UBC Social Ecological Economic Development Studies (SEEDS) Student Report

An Investigation into Sugar Cane versus Wood Fiber Paper

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ABSTRACT

This paper uses the triple bottom line method to compare wood fibre paper and sugar cane paper's economic, environmental, and social aspects. Specifically, this investigation focuses on the company TreeZero's sugar cane paper to compare against the 30% recycled wood fibre paper used at the University of British Columbia. The investigation relies heavily on scholarly articles, trustworthy online articles, public surveys, and information provided by TreeZero.

On the economic front, the supply and demand were measured to ensure that TreeZero has more than enough supply to provide UBC of its needs, and the final price is assumed to be the same. However, any investment made into TreeZero is an investment into foreign economics instead of local. On the social front, the CEO of TreeZero claims that their employees are treated extremely well with above average wages, health plans, insurance and benefits. If true, then risk of serious respiratory illness caused by working with bagasse should be minimal. Also, through public survey of 197 students, most students do not know much about sugar cane paper but show support towards UBC transitioning to sugar cane paper. On the environmental front, the investigation of the raw material support that sugar cane is the best choice for the university; however, based on the carbon dioxide emission both papers are the same. Investigation on energy requirement, waste generation, SO_2 and NOx emission, chemical waste of pulping/bleaching process, renewability and life cycle reveal that sugar cane is more suitable for the environment.

The findings indicate that sugar cane paper is the better option of the two for UBC. Given that it is not possible to produce sugar cane locally there may be other alternative sources worth considering. However, the public appears ready to adopt alternate sources even with minimal information and they have an interest in promoting UBC's image as a leader in sustainability initiatives.

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GLOSSARY

Alveolar Macrophage	A type of macrophage in the lung alveoli which eliminates foreign particles, such as dust, from the inhaled air.
Bagasse	A fibrous matter that remains after the crushing sugarcane for the extraction of its juice; the raw material used to make the sugar cane paper.
Carcinogen	Any substance that is an agent in causing cancer.
Cytotoxic	Being toxic to cells.
Dyspnea	Difficulty in breathing; shortness of breath.
Lignin	A polymer related to cellulose which provides rigidity and structure in plants
Sputum	Mucus that is coughed up from the lower airways.

LIST OF ABBREVIATIONS

TBL	Triple Bottom Line assessment
UBC	University of British Columbia
CO_2	Carbon dioxide
NOx	Nitrogen mono-oxide
SO_2	Sulfur dioxide
CEO	Chief Executive Officer

1.0 INTRODUCTION

This investigation report is concerned with the comparison of sugar cane paper versus wood fibre paper and aims to aid UBC with its decision between the two. Specifically, this investigation focuses on the company TreeZero's sugar cane paper to compare against 30% recycled wood fibre paper currently used at UBC.

Sugar cane paper is claimed to be the environmental-friendly alternative of wood fibre paper. However, a variety of aspects must be considered before UBC could decide to switch. In this investigation, the primary method of comparison used is the Triple Bottom Line assessment focusing on the economic, social, and environmental aspects of the two choices. The investigation relies heavily on scholarly articles, trustworthy online articles, public surveys, and information provided by TreeZero. Note that any TreeZero specific information were provided by the CEO Nilan, and could be significantly biased towards sugar cane paper.

The paper is broken down into sections to reflect our triple bottom line assessment. The economics section examines the supply and cost of the TreeZero sugarcane paper to ensure it suits UBC's needs. Also, the regional economic impact is weighted. The environmental section compares the raw materials, the energy requirements, and emission rate of CO_2, NOx and SO_2 of the sugar cane paper and 30% recycled wood fibre paper. Then it focuses on the renewability and the life cycle of source of both paper sources. The social section investigates the health effects from working with the raw materials and the labour care of TreeZero employees. Local public opinion and support for UBC transitioning to sugar cane paper is gauged by a public survey conducted on UBC students.

The paper concludes with a summary of the findings and a comparison on a whole justifying our final recommendation towards either sugar cane or wood fibre paper.

2.0 ECONOMICS

The comparison of sugar cane to wood fibre paper from an economic standpoint comes down to both the consumer product and the regional impact. The the consumer product's supply and cost is of concern directly to UBC. The regional economic impact is much harder to gauge but also must be considered as part of this comparison.

2.1 Supply and Demand

Paper usage at UBC over the past several years has been decreasing at a rate of approximately 10-15% annually. The numbers over the past three years from UBC's primary suppliers Grand & Toy, Unisource, and Staples are as follows:

2010	53,040,018 sheets
2011	47,665,332 sheets
2012	40,712,550 sheets

Fig. 1: UBC Paper Consumption (Goldspink, 2013)

Given the continuation of this trend over the next few years, we can expect this number to dip under 30 million sheets before realistically being in a position for the wide adoption of sugar cane paper. TreeZero currently produces 50,000 metric tons of paper, the equivalent of about 11 billion sheets of paper, annually and intends to double that amount over the next few years (Nilan, 2013). In so it is easy to conclude given the renewable nature of sugar cane that there is sufficient supply to cover UBC's usage.

2.2 Consumer Price

Ultimately, regardless of other aspects, the final sales price of the paper will be the deciding factor for many, as paper is a consumer product. If the price difference is too great, social or environmental awareness will likely not overcome practical needs.

According to Nilan(2013) TreeZero paper can be purchased in bulk at about $40 per case of 10 reams of 500 sheets of paper. The paper would need to then be distributed through one of UBC's official distributors. At a high enough quantity most extra transportation and freight fees would be waived (Goldspink, 2013). 30% recycled wood fibre paper comes in at approximately

$4.50 per ream. In so it is probably safe to assume with some additional distribution costs, both types of paper will be roughly the same price. However, exact numbers are not available without negotiating specific quantities.

2.3 Regional Economics

The forestry industry in British Columbia has been struggling for over a decade now. Viable timber has been reduced due to the infestation of the Mountain Pine Beetle which has increased due to climate change. Poor management and government cuts have led to insufficient replanting of trees. Staying competitive with alternate sources like steel and plastics has been increasingly difficult (BC Ministry of Forests, 2003). As a result, investment in BC Forestry has decreased. More significantly, revenue has decreased to a tenth of its 2001 numbers in just 10 years (Industry Canada, 2012).

There is no possibility of producing sugar cane paper in Canada as we do not have the climate for it. So any investment in sugar cane paper means an investment in foreign economies over local ones. This is currently true but likely will not continue to be. The truth of the matter is that other pressing environmental concerns and the current issues with BC forestry will likely lead us to seek reasonable alternatives in the near future anyway.

On the other hand, TreeZero provides year round work for about a thousand workers in its mills in Colombia (Nilan, 2013). The raw bagasse is diverted from transportation to the landfill and taken directly to the mills for processing. Comparatively, due to differences of cost of living and wages, this provides a much larger net positive benefit for the workers in Colombia versus the impact of producing more 30% recycled wood paper locally. It is a much more efficient process with significant environmental benefits as presented in the next section.

3.0 ENVIRONMENT

3.1 Raw Material

Bagasse is the main raw material for sugarcane paper, and it is found from sugar mills. It takes six tonnes of bagasse (Manonmoney, 2007) in order to produce one tonne of paper. On the other hand, to produce one tonne of 30% recycled wood fibre paper, it takes three tonnes of trees. According to Paula Goldspink, UBC used 204 tonnes of 30% recycled wood fibre paper last year. Hence, UBC consumed 612 tonnes of trees last year. The composition of bagasse and wood are given below in Figure 2:

	Bagasse	**Wood**
Cellulose	45-55%	40-50%
Hemi-cellulose	20-25%	25-30%
Lignin	18-24%	25-35%
Ash	1-4%	1-2%
Waxes	<1%	<1%

Fig. 2: Composition comparison between bagasse and wood fibre paper (Pulp and Paper Resources and Information Site, 2010).

Table 1 shows that wood has more lignin than bagasse, so it will take less chemicals and power to make pulp from bagasse.

3.2 Energy

Paper mills need energy to produce paper, and energy cost is the 25 percent of the production cost of paper, approximately. Coal is the most common input in paper mills to produce energy. It takes 1288 kWh to 1985 kWh to produce one tonne of paper by using bagasse as raw materials (Manonmoney, 2007). However, it takes 11,134 kWh to produce one tonne of paper from wood fibre (Paper Facts, 2013). The average energy wastage in paper mills is 20 percent in western countries. Therefore, in terms of energy, bagasse consumes less energy than wood fibre.

3.3 Waste Generation

Chemicals are very essential to produce paper, and the use of chemicals varies on the raw materials. The major chemicals utilized in paper mills are China clay, calcium carbonate and titanium dioxide as loading material. Calcium soda and chlorine are used for bleaching and making pulp. Paper mills generate high amounts of toxic soda, and soda has a very negative impact on the environment, so it is very essential to remove soda from the pulp sludge before it discharges into the atmosphere. The only way of removing soda is to use a soda recovery system which burns organic soda and produces inorganic compounds. Most of the western paper manufacturers have this soda recovery system (Ahuja, 1992).

3.4 Carbon Emission

Treefrog produces paper from 100% bagasse which is a by-product of sugar cane in order to minimize air pollution due to the disposal of sugar cane. According to TreeFrog, sugar cane paper has 12-16% less carbon emission compared to wood fibre paper when making pulp. For transportation, an average container truck emits 0.112 kg of CO_2 per kilometer per tonne of load, and the distance from Atlanta, Georgia to Vancouver, Canada is 3626.4 km. Therefore, from Atlanta, Georgia to Vancouver, Canada the amount of CO_2 emission is 406 kg in total (Athens, 2008). The carbon dioxide emission from transportation will be less if UBC gets wood fibre paper from local sources.

3.5 SO_2 and NOx emission

It is assumed that SOx and NOx emissions are the same as wheat paper since they are both environmentally friendly. Previous report shows that NOx emissions is 2.6 kg/ton and SO_2 emissions is 1.52 kg/ton for wood fibre paper. Whereas these emission are less than 50 % for sugar cane paper (Guangnan Yu, Kimmy Poon, and Daniel Kudokas, 2012)

3.6 Chemical waste of pulping/bleaching process

Primary investigation shows that TreeZero uses the same processes for pulping and bleaching as wood fibre paper mills use. It also shows that it takes less time to produce pulp from bagasse so it uses fewer chemicals for pulping and bleaching and produces less chemical wastes compare to wood fibre paper (TreeZero).

3.7 Renewability of source crop

In Colombia, sugar cane can grow 3 times a year, so the bagasse is available for the manufacturer throughout the year. Sugar cane paper is cellulose fibre based paper, so it can be recycled normally. However, it takes 10 years for a tree to mature before it feeds for paper production. That's why rainforests are disappearing very quickly, and it's affecting global warming and medical research (TreeZero).

3.8 Life-cycle

Sugar refinery collects sugar cane and extract sugar juice by crushing the sugar cane stalks. After the sugar has been extracted, the process leaves behind bagasse, which is sent to paper mills to produce paper board, photocopy paper, food container and such. Any organic waste remaining after any production can be composted and be used to fertilize growing sugar canes. The life cycle of sugarcane paper is given below:

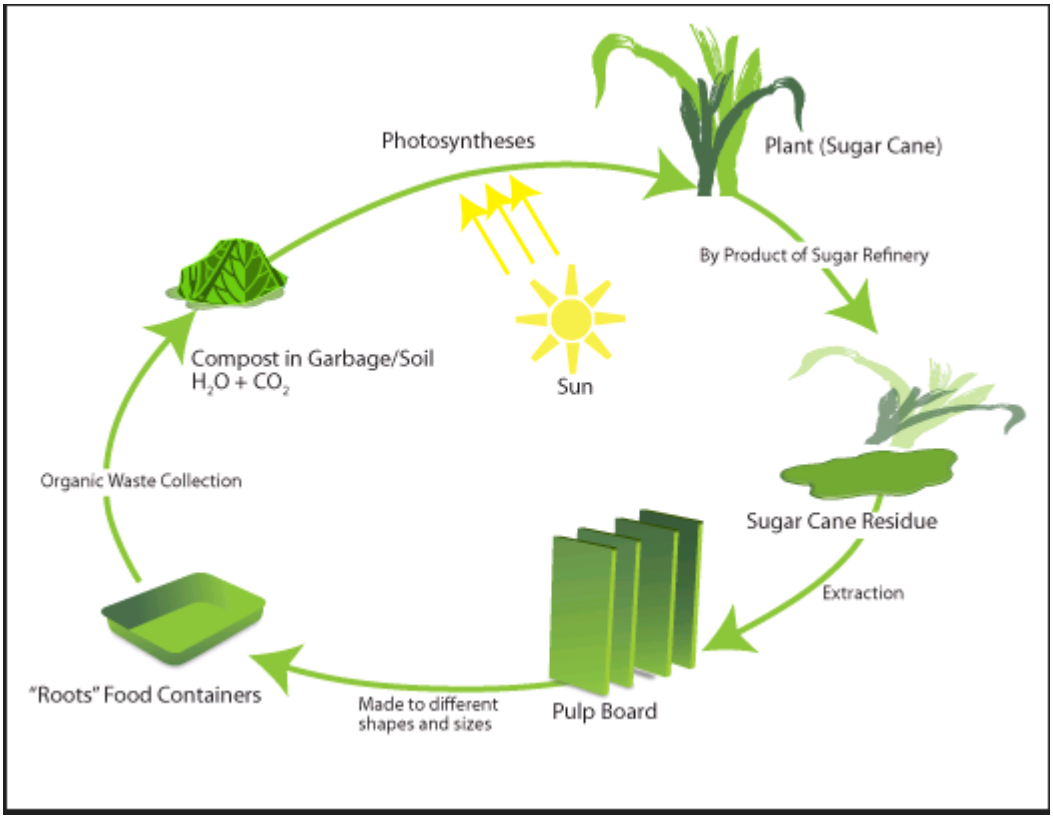

Fig. 3: The life cycle of sugarcane paper (Green, 2011)

4.0 SOCIAL

4.1 Employment and Labour Conditions

The labour laws in Colombia are very similar to the laws here in Canada. There are set minimum wage standards, working hours and overtime, other employee benefits such as vacation and employee rights similar to labor laws here in Canada (Baker & McKenzie, 2008). The legal working age in Colombia is 15 years old, and there are codes put in place such that there would not be exploitative child labor. Colombia laws state that no adolescent, anyone under the age of 18, may perform work that is dangerous or harmful to their health (U.S. Department of Labor, 2008).

TreeZero currently operates two sugar cane paper mills in Colombia which employs approximately 1000 people. According to an email correspondence with the TreeZero CEO Michael Nilan, the mills are very employee focused. Their employees have an average tenure of 17+ years of experience with above average market wages. They are also provided with health plans, life, home and auto insurance, family business management, vacation plan, family days, couples retreat, gyms and a complete healthy living program (Nilan, 2013). Nilan states that all their employees are treated incredibly well. From this, it can be determined that TreeZero complies with majority of the UBC's Supplier Code of Conduct. However, there are certain aspects of the employees working conditions that are difficult to determine or confirm since it is the duty of the CEO to promote their company.

4.2 Health Effects

While there are no known health risks with using sugar cane paper, there are known health risks in handling bagasse fibre. Cases of health risks involved with working with bagasse were reported from as early as 1944. Workers employed to deal with bagasse can acquire respiratory illness as early as 1 week of working with the raw material. Common symptoms displayed by affected individuals include breathing problems, coughing, sputum, tightness in chest and dyspnea. Individuals may experience any combination of these symptoms and have varying severity of these symptoms (Sodeman & Pullen, 1944). These health problems arise when very fine bagasse dust are produced from the handling of the sugar cane raw material which is then inhaled by the workers. An experiment was done to determine the effects of

bagasse fibre dust exposure on alveolar macrophages, a model for lung cells, and it shows that bagasse fibres are more cytotoxic than fibreglass (Bhattacharjee et al., 1980).

With the assumption that bleaching and various processes are similar for both sugar cane paper and wood paper, it can be observed that for wood paper the raw material must also be handled. In the wood pulp and paper industry, trees must be cut down and prepared for pulping. These processes expose workers to sawdust, spores, fungi, various wood volatiles and chemicals. Sawdust is a known carcinogen to humans, however it has been determined that the chemicals required for pulping, primarily sulfate and sulfite, have shown to be the cause of death of workers in the wood pulp and paper industry. Majority of deaths were due to stomach cancer which was related to the workers employed in sulfite mills (Robinson et al., 1986). Despite the fact that there are health issues in the wood pulp and paper industry, these issues have always been there and there are training to prevent or minimize these hazards. The main focus will be on the health issues in the sugar cane paper industry since it cannot be determined whether there are regulations or any safety precautions that are being undertaken in the sugar cane mills in Colombia.

4.3 Social Perception

In order to know the public opinions on sugar cane vs wood fibre paper, 197 UBC students were surveyed. First, each student was asked “Have you heard about sugar cane paper before?" If not, they would be informed of the basic conclusions such as the environmental benefits to sugar cane paper, and similar cost. Results show that 93.4% of students have never heard of sugar cane paper before.

Second, the student would be presented with sugar cane paper and wood fibre paper and asked to compare them for any noticeable difference. Vast majority of students say that the two paper are almost identical except that sugar cane paper is slightly more yellowish. Note that since the comparison test results are so consistent across students, it was decided that there was no need to continue the comparison tests after 90 students.

Third, students were asked “If UBC were to transition to from wood fibre paper to sugar cane paper, on a scale of 1 to 5, how much would you support this decision?” The average of all students came out to be 4.2 out of 5(for detailed statistics, please refer to Appendix A). Vast majority of students point out that the transition to sugar cane paper would not impact them. So if it is good for UBC’s image then they do not see a reason not to support it. Few students raised

concerns that the transition might be costly and raise the tuition fee. They point out that students buy their own papers anyways, so they do not wish to pay extra for UBC's paper usages.

In summary, although 93.4% of students have not heard of the sugar cane paper before, and cannot make an informed judgement on whether to transition to sugar cane paper or not, they show a clear support towards sugar cane paper since it has good environmental benefits and will improve UBC's image. By using the sugar cane paper, UBC could also raise the student awareness of such product.

5.0 CONCLUSION

Upon assessing the multitude of factors, there really is no clear winner across the board. Sugar cane paper definitely is much friendlier to the environment. The supply is renewable and even when considering transportation, requires less energy and produces less waste and emissions. The fact that it is made from a waste product, decomposes faster, and can be recycled along existing processes only aids in its acceptance. However, we will never be able to produce it locally in Canada. It is foreseeable that at a certain point other alternate sources closer to home could compete, if they do not already. But that is outside the scope of this report.

The economic comparison is fairly even given that the driving factor of the paper is largely the end consumer cost. Both types of paper are priced competitively. While we do not have specific numbers for any additional distribution fees on the sugar cane paper, we assume at bulk quantities it is a minimal increase over the list price putting it right in the same price range. The impact on local industry is only a small portion of the trouble BC Forestry is having as it is forced to compete with increasingly better alternatives. Whereas sugar cane production does provide a steady stream of year round work in Colombia.

It is in Colombia where the biggest questions lie. While we can research Colombian labour laws and report what the CEO of TreeZero informs us of the work conditions, the true social impact is hard to measure. Beyond the process of making the paper, workers harvesting the sugar cane in the fields already expose themselves to the bagasse. So it is difficult to even weigh what we should consider our social responsibility to be. To a certain extent we have to take Nilan's claims at face value.

Even if the local awareness is still low there has been a general shift towards supporting environmentally and socially concerned initiatives on campus. The acceptance of those surveyed was overwhelmingly positive even with low amounts of knowledge. People are ready to accept alternative sources of paper at UBC. So even if sugar cane paper ends up not being the best option, we believe it is a good option. At the least, it is arguably a better option than the 30% recycled wood fibre paper currently being used. UBC should definitely consider adopting sugar cane paper.

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APPENDIX A: Public Survey Statistics

Below is a table of the distribution of the students when asked “If UBC were to transition from wood fibre paper to sugar cane paper, on a scale of 1 to 5, how much would you support this decision?”

	1	2	3	4	5
#Students	2	6	16	108	65

Total Participants	197
Average Rating	4.157
% Student who have NOT heard of sugar cane paper	93.4 %

Although, it is assumed that the price would be roughly the same, it was mentioned that the final price will not be known until negotiated with suppliers. The few 1’s and 2’s are students who are extremely concerned that the transition that UBC is making will be costly and therefore raise tuition for them. They also have a negative point of view, “Since the students buy their own paper anyways, why should we risk the raise of tuition?”

The vast majority of students do not know too much about sugar cane paper but do believe in its environmental benefits and had a “why not” attitude.

APPENDIX B: Correspondence with Mike Nilan

The following is from our correspondence with Mike Nilan, CEO of TreeZero on March 12th and March 15th, 2013 (his responses are italicized):

We are engineering students from the University of British Columbia (UBC) researching the feasibility of our University adopting the use of sugar cane paper from TreeZero. As part of UBC's sustainability initiative there are several factors we must look into before giving our recommendation. It is our hope that you can help us answer a few questions specific to TreeZero's paper and process to best represent your sugar cane paper as a viable alternative to the 30% recycled wood-fibre paper we already use.

How much paper can you supply on an annual basis? Now? *About 50,000 Metric Tons. (that is approximately 22,000,000 reams)*
In the next few years? *100,000 MT*
What are the prices of bulk sugar cane paper purchase you offer? *It sells for about $40.00 per case - depending on the distributor, location, quantity and other factors.*
Where does the paper production take place? *Colombia SA*
Where does the bagasse come from? *Colombia SA - contiguous to paper mill.*
How are the products and materials transported? *Mill is contiguous to sugarcane plantation.*
What is the typical route for bagasse to become the product? *Diverted from landfill and shipped directly to our mill.*
What are the emissions rates of NOx and SOx (kg/ton) in the air due to burn fuels or use of chemicals in order to produce pulp and paper from bagasse?
I do not have the exact # (i am not the engineer), but we do emit 13% less CO2 than production of wood based paper. I takes significantly less time to pulp a bagasse based paper than a wood based paper.
What type of process does Treezero use to make pulp from the bagasse? Is it soda or kraft or both? *Same as wood based paper.*
What is the percentage of lignin in the bagasse? *I will inquire and get back to you on this.*

Another advantage of using bagasse based paper is that it is from a diverted waste product and does not effect the food chain (like ethanol). Also - it is advantageous vs. recycled paper also as it does not have to go thru the recycling process i.e. gathering of the paper, de-inking process (highly toxic), transporting de-inked pulp, re-manufacturing etc. Also - our raw material - sugarcane, is a highly prolific renewable source of a cellulose fiber - unlike trees that take 7 - 15 years to grow, harvest and transport.

Thank you for your responses. They've very been helpful. If you wouldn't mind we have a couple follow up questions.
You said it was about $40 per case. How many reams in a case? 10? *Yes - case of 10 reams.*
How many mills do you use in Columbia? Approximately how many people do they employ? *2 mills that employ about 1,000*
Given that sugar cane is seasonal is the production of the paper also seasonal? *Because the plantations are close to the equator, the sugarcane is a year round crop yielding 2 to 3 crops per year.*
Also any additional information would be helpful on the work conditions at these mills. Average Hours/Wages?
Our mill is completely employee focused with average tenure of 17+ years for employees with above average market wages, health plans, life insurance, home and auto insurance. Provide family business management, vacation plan, family days, couple retreat, provides gyms and a complete healthy living programs. They treat all employees incredibly. Mills are ISO 9001, 14001 and 17025 certified.