The Sustainability of Tree Paper vs. Hemp Paper

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December 7, 1998

ERS 218

University of Waterloo

Tree + Hemp.

P.1: why 'prod.' (tree) + 'cons.' (hemp)?

Intro. good, though last para. a bit confusing!

(Hever, 1993), not in your biblio.

P.2: westhemp URL shld. be referenced more fully + in the back too.

P.2 Motivation for botany in 1998?

P.3 → Sources for your table?

→ Table: are processes identically in parallel as you say?... horizontal lines suggest that... use ↓ arrows instead?

P.3: (Pulp and Paper, 1991) not in biblio.

- could be arranged into more paragraphs.

P.7 → Is not there also machinery use in paper-making, which contribute to global warming?

P.8 '300-300 mm of rainfall' → over what period?

→ how compare with actual values in S. Ont.?

P.9 → top line: not a sentence.

P.10 → Economic discuss less clear: env. elements flow into it (can you say of the? Simply these impacts shld. be costed?)

→ impacts be quantified?

→ can you substantiate statements more?

→ more about potential for economies of scale?

P.11: Good to try + integrate env. + econ.

→ a bit uneven to read + places old, have more substantiation by evidence or examples... good research.

*This report has been printed on hemp paper

Introduction

The current paper system that exists today is a very resource intensive industry, A great amount of trees are needed to produce the paper used for various uses in this day and age. As the importance of finding a viable alternative for tree paper, people have been looking at other natural resources to compensate the need for paper in our society. The hemp plant, a distant cousin of marijuana is, an abundant resource for paper and other products. The cradle-to-grave systems of tree paper as compared to the system of hemp paper are very important to look at. One can assess the sustainability of a system through looking at all the aspects that go into the process, ranging from economic, social and environmental aspects. The question that is being posed is what is the relative sustainability with regards to the environmental, economic and social aspects of the present tree paper consumption as compared to hemp paper production? For the purposes of this assessment, 100% tree paper will be looked at as in comparison to 100% hemp paper.

The University of Waterloo campus uses an exceptional amount of paper. Another question that was posed was; how can this be related to the UW Campus? Looking at the current system and attempting to find alternatives in which the system operates can assess the sustainability of these-' systems with respect to the campus.

History of Hemp

Hemp has played an important role in the development of the paper making industry throughout history. In examining the current state of the hemp pulp and paper industry, it is important to consider its historical role. According to 'The Emperor Wears No Clothes', by Jack Herer, "From

7.5 to 90% of the worlds paper manufactured before 1883 was made from cannabis hemp, including the Gutenberg Bible and the first two drafts of the Declaration of Independence" (Herer, 1993). Many different factors explain why hemp has been so important in history. Hemp's durability made it a very reliable and accessible natuml fiber. In addition, most of the paper prior to the 1900's was made from rags. Remaining scraps and clothes were mixed together and recycled into paper. Considering that hemp and flax were the primary materials used to make clothing in that time period, most paper was composed of hemp and flax fibers (http://www/westhemp.com/paper.html). However, as the demand for paper continued to grow industries began to search for alternative resources to use for papermaking, timber being of primary emphasis. The early 1900's was a booming period for timber, paper and large newspaper companies. The increased demand for paper resulted in the increase in the use of tree pulp in the paper making process. Meanwhile, hemp cultivation continued,,,until 1938 for the purpose of papermaking. During this time, hemp fiber stripping machines and machines to conserve hemp's' high cellulose pulp, were being perfected and began to enter the market. However, in 1938 Canada banned the production of hemp under the Opium and Narcotics Act (Draper, 1998). As a result, hemp disappeared from the market because it was no longer cultivated. Therefore, public knowledge of hemp and its uses also declined. Thus, it is important to realize that current hemp technologies are in the developing stages because they are often based upon the state of the technologies prior to 1938. In June 1996, the Canadian government made it legal to cultivate industrial grades of hemp (Draper, 1998). Currently, technologies continue to improve for hemp as a paper making material and perhaps, in the years to come hemp will again secure its place within the paper making industry.

Comparison of Hemp and Tree Pulp Paper-Making Processes

Tree Pulp Paper	Hemp Pulp Paper
Source: Trees from naturally standing forests or tree plantations. Methods used for logging include: primarily clear cutting and also selective cutting, shelterwood cutting, and patch cutting.	Source: Hemp seed is sown in a well drained, sandy loam soil with a pH above 6.0. A pH of 7.0 to 7.5 is preferred. Hemp is harvested 60 to 90 days from the seed date. The plant grows approximately 10 tons per acre in approximately 4 months.
Cleaning: All non-fibrous components need to be removed and remaining fibers must be cleaned of dirt, rocks, and other contaminants.	Harvesting: Hemp is harvested using sickle-bar mowers and hay swathers that cut the hemp stock and prepare it for retting.
Fiberizing: The elementary fibers are taken apart by either chemically removing the glue that holds them together, or by mechanically tearing the fiber structure apart. This results in material known as pulp.	Retting: Is the process of beginning to separate the bast fibers from the hurds or other plant tissues (http://www.gov.on.ca/omafra/english/crops/fax/hemppr od.htm) pg7*. Dew retting occurs in the field where the stalks are spread on the ground so that dew, rain, sun and bacteria dissolve and wash away the chlorophyll and most of the gums , leaving only the fibrous bark and wood remaining. Retting may also be controlled unnaturally by using water and/or chemicals. This process occurs over a 12 to 18 days and the swaths need to be turned once or twice during this periods to ensure even retting.
Cutting: Fibers must be cut to the right size to give a homogeneous paper sheet.	Binding: Hemp is bound into bundles when the woody core breaks away easily and is then baled for the paper mills.
Classification: Fibers suitable for use are separated from ones that are too short, too long, too dirty etc.	Cooking: Hurds are cooked to reduce the fibrous raw material to a residue of cellulose pulp by means of a chemical and heat process. Water is added (5 to 10 times the fiber weight) along with chemicals to remove the lignin and pectin from the fibers. The fibers are cooked until they are separated form each other.
Bleaching: The suitable fibers may be bleached to higher "whiteness"	Beating: Fibers are cut to a proper length and given the required surface roughness for better bonding capacity.
Refining: Fiber surfaces are "roughened". The greater the surface roughness of a fiber, the better it adheres to other fibers in the paper sheet. Thus, increasing the strength of the paper sheet.	Bleaching: Bleaching is added during the beating process or transferred to separate tanks. Bleaching often involves chlorine compounds but can also use oxygen and hydrogen peroxide, which generate wastewater that can be recycled back into the process.
Dilution: Fibers are laid out evenly into a homogenous sheet. Pulp is then diluted with large amounts of water.	Pressing: Once bleached, the pulp is ready to be pressed by the paper machine.
Formation: The fiber-water slurry is poured on a fine mesh wire. Water will fall through the wire, leaving the fibers to settle into a flat sheet.	
Drying; The wet sheet is dried by subsequent pressing and steam heating processes.	

The tree pulp paper making process and the hemp pulp papermaking process impact on the biophysical environment. Tree pulp paper can result in a short lived, acidic paper that becomes brittle and yellow (Pulp and Paper, 199 1, p. 119). Specifically, the tree pulp papermaking

process illustrates numerous effects on air, land/soil and water. A brief overview of the effects are as follows:

Air

The destruction of forests for the production of paper has great implications upon the atmosphere. Large forests are major producers of oxygen and absorbers of carbon dioxide; thus, they play an important role in filtering pollutants from the air. Forests moderate climate; they take in and hold a great stock of carbon which aids in balancing the stock of carbon dioxide in the atmosphere. As a result, forests are crucial in combating global warming. There is evidence that the Northern Hemisphere's land-based carbon sinks are more important for carbon storage than oceans (Draper 1998, pg. 290). Old growth forests, in particular are the planet's most important land-based carbon sinks (Draper 1998, pg. 291). Unfortunately, old growth forests continue to be the prime target for logging due to then strong and long fibers. Deforestation continues despite the important role of forests in maintaining the ecological balance of atmospheric gases, hence, combating the greenhouse effect.

Land and Soil

Deforestation has devastating effects on the surrounding fand and soil. Trees play an enormous role in replenishing soil and preventing soil erosion by holding soil in place, particularly on slopes. In addition, they keep rivers and seacoasts free from silt because of their intense root systems that anchor the soil. This is especially important for fish such as salmon that can only live in clear running water. Studies have shown that increased runoff due to the absence of trees has greatly injured the salmon's survival rate and reproductive ability (Thompson 1995, pg. 184). There is generally a poor regeneration of these logged areas because of the loss of nutrients due to erosion. Higher levels of acid deposition as well as soil compaction normally occur in

heavily logged areas. This greatly reduces area's ability to return to its original state. Tree plantations also place a tremendous burden upon the soil. It is important to note that tree plantations are not forests. They do not perform the same ecological function as natural forests The first step involved in developing a tree plantation is slash burning in order to remove debris. Slash burning increases the likelihood of soil erosion and decreases the availability of soil nutrients (Draper, 1998 pg.284). They are also heavily sprayed with chemical pesticides to remove brush. The increased use of pesticides results in chemical runoff into nearby rivers and has the potential to contaminate groundwater.

The pulp and paper process itself contributes to land pollution. The process produces an end product known as mill sludge. It is disposed of through land application as fertilizer since it contains traces of nitrogen, phosphorus and potassium. Despite its desirable qualities, sludge from pulp and paper mills that use chlorine in the bleaching process have been found to contain measurable quantities of polychiorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) (Keane & Meyne 1996). Exposure to the mill sludge for wildlife includes direct ingestion, inhalation of sludge or contaminated soil or ingestion of prey that have bioaccumulated dioxins and furans. It has been found that when parents are exposed, the embryos are less healthy at development due to physiological stresses caused by the toxicant (Keane & Meyne 1996). These dioxins and furans integrate into the soil, reducing soil quality and increasing the possibility of surface runoffs therefore contaminating the water supply.

Water

The-type of technology used is of great importance, especially in the bleaching process. Old style pulp mills use excessively high amounts of chlorine compounds in their bleaching process that is known to have hazardous side effects. Modern pulp mills that use oxygen based

bleaching (using compounds such as oxygen, ozone and peroxide) results in less environmental degradation. Different bleaching methods currently used in kraft mills are chlorine-based, elemental chlorine-free (ECF) and totally chlorine-free. The degree of environmental impact will vary with the type of bleaching method implemented. Chlorine based bleaching poses a greater threat to the environment. Its processes involve using molecules of two to five chlorine atoms as compared to only one in ECF bleaching. This results in a molecule with increased toxicity, persistence and lopophilicity, therefore increasing its tendency to transfer from water to fatty tissue of fish. The problem of high persistence leads to bioaccumulation of the molecule up the food chain where it causes further damage. In ECF bleaching, dioxins are minimized so less chlorinated organic compounds are present. Damage to the environment still exists in ECF bleaching 5-M to a lesser extent. In TCF, no chlorine is used in the process; the pulp quality, however, is jeopardized The strength and brightness of the paper is drastically reduced as well as the pulp yield. To produce the same amount of paper, ten per cent more wood must be used (Thompson 1995, p 64). Its potential to be recycled also decreases and the technology to install such a system is high. Due to the problems associated with implementing TCF, the use of ECF is more common in Canada. Despite efforts in recent years by industry and government to reduce both the amount and toxicity of wood pulp mill effluent, the use of chlorine and other toxic chemicals in the pulping and bleaching processes is still commonplace. Research concerning the toxicity of the concentration of timber resins produced by large-scale pulp mills is increasing. Also, pulp mill effluent contains pesticide/herbicide residues from those trees that are harvested from managed tree plantations.

As recently as 1990, the average British Columbia pulp mill released 1,125 kg of organochlorines to the marine environment per day. (Bard, 108). Responding to observations

made in 1980 of elevated dioxin levels in sediment and organisms near B.C. pulp mills, Environment Canada announced extensive fisheries and duck-hunting closures and Health Canada issued public warnings concerning the consumption of seafood.(Bard, 108)

Solid waste from pulp mills also poses serious threats to marine ecosystems. Wood pulp fibers discharged in mill effluent can accumulate around discharge pipes to form large mats from several centimeters up to 15 meters thick.(Bard, 108) These dense mats produce toxic hydrogen sulfide gas. Wood pulp fibers that are diffused into the water system tend to collect with free-floating green algae to produce large fiber mats which, when washed ashore, smother inter-tidal organisms.(Bard, 108)

Organic nutrients that are emitted from wood pulp mills create an increased biochemical oxygen demand. Where little tidal flushing occurs, a concentration of decomposers can deplete ambient dissolved oxygen and, in a synergistic effect, the toxicity of the effluent is intensified.(Bard, 108)

Specifically, the hemp pulp papermaking process illustrates numerous effects on air, land/soil and water. Optimistically, hemp pulp is high in cellulose for easy papermaking. These effects will not be completely understood until the hemp paper- making industry expands. The effects are as follows:

Air

The machinery that is used to cut hemp such as the sickle-bar mower and hay swather requires either gasoline or diesel for fuel . Therefore, both pieces of machinery contribute to global warming by emitting carbon dioxide into the atmosphere.

Soil and Land

Soil erosion is a minimal problem while growing hemp. Hemp actually aids in the preservation of erosion, because the plant acts as an anchor therefore, protecting the soil from runoff The plant has the ability to build and preserve topsoil and subsoil structures, that are very similar to those of our natural forests (Conrad, 68).

Water

Moisture or water is an essential component for all plants to grow. In particular, the hemp plant is a heavy user of moisture. Research measurements undertaken by Ridgetown College indicate that a single crop of hemp requires approximately 300 to 300mm of rainfall (http://www.gov.on.ca/anafa/english/crops/fax/hempprod.html). This is highly unlikely to occur in Southern Ontario. Therefore, irrigation is necessary to fulfill the moisture requirements of hemp. Depending on the system of irrigation, it can put stress on existing local or ground water supplies.

Nutrients of Nitrogen, Phosphorus and Potassium are required in high amounts to ensure a maximum yield hemp crop, It also leaves open the possibility of excess nutrients that are not being absorbed by the plant or retained in the soil, to leech into the surface g-round water. This is more likely to occur in a sandy loam soil than a clay soil. This is the more favored medium in which the hemp plant grows. Leeching of nutrients such as nitrogen into the ground water system can Iead to nutrient pollution. Excess nitrogen in water can make it unfit for human consumption. This can be seriously detrimental to the inhabitants of Southern Ontario given that overall 26% of Canadians rely on ground water for domestic purposes (Draper, 163).

Herbicides and pesticides are not required to ensure a good growth of hemp. If hemp is grown under optimum conditions, it will germinate quickly and reach 30 cm in 4 to 5 weeks from

planting. Therefore, suppressing weed growth and insect infestations (http://www. gov. on. ca/anafa/english/crops/fax/hempprod. htm).

Large amounts of water are used during the hemp paper-making process. Water is used in the cooking process and after cooking for washing away the cooking chemicals, lignin and pectin. Hemp is a highly absorbent material, therefore large amounts of water are required. This is a barrier to hemp paper use with respect to the degradation that this will have on the environment. The use of so much fresh water is not very sustainable.

Economic Sustainability of Tree and Hemp Paper

The main component of any economic structure is money; the amount gained, invested, and spent is the heart of that system. Costs determine what today's action and decisions will be. Generally nothing stands between the profit gain of a company which utilizes the most efficient and successful means toward reaching economic goals. Environmental and health concerns are generally avoided when production of goods, are being established due to the high degree of excess financial burden. Profits are the heart of any economic matter; jobs, future success and the sustainability of a company are immediate concerns. The pulp and paper industry works with these similar premises as the cheaper costs are involved from cutting trees to the production of paper, higher profits can be achieved. Although the way in which success is achieved does not always take into account the well being of the natural environment.

Changing attitudes associated with the manner in which products are generated from forestry practices have resulted in the need for alternatives. Hemp is beginning to the lead the way as a positive alternative that maintains the need of current production demand as well compensating for today's changing environmental standards, Economically speaking, hemp can maintain and

even surpass the necessary rate of production with comparison to current forestry practices by a yield of 4 acres to every 1acre of forest used. It offers a wider variety of products that can be marketed with a decreased amount of harm to the environment. Hemp requires no pesticides and fertilizers to successfully maintain its crop while producing a wider variety of materials that will last longer as compared to that made from trees.

The market demand of environmental friendly alternatives compared to trek products is subject to the success of current forestry practices. Hemp is breaking that barrier by reaching a broader audience through the production of new products in terms of paper, clothing, car parts, foods and even beer. It is covering all aspects and needs of the general consumer, while decreasing environmental degradation. Unfortunately it will still take time for hemp products to justify the regular spending habits of the public. Integration of products currently in the market is key towards popularizing the use and growth of hemp.

Paper is such a product that can use various degrees of fiber within its overall composition. Hemp could be integrated with existing tree pulp and paper industries which would allow for a decrease of production, jobs and overall profit loss while maintaining and improving the sustainability of Canada's forestry practices. The current use of paper is not comparable to the existing hemp paper manufactures and suppliers as compared to the present forest related pulp and paper mills. This result can be seen through the comparative cost relation of hemp and tree paper. As noted by Bob Corner at the Graphic Resources, the University of Waterloo's supplier of paper head-quarters; 1000 sheets of tree paper at a size of 8.5x11 will cost $7.00 while 1000 sheets of hemp paper exceeds to $40.00. This price difference reflects the minimal production and distribution of hemp paper in Canada thus making it an expensive choice to consumers. If both forest and hemp crops were integrated into similar products, both the environment and

consumer would benefit from a sustainable alternative while satisfying the continual needs of people.

Conclusions/ Recommendations

Overall, the current system of tree paper is not sustainable. The environmental effects it has on our environment are far too severe to continue in this manner. However, the economic benefits of continuing to use tree paper are far more viable than hemp paper. Because of the widespread availability of tree papermaking facilities, as well as a concrete market in place, tree paper is and still will remain a major co-mpetitor in the paper market, Hemp paper on the other hand is an e-merging product in Canada because of the recent legalization of growing the hemp plant. Without the availability of processing plants in Canada for hemp paper as of yet, the economic sustainability fiacto of hemp paper is not as viable as tree paper. In other countries, such as in Europe and China there, widespread hemp use is prevalent, the technology for processing is in place. If Canadian companies could borrow the technology from these countries until our own refined technology is developed, the hemp industry could really take off in Canada.

The hemp industry in Canada is in a growing/transition period. In the future with more research and develop-ment carried out on this plant, hemp paper has the potential to dramatically combat paper consumption in respect to the tree paper industry.

Comparatively, the environmenta! sustainability of hemp paper is much more than that of tree paper. Over time, with the development of new technologies in Canada, hemp paper could emerge as a large player on the paper market,

Recommendations for these systems would be to introduce hemp paper as an alternative into our society to increase awareness of its benefits for the environment. If a market is created for it, the

price of the paper will diminish. Locally, hemp paper could be offered in the Environmental Studies Copy Centre of the University of Waterloo campus. The market of this type of people who are conscious of the environment would be willing to try alternatives to lessen their personal impact on the environment. Eventually, if a market indeed has been created on campus, offering hemp paper in all Graphics Services locations across campus could aid in the transition to hemp paper.

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