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PERENNIAL GRASSES: A PROMISING ALTERNATIVE FOR NEW GROWTH IN THE PULP AND PAPER INDUSTRY

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ABSTRACT

Growing concerns about the rising cost and diminishing supply of wood fibre has created a renewed interest in the use of alternative fibre sources in the manufacture of paper products in North America and Western Europe. Canada is no exception. Tree plantations are usually the first option considered to increase the wood supply but the climatic conditions prevailing in Canada limit their economic viability. More promising strategies for this climate include improved efficiency in the utilization of fibre produced from the natural forest (improved forest management, production of value-added products, etc.) as well as the development of Canada's vast agri-fibre potential. Agri-fibres in the Canadian context refer to crop residues such as cereal straw and com stalks and new dedicated fibre crops such as hemp and perennial grasses. In eastern Canada, perennial grasses offer the best potential among the agri-fibres. Agricultural residues suffer from major technical problems when used for pulping as well as logistical problems related to supply. Annual fibre crops are currently uneconomical as dedicated feedstocks for the pulp and paper industry. In contrast, no major supply, price, or quality traits appear to limit the use of perennial grasses as a pulp feedstock in eastern Canada.

KEYWORDS: ***Agricultural fibres; economics; hardwood; switchgrass; pulp.***

Making a Business from Biomass

INTRODUCTION

The world market for pulp and paper products is forecast to nearly double during the next two or three decades in response to a growing population and the economic development of countries in the Pacific Rim, including China. Significant new export business opportunities await the Canadian industry, provided it maintains its competitive edge. The Canadian industry has for decades enjoyed access to a vast, untapped, natural forest resource which translates into relatively low fibre procurement costs. The continued growth of the industry has created serious wood supply concerns. This, along with the introduction of new environmental regulations, has pushed fibre costs upward. This is having an impact on the competitiveness of the industry-an industry oriented mainly towards exports of commodity products. At the same time, aggressive new players are entering the world market. Fibre producers located in the southern hemisphere, where tree growth is much more rapid and production costs minimized, are capturing an increasingly large share of the world market. In this context, it is important for Canada to develop low-cost, sustainable fibre sources so that the pulp and paper industry can reduce its reliance on the nation's forests and remain competitive on the world market. The goal of this paper is to explore the role of agricultural fibres in the pulp and paper industry, especially in the provinces of Quebec and Ontario.

Sources of Agricultural Fibres

In the history of papermaking, annual plant fibres were used long before wood fibres. In fact, up until the industrial revolution of the nineteenth century, rags and annual plant fibres were the main fibre sources, until new pulping technologies were developed that could use wood fibre. Nowadays, agricultural fibres represent approximately 10% of pulp production capacity worldwide, with most of this production located in China and India which have limited forest resources. In North America, agricultural fibres represent less than 1% of the pulp production capacity.

Fast growing tree plantations are generally the first option considered by the industry to increase its fibre supply and, in fact, they are a viable option for many of Canada's competitors. The potential of these plantations is nevertheless limited in Canada due to the prevailing climatic conditions. In the southern part of the country, hardwood plantations can be more productive than the natural forest; for example, hybrid poplar plantations in eastern Ontario yield between 2-3 odMg/ha/yr (Hendry, *1990)* compared to 0.75-1 odMg/ha/yr for the natural forest. However, this is still far below yields in South America where, for instance, hardwood eucalyptus plantations regularly achieve annual growth rates *of 10-15* odMg/ha. Increasing the wood fibre supply in Canada would be best achieved by improving the management of the natural forest and developing industries that produce value-added forest products.

Besides increasing wood fibre supply, the Canadian industry is now investigating the potential of agricultural fibres, which can either be residues from current crop production or dedicated fibre crops. The availability of agricultural residues for industrial purposes is restricted to the Canadian prairies. Approximately 37 million tonnes of cereal straw is combined annually on the prairies (Stumborg *et al., 1995),* most of which is available for industrial purposes. Technical problems associated with using straw as a pulp feedstock include the low pulp yield and the high silica content of the feedstock (Rowell *et al., 1997).* Residues from oilseed flax production are also available and currently used in the manufacture of cigarette paper. In Quebec, a recent study estimates that only 115,000 tonnes of cereal are available annually for industrial purposes, a quantity which is scattered over the province (Chartrand, *1995).* Corn stalks have also been considered in Quebec for pulping and approximately *750* thousand tonnes a year could be harvested for industrial demand. However, problems with this feedstock include high percentages of unusable plant parts, such as pith and and nodes, and a low reliability of harvest (Rowell *et al., 1997).*

The alternatives to crop residues are dedicated fibre crops. Annual crops such as hemp, flax and kenaf are known to be suitable for pulping and are, in fact, already being used in the production of specialty paper such as currency and cigarette paper. As far as the production of these crops in Quebec and Ontario for the sole purpose of papermaking is concerned, however, there appear to be significant limitations. Kenaf is well adapted only to the southem part of United States (such as Texas, and Louisiana). Hemp is much better adapted to cooler climates, but it still suffers from legislative problems. The Canadian government is currently considering allowing farmers to grow industrial hemp, but the political uncertainty related to the timing of any legislation reduces the interest of the industry in undertaking serious research into the potential of this crop. Research trials are nevertheless permitted in Canada and preliminary results have shown that productive yields can be obtained on good quality sods. A good rule of thumb for Quebec and Ontario is that hemp requires soils which can support grain corn production. The main problem facing the use of hemp for pulping is that the long fibre (bark or bast fibre), which has high value for pulping, represents only 30-35% of the entire. stem. The remaining inner core of the stem consists of very short fibres. Assuming yields of 10-12 odMg/ha of whole stem, only approximately 3-4 odMg/ha of long fibre are harvested, without accounting for losses. When this fibre is pulped chemically with an assumed 45% yield, only 1.5 odMg/ha are actually transformed into pulp (15-20% of the initial field yield). If whole stem hemp is selling at the same delivered price as softwood, or approximately $100/odMg[1], the fibre cost of a tonne of hemp pulp would be $570 versus $220 for softwood. This explains why hemp bast fibre has not been used in commodity paper manufacturing but only for specialty paper production.

[1]Estimates computed by REAP indicate that whole stalk hemp would need to sell for $70-$100/odMg to compete for land with cash crops (including government support to farmers) in Quebec.

The key to the commercialization of hemp lies in the development of new technologies that can use the entire stem. Otherwise, hemp will either have to wait until softwood prices increase to a point where hemp will become profitable or until it is grown for other purposes (such as textiles) and the residues from these industries used for pulping. Flax and kenaf are also composed of two components, a short fibre inner core and long fibre bark, and in similar proportions to hemp. The issues presented with hemp apply to these two crops as well. Kenaf has been researched as a fibre crop in the United States since the 1960s and yet, given all this effort, no major commercialization efforts have materialized.

In Quebec and Ontario, the development of hemp and flax as dedicated fibre crops for the manufacture of paper faces two barriers, namely, inappropriate processing technology and competition with food crops for good quality soils. The former can potentially be overcome by a substantial research effort while the latter will depend on the price of food crops, including variations in the level of government financial support to farmers. A better strategy would be to grow fibre crops on idle land or on land of lower quality, where conventional crops are not very profitable, so that they would complement the existing farm economy and be less vulnerable to fluctuations in food crop prices. Unfortunately, hemp and flax do not appear to be suitable for those lands-at least not on the scale required by the pulp and paper industry.

Perennial grasses grown for energy production have been studied by the US Department of Energy since the mid- 1980s. Switchgrass was chosen as the model crop from their research program due to its ability to produce high yields on idle land or marginal soils. This crop has been researched by REAP-Canada in Quebec and Ontario since the beginning of the 1990s. Yields in the order of 8-12 odMg1ha/yr have been reliably achieved. The grass can be used for energy production but was more recently identified as a close substitute for hardwood fibre in pulp and paper making (CSPP, 1995; Radiates, 1996). In regions of Quebec and Ontario where grain corn can be grown, switchgrass should receive sufficient heat units to grow successfully. In cooler regions, reed canary grass, which has also been identified as substitute to hardwood fibre by the Scandinavians, would be better adapted. In the main cash crop cultivation areas of Quebec and Ontario, the possibility of growing a dedicated fibre crop as a complement to the existing farm economy now exists.

Potential Market Size and Economics

The production capacity for fine papers in eastern Ontario and southwestern Quebec is nearly 900,000 tonnes annually. Switchgrass has been shown to successfully replace 20% of the hardwood component of this type of paper, which usually includes up to 80% hardwood pulp. Given these ratios and current knowledge, up to 15% of the paper produced could be switchgrass paper. This translates into a potential market size of 135,000 odMg of switchgrass pulp, and 300,000 odMg of switchgrass; fibre. An additional 100,000 odMg of switchgrass fibre could be used if the chemical hardwood market pulp production capacity in the region is included. Thus, with the current level of technology, a market demand of nearly 400,000 odMg per year is within reach of farmers in eastern Ontario and southwestern Quebec. In order to supply this market, 33,000 to 50,000 hectares of land and yields of between 8. and 12 odMg/ha/year would be required. Ile agricultural land base of southwestern Quebec and eastern Ontario suitable for switchgrass production totals more than one million hectares. Hence, the production of 400,000 odMg of switchgrass would require less than 5% of that land base, which is not substantial. Girouard *et al.* (1996) and Fox *et al.* (1997) have estimated that on medium to low opportunity cost land, farmers in those regions would at least break even with prices of $50/odMg (FOR mill). Hardwood fibre in the region usually sells for $80-$100/odMg to pulp mills. Assuming a minimum price of $50/odMg and maximum price of $100/odMg farm receipts of $20-40 million are possible. With most acreage on idle or low quality land, these receipts would add to existing farm receipts and strengthen the farm economy. The economic benefits generated by the pulp and paper industry itself in rural communities should also not be overlooked.

DISCUSSION AND CONCLUSION

While several possibilities exist for increasing the supply of fibre to the Canadian pulp and paper industry, many of these have serious drawbacks that will limit their viability as future strategies. Tree plantations have limited potential in Canada due to our cold climate. In the Canadian prairies, the major limitation of the use of agricultural residues for pulping is the near absence of pulp mills in the regions where those residues are available. In Ontario and Quebec, cereal straw residues are not available in quantities sufficient to support most pulp mill requirements. Annual crops like hemp and fibre flax produce high quality fibre but are prohibitively expensive compared to softwood. A low long fibre yield (30-35%), the need to use good agricultural land to obtain high productive yields, and the very fact that they are annual crops with corresponding yearly establishment costs, explain their limited attractiveness as fibre sources by the paper industry.

The key to the production of a long term, stable, low cost supply of fibre for industrial markets in Quebec and Ontario appears, therefore, to be the development of adapted perennial grasses. Perennial grass fibre crops such as switchgrass appear to hold promise due their adaptability to low quality, low opportunity cost soils. The addition of 15% switchgrass fibre to the blend of pulp used to produce fine papers in eastern Ontario and southwestern Quebec would require the production of nearly 400,000 odMg annually. This would provide additional farm receipts of $20-40 million/year.

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