produce cigarette burning tube and lightweight printing paper; **hemp bast** to produce cigarette burning tube, currency, ultra lightweight printing (bible) paper and lightweight printing paper; and **sisal** to produce tea bags, condenser paper, porous plug wrap, filtration papers, laminate substrates, abrasion resistant paper, high value tape base and meat casing. And, cotton pulps from cotton linters and rags are used in many specialty papers.

These and other specialty papers are have very limited markets with high entry level requirements. Due to the smaller market size and difficult market entry, it is unlikely that there will be new market entrants.

4.4.1.5 Summary Comments

The foregoing does not present a hopeful picture for the larger scale use of nonwood fibres in the Canadian and US paper industry. Most of the current usage is in specialty products with limited markets and high entry requirements. And, the one area where new market entrants appear to have made some headway - printing/writing papers - appears to have a limited market due to the high cost of the paper on the market.

The question remains " Are there possible opportunities which can be developed and under what circumstances?"

4.4.2 Potential New Markets for Nonwood Fibre Papers

Two recent unpublished market studies one for a Canadian project and the other for a US project[54, 55] indicated that there are potentially good market opportunities for nonwood fibre based papers under certain conditions:

- the quality of the nonwood content paper must be equivalent or better than that of wood based papers currently on the market
- the prices of the nonwood content paper must be in the same range as the prices of equivalent wood-based papers - i.e. do not expect a premium for the nonwood content papers
- certain paper grades offer more potential market opportunity than other grades

Under the above conditions especially the price and quality considerations, there appears to be sufficient Canadian and US market potential to justify at least one word-class integrated pulp and paper mill in each location. And, based on information from various sources it is conceivable that other mills could be built to serve a larger suppressed demand which has not been evident due to the higher cost of currently available nonwood papers.

As discussed in section 2.2 above, around the world, the current uses of nonwood fibres to produce paper[56] include virtually every grade of paper produced including, but not limited to:

- printing and writing papers
- linerboard
- corrugating medium
- newsprint
- tissue
- specialty papers

Typically, common nonwood pulps (hardwood substitutes) produced from nonwood raw materials such as cereal straws and corn stalks are produced in integrated pulp and paper mills located fairly close to the available fibre supply. Softwood kraft is usually added to provide strength to the paper; however, another nonwood pulp such as cotton linters or flax or hemp bast pulp may be used instead. And, wastepaper pulp may blended in the furnish. The nonwood portion can vary from 50 to 90% and even up to 100% depending on the grade and required quality. The possible combinations are endless and can be adjusted to meet market requirements.

Specialty papers such as currency, cigarette papers, tea bags, dialectric paper etc. may be made from a furnish of 100% nonwood specialty pulps. These pulps may be produced on-site in an integrated pulp and paper mill or in a stand-alone paper mill using purchased pulp supplied by one of a very few specialty pulp mills.

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54 "Prefeasibility Study - Nonwood Pulp and/or Paper Mill, Manitoba, Canada" unpublished report, HurterConsult Incorporated, 2000 - to be made public in mid 2002.

55 "Technical & Economic Feasibility Study for Nonwood Pulp & Paper Mill, Iowa, USA" unpublished report, The Optimum Group of Kellogg Brown & Root, Inc., 1999.

56 Hurter, Robert W., "Nonwood Plant Fiber Uses in Papermaking", September 2001, http://www.hurterconsult.com/nonwood_uses.htm

Combinations of common and specialty nonwood pulps will permit the production of virtually any grade of paper to meet any quality requirements demanded in the global market. Adding possible combinations which include wood pulp, nonwood pulp and recycled wastepaper pulp increases the possibilities for developing paper with specific sheet properties designed to meet specific customers needs.

Furthermore, nonwood pulps can be used as an additive to wood-based papers for a variety of reasons such as:

- to provide the papers with certain specific desired properties - i.e. production of ultra lightweight papers, or papers with increased opacity or better bulk etc.
- to offset higher wood costs
- to provide an incremental increase in mill capacity in a region where woods resources are finite.

The foregoing illustrates that there are may potential uses of nonwood fibres in paper and paperboard production; however, each possible application needs to be assessed on both economic and technical terms.

4.5 Potential Canadian Projects Using Nonwood Fibres in Paper and Paperboard

There are several potential projects which appear to offer potential for the production of nonwood fibre based papers or the use of nonwood fibres in wood based papers:

1. A stand-alone greenfield integrated pulp and 200,000 - 250,000 tonne/year paper mill which would use cereal straw (likely a Prairie project) or corn stalks (likely an Ontario project) as the major fibre raw material to produce printing and writing papers. The nonwood component of the paper could be 40 - 60% with the balance being purchased pulps including recycled fibre pulp and either softwood kraft or cotton linters pulp for reinforcing fibre.

   The key to success for this project will be to produce good quality paper at a cost comparable with wood-based paper.

2. The addition of a nonwood fibre pulping line (from raw material preparation to pulping and bleaching) to an existing integrated wood-based pulp and paper mill and then to blend the nonwood pulp with the woodpulp to produce nonwood content paper.

   The selection of the nonwood fibre would depend on the characteristics of the pulp required as well as availability and costs. Depending on these factors, the nonwood fibres selected could be flax straw, hemp straw, cereal straw, corn stalks, switch grass or any other nonwood fibre raw material which is available.

   Several possible examples of this type of project include:

   a) the addition of a cereal straw, corn stalks or switch grass full chemical pulping and bleaching line to an existing pulp and fine paper mill to provide an incremental capacity increase in production or to substitute for some of the hardwood used in the mill - typically, there will be little if any difference in the paper machine operation if the nonwood fibre content of the fibre furnish is less than 30%

   b) the addition of a cereal straw high yield semi-chemical pulping line to a corrugating board or linerboard mill

c) the addition of a flax/hemp pulping line (from raw material preparation to pulping and bleaching) to an existing wood-based pulp and fine paper mill to provide an incremental capacity increase in production or to substitute for some of the softwood used in the mill

4.6 Possible Government Intervention

Although the market surveys referred to earlier clearly indicate that the general public would be willing to accept nonwood fibre content paper provided that the quality and price of the paper was equal to or better than that of wood-based papers, it may still be difficult developing sufficient market opportunities for companies and entrepreneurs to take the risks involved in developing a project which would incorporate nonwood fibres in the paper.

One approach which could help to alleviate some of these risks is for the Federal Government to develop preferential purchasing practices for nonwood content papers similar to the approach taken in the US under the Clinton Administration with respect to post-consumer recycled fibre content papers.

In October 1993, President Clinton issued "Executive Order 12873 of October 20, 1993: Federal Acquisition, Recycling, and Waste Prevention." which required that all printing and writing papers purchased by the US Federal Government would contain 20% post-consumer waste by December 31, 1994, and 30% by December 31, 1998.[57] On September 14, 1998, President Clinton issued "Executive Order 13101: Greening the Government Through Waste Prevention, Recycling and Federal Acquisition." which required that all paper purchased by the US Federal Government would contain 30% or more post-consumer recycled fibre where practical.[58] As a result of this Executive Order, the US Government Printing Office issued new Government Paper Specification Standards, No. 11.[59]

Similar to the approach taken in the US with respect to post-consumer recycled wastepaper content for federal government paper purchases, the Canadian Federal Government could establish a policy mandating that its paper purchases should include a percentage of nonwood fibres where practical.

57 http://palimpsest.stanford.edu/byorg/abbey/an/an17/an17-5/an17-502.html

58 http://www.access.gpo.gov/public-affairs/news/99news14.pdf

59 http://www.access.gpo.gov/qualitycontrol/paperspecs/index.html