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An Investigation Into Biodegradable Plastic Bags at UBC Point Grey Campus

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An Investigation into Biodegradable Plastic Bags at UBC Point Grey Campus

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ABSTRACT

Since polyethylene plastic bags are a significant source of world pollution, researchers have created plastic bags that can biodegrade in a compost system. The Design Team for the new Student Union Building (SUB) at the University of British Columbia (UBC) is aware of these issues and desires to select a sustainable product for the building.

An assessment was made of the social, environmental, and economical impacts of biodegradable compostable bags in comparison with polyethylene bags. The product currently being used by the UBC custodial staff is a polyethylene bag supplied by Acklands-Grainger, which is compared with two compostable plastic bags, namely 'Bag-to-Nature' by Indaco Manufacturing Ltd. and 'BioBags' by BioBags Canada Inc.

While the polyethylene plastic bags are relatively inexpensive throughout the life cycle, and thus economically sustainable, the researched compostable bags proved to have more beneficial environmental and social impacts. In the long run, however, the cost of using the newer biodegradable/compostable technology will decrease while the use of polyethylene bags decreases.

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GLOSSARY

- Polyethylene – most widely used plastic, primarily for packaging, and has different densities.
- Biopolymers – polymers produced by living organisms, including starch.
- Carbon emissions – Carbon dioxide and monoxide emissions produced by the use of fuels and breakdown of materials
- Biomass – biological material derived from living organisms, which can be used for energy
- Feedstock – raw material required for an industrial process

LIST OF ABBREVIATONS

UBC- University of British Columbia

SUB- Student Union Building

GHG- Greenhouse gas emissions

HVAC- Heat, ventilation, air conditioning

EN13432- European Standard

ASTM- American Society for Testing and Materials

1.0 INTRODUCTION

Over the summer of 2009, the UBC Waste-Free Committee made an assessment of the garbage bags that were being used at the Point Grey campus in order to determine whether there was a more sustainable alternative. The bags that were being used at the time were regular polyethylene bags and were manufactured in China. The issue faced by the committee, which is a worldwide issue, is the pollution caused by overwhelming amounts of plastic bags. Researchers and engineers are currently designing more sustainable alternatives to decrease that pollution, such as compostable plastic bags. Because UBC strives to be a leader in sustainability, the Design Team for the new SUB is considering using these compostable plastic bags for garbage disposal.

The purpose of this assessment is to determine whether the compostable plastic bags available on the market are a viable option with regards to their social, environmental, and economical impacts. The current product, which was selected by the committee, is a degradable plastic bag supplied by Acklands-Grainger and it will be compared with two compostable plastic bags, namely 'Bag-to-Nature' by Indaco Manufacturing Ltd. and 'BioBags' by BioBags Canada Inc. A recommendation will then be made based on information available from each company and on the Internet, as well as from UBC personnel.

2.0 ACKLANDS-GRAINGER DEGRADABLE BAGS

The custodial department at UBC orders garbage bags from Acklands-Grainger Inc., which is a large distributor of industrial products. These particular bags are labeled as "degradable" and claim to have at least 30% recycled content (Acklands-Grainger, 2009).

2.1 ENVIRONMENTAL IMPACTS

The polyethylene used to manufacture these plastic bags comes from oil refineries as small resin pellets. Energy is needed to heat these pellets into plastic. Recycling plastic involves heat and remoulding, which also requires more energy. Tests performed at 25% recycling indicate that 1/6 barrel-sized (approx. 20L or half of 26"x36") polyethylene plastic bags require 6.1 million Btu's (6,435 MJ) per 10,000 bags (Franklin Associates, 1990). Further environmental impacts are assessed in a cradle-to-grave approach, beginning from the manufacturer to the distributor to UBC campus to disposal at the landfill.

2.1.1 W. Ralston (Canada) Inc.: Manufacturer

The manufacturing company, W. Ralston Inc., has associated environmental impacts, such as greenhouse gas (GHG) emissions produced to manufacture the plastic bags. A study shows that at 25% recycling, 1/6 barrel-sized polyethylene bags produce 11.3 lbs (5.1 kg) per 10,000 bags (Franklin Associates, 1990). The materials and chemicals used to manufacture the bags must be transported to the plant, which also has an impact on the environment. The workers for the company have a similar impact as they travel to and from the plant. The plant also has the HVAC impacts from its operation.

2.1.2 Acklands-Grainger Inc.: Distributor

The cartage from the manufacturer to Acklands-Grainger, the distributor, presents more environmental issues, such as the emissions and usage of the trucks. Travel by workers and HVAC impacts also apply for its warehouse.

2.1.3 UBC Campus

The transportation issues apply for shipment from the distributor to the university campus as well. The loading and unloading of the cases probably requires a forklift, which produces emissions. The janitorial staff at UBC must commute to the university, which also has an impact.

2.1.4 Vancouver Landfill

Dr. Anthony Lau, from the Chemical and Biological department at UBC, performed tests on the acclaimed "degradable" bags and found that they did not degrade any more or any quicker than regular polyethylene bags. Assuming these tests replicate the conditions at the landfill, the disposal will have the same impact as the regular ones. Though it is impossible to quantify the GHG emissions produced exclusively from these bags at the landfill, it is evident that an increased plastic content in solid waste increases GHG emissions.

2.2 SOCIAL IMPACTS

Understandably, there are many social impacts associated with using a polyethylene plastic bag. Below are just two examples of such impacts, which are related with the product source and a term called "greenwashing."

2.2.1 Product Source

One of the main reasons for selecting the Acklands-Grainger product was that it is manufactured in Drumheller, Alberta, which involves issues other than transportation costs. For example, since the product is manufactured and sold in Canada, as opposed to its previous source in China, it provides jobs for Canadians both at W. Ralston Inc. and at Acklands-Grainger Inc. Vicki Wakefield, of the supply management at UBC, calls this "responsible sourcing" as it benefits our society in Canada.

2.2.2 Greenwashing

According to an environmental encyclopedia, “greenwashing is a form of corporate misrepresentation where a company will present a green public image and publicize green initiatives that are false or misleading” ("Greenwashing," 2009). Upon purchasing the degradable bags, perhaps the supply management believed they would have a lighter ecological footprint. However, from Dr. Lau’s tests, of which the UBC Waste-Free Committee is aware, it is understood that this product performs no better than regular bags. While the members of the committee and researchers like Dr. Lau acknowledge the inconsistency in the green claims, students and others who use the garbage bags without that awareness might have a false notion of the associated environmental impacts.

2.3 ECONOMICAL IMPACTS

As previously mentioned, transportation plays a large role in the entire process involved with the use of polyethylene bags. The price of the product itself and dumping costs are highlighted below, as well as the transportation costs.

2.3.1 Product Price

Although UBC most likely pays a discount price on these bags, for comparison it would be fair to list the price indicated on the website. The custodial department orders three sizes of bags (26”x36”, 35”x50”, 30”x38”), which are priced per case at $57.68 for 250 bags, $67.24 for 125 bags, and $70.08 for 200 bags, respectively (Acklands-Grainger, 2009).

2.3.2 Transportation Costs

The distance by truck from W. Ralston (Canada) Inc. in Drumheller, AB, to UBC is approximately 1 110 kilometers. In order to obtain the number of cases demanded, the custodial department would require multiple shipments per year, which would sum up to a larger total number of kilometers traveled per year.

2.3.3 Dumping Costs

These garbage bags are disposed at the landfill, which involves dumping costs in addition to more transportation costs. As of January 2, 2010, the garbage rate at the Vancouver South Transfer Station and Vancouver Landfill will increase to $82/tonne ("Solid Waste – Vancouver Landfill," 2009).

3.0 BIOBAGS CANADA INC. BIODEGRADABLE COMPOSTABLE PLASTIC BAGS

BioBags are a type of bag made from a family of biopolymers consisting primarily of cornstarch and biodegradable polyesters. Mater-Bi, the patented technology used for the raw material, is completely biodegradable and compostable (BioBags Canada Inc, 2009).

3.1 ENVIRONMENTAL IMPACTS

3.1.1 Production and Transportation Emissions

The production of BioBags results in much fewer carbon emissions compared to standard polyethylene bags. Mater-Bi, the raw material of BioBags, emits approximately 1.54 kg of carbon emissions per kg, which is considerably lower than polyethylene bags (Novamont Mater-Bi). Since the manufacturer is located in Norway, transportation is assumed to be done by plane. A calculation of transportation-estimated carbon emissions for a flight from Norway to Vancouver yields 0.77 tons of $C0_2$ (Carbon Calculator).

3.1.2 Energy Consumption

Energy consumption in the production of bioplastics is considerably lower than polyethylene plastic. The total life cycle energy requirements for the production of Mater-Bi are 48.5 MJ per kg, which is also lower than polyethylene bags(Novamont Mater-Bi)

3.1.3 Decomposition

BioBags, if properly disposed of, take a short time to break down into natural materials. According to the manufacturer, if composted at a commercial composting facility, the decomposition time is within 10-45 days. They further state that their product meets the EN 13432 European standards (BioBags Canada Inc, 2009). Mater-Bi is also recyclable and biodegradable. The material can be biodegraded in any environment containing bacteria. Due to the abundance of bacteria on the planet the bags can be broken down virtually anywhere. Some examples include, composts, or buried in soil and even at the bottom of the sea (Plastral, 2007).

3.1.4 Health Issues

There may be some health risks that are involved with the transition to bioplastics. With a high demand for corn, there will be more pesticides and fertilizers that come with the production of the corn, potentially causing an increase in environmental problems. Some negative impacts of pesticides include residues in food, ground water contamination and poisoning hazards (Kent).

3.2 SOCIAL IMPACTS

3.2.1 Societal Impacts on Users

With the use of bioplastic garbage bags at the new SUB, there is a potential for job creation. Instead of transporting plastics away from the University of British Columbia, bioplastics can be sent to UBC's In-Vessel Composting Facility. This would increase employment in the UBC community, particularly at the compost facility and in initial disposal. Composting at UBC also raises awareness about the importance of our environment and would help promote social sustainability.

3.2.2 Ethical/Human Rights Implications

The use of bioplastic raises ethical/human rights implication in society. Since bioplastics are made from renewable resources like corn starch, there are some members of society who believe that these resources could be used as food for poor and starving third world countries instead of the creation of bioplastics. These resources could be used to prevent starvation in poor countries but instead are being used as products such as garbage bags and food utensils.
The European Bioplastics trade group estimated that the production of bioplastics would increase to 1.5 million tons by 2011 (Ryan, 2008). Alternatively, these raw materials could be used to help poor countries that are facing a food crisis.

3.3 ECONOMIC IMPACTS

The transition from plastics to bioplastics also has an economical impact on society. Bioplastics are more expensive compared to standard polyethylene plastic. However, as the number of companies in bioplastics starts to increase and new methods of production are created, it is believed that prices of bioplastics will come down (Momami, 2009).

Also, the price of raw materials, in this case corn, will also increase as industries increase production of bioplastics. As the demand of bioplastics rises, the supply of corn will be lower, resulting in an increased price. This has already been seen over the past few years, for example, from 2007 to 2008, the price of corn rose 80 cents (Momami, 2009).

3.3.1 Estimated Cost of Bioplastic Production

The estimated price of bioplastic is 50 cents to 1 dollar per pound
(Sustainable Bio Materials).

3.3.2 Cost of Bio-Bags

50 litre - 26.6” x 37” = Roll of 32 BioBags for $17.94
Unit Price $0.56/Bio-Bag

125 litre- 32.5” x 39” = Roll of 5 BioBags for $5.54
Unit Price $1.108/Bio-Bag

140 litre -34.3” x 52” = Roll of 16 BioBags for $19.80
Unit Price $1.24/Bio-Bag

3.3.3 Cost of Composting

Composting can be done at UBC’s In-Vessel Composting Facility. The cost of composting at the UBC facility must be taken into consideration.

3.3.4 Estimated Lifespan of BioBags

Estimated Corn Production Time: 60 to 90 days (Mierzejewski, 2009)
Bioplastic Production: N/A
Estimated Travel Time from Norway to Vancouver: 2-3 days
Estimated Use: 1 day per bag
Estimated Composting Time: 10 - 45 days
Estimated Life Span: 139 days
*Bioplastic Production not added

4.0 BAG-TO-NATURE COMPOSTABLE BAGS

Compostable plastics are products which can be broken down by micro-organisms into carbon dioxide, water and biomass at a comparable rate to organic material found under the same conditions in municipal and industrial composting facilities ("Compostable plastics," 2009). Products that are made from these plastics will leave no residue behind when composted correctly ("Evaluation of the…," 2007) .

4.1 ENVIRONMENTAL IMPACTS

Bag-to-Nature bags are made from organic starch based polymers derived from renewable resources such as corn, potatoes and wheat ("Bag to nature," 2009). Because the polymers are derived from plants instead of oil the process is renewable and will reduce the need for fossil fuels used as inputs for traditional plastic. They have been certified compostable by meeting ASTM standard D6400-99 ("Bag to nature," 2009). This certification means that they must degrade by at least 60% in under 180 days ("Degradeable and biodegradeable,"). Therefore Instead of accumulating in landfills and degrading over thousands of years after being used, these bags will become part of the compost they are added to. This compost can then be used locally for agriculture instead of imported nutrients.

4.1.1 Disposal Problems

If these bags are instead put in a landfill the conditions may prevent breakdown of the polymers. Landfills can sealed to keep out air and water but this also stops the necessary microorganisms from breaking down the polymers ("Compostable plastics," 2009). The bags then just add to the build up of methane from other decomposing organic garbage. Because methane is a dangerous greenhouse gas, responsible for 10.6% of human global warming in the US (35.8% from landfills), these bags should be used for organic material going to personal or industrial compost facilities where they can biodegrade in proper conditions (Ewall). This also forces people to have two bins and separate out compostable waste.

4.2.2 Agricultural Impact

The increase in demand for feedstock to use for starch also has environmental consequences. Corn requires high amounts of fertilizer and pesticides (*Water implications of*, 2008). Increased concentrations of nitrogen and phosphorus can leech into water supplies making it less potable and possibly causing an algal bloom ("Compostable plastic: unravelling," 2008). Algal blooms are especially dangerous because it is a rapid increase in algae levels that will deplete the oxygen in the affected aquatic area and cause all other organisms to die ("Algal bloom,"). Pesticides can also pose a health risk for organisms living near the farm depending on what chemical it is and how responsibly it is being utilized. The rise in popularity of these biomass crops can also lead to soil degradation (compacting) as industrial practices are used to extract the maximum level of product ("Soil degradation,"). Poorer farmers will also resort to deforesting for extra land if the crop is profitable enough (Lindsey, 2007).

4.3 ECONOMIC IMPACT

4.3.1 Bag Price

Compostable bags are more expensive than most plastic bags at $10. 50 for fifteen kitchen bags (30"x47"), so the unit price is $1.05 ("Conservation," 2009).

4.3.2 Price Changes

This can be attributed to the fact that Indaco manufacturing is a small Canadian company that is trying to extend its reach west and most of their products are sold via the internet. Because of this they have a relatively small production scale when compared to today's plastic corporations. If the demand for these bags rose then more producers would shift their focus and the prices of compostable bags would become competitive.

4.3.3 Travel Cost

The bags must be shipped from Ontario to Vancouver. Because there is a lack of stores that hold these products they are being shipped once to a internet distributor and then to their destination in Vancouver.

4.3.4 Disposal

The main economic issue is the lack of municipal and industrial composting in the area. However UBC does not face this problem because it already has a composting program and the in-vessel composting facility operated at optimized temperature, oxygen and moisture levels ("Composting," 2008). This could allow people to collect organic waste from their places on campus and use it to fertilize UBC gardens.

4.4 SOCIAL IMPACT

4.4.1 Food Shortages

Renewable resources are great for creating sustainable environments however the issue arises of how to responsibly allocate them. Plants that can be used to make plastic can also feed people, and with the growing shortage of food in the world it may be necessary to meet everyone's basic needs.

4.4.2 Education

As students become more use to separating their waste composting could spread from only being at certain spots to campus wide composting. If everyone on campus used Bag-to-Nature bags and composted their organic materials even more waste could be diverted. This process would require more employees to gather organic material from locations not already visited, employing UBC students.

4.4.3 Widespread Use

These bags provide a vehicle for the implementation of an organic waste collection program on a much larger scale, similar to the Green Bin Program in Toronto ("Green bin program," 2009). If enthusiasm grew and UBC was used as an example the city may be coerced into running city wide organic waste collection. Organic material usually makes up 30% of our waste, so this can be diverted from landfills by curb side collection and turned into more useful compost ("Green bin program," 2009). This would also provide jobs for people working the composting facilities, collection crews and sorters ("Green bin program," 2009).

5.0 CONCLUSION

The following is a summary of the findings of the social, environmental, and economical impacts of the three bags that were evaluated. Each section suggests reasons for the recommendation of BioBags to be used at the UBC campus.

Regarding the social impacts of the evaluated products, the compostable bags seem to be similar in effect. Although they might require crops that could be used for food elsewhere, their use could potentially create jobs at the UBC composting facility. As for the acclaimed "degradable" polyethylene bag, which might have greenwashing effects, its sourcing contributes to jobs in other Canadian places. Overall, the BioBags show a greater potential for use at UBC.

After conducting our research we decided that the Biobag bag is the best option for normal trash collection and that compost able and biodegradable bags should have a role in organic waste collection. Polyethylene plastics emit 3.4kg of carbon emissions per kg of plastic whereas compostable plastics only create 1.5kg per kg of plastic produced. The production of polyethylene also uses more energy at 85.9 MJ per kg of plastic produced while compostable plastic only use 48.5 MJ per kg of plastic made (Momami, 2009). Compostable plastics degrade much better than polyethylene based plastics but only when disposed of correctly. After they have been used they can simply be composted instead of filling more landfill space. When discarded in landfills that are sealed and anaerobic biopolymers cannot be broken down properly because the environment lacks oxygen and moisture which prohibits the growth of micro organisms, thus the decomposing matter is converted to methane. However if the landfill is open while the bag degrades then it will decompose at a comparable rate to other organic material in the landfill. Polyethylene plastics are made from polyethylene, which is an oil product; they are not sustainable because they require fossil fuels as raw inputs instead of renewable resources. Farming has less of an impact on the world than mining fossil fuels, but there will be an increase in pesticide and fertilizer use because corn requires more of these products than other feedstock. These extra chemicals can leech into the environment where they cause environmental problems such as algae blooms and release extra greenhouse gases. When put in a landfill polyethylene bags take close to a thousand years to break down enough for microorganisms to process the polymers. They still release greenhouse gases such as methane and because they don't break down they accumulate in landfills. Therefore the environmental benefits gained from using the Biobag and the inability of polyethylene to breakdown or be sustainable make the Biobag more sustainable from an environmental standpoint.

With regards to the economic impacts in the comparison of BioBags, Indaco compostable bags and Acklands-Grainger "degradable" bags; BioBags were found to be the most expensive per unit. The price for the 140 litre garbage bag for BioBag is listed below:

- BioBags- $1.24
- Indaco compostable bags- $1.05
- Acklands-Grainger "degradable" bags - $0.54

The Acklands-Grainger "degradable" bags are the cheapest bags per unit compared to the compostable bags thus being the most economically friendly bag. Transportation of the product is also taken into consideration for the economic impacts. BioBags are manufactured in Norway, whereas Indaco and Acklands-Grainger are manufactured in Canada. Therefore, the transportation costs for is more expensive for BioBags. As technology and efficient methods of production for bioplastic are created, however, the prices of the bags will start to decrease. This is a positive benefit from an economic standpoint for consumers (i.e. UBC custodial staff). Another positive economic benefit from using BioBags is that the bioplastic bags can be taken to the UBC In-Vessel Compost Facility which saves disposal and transportation costs. Lastly, the price of BioBags may be reduced by creating a long term contract for the use of the product at UBC.

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