# An investigation into Compostable Plastic Bags

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**APSC 262**

**February 02, 2016**

UBC Social Ecological Economic Development Studies (SEEDS) Student Report

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# ABSTRACT

UBC has been continuously making improvements to the way that we recycle and reduce our waste around campus. From what started as just a garbage can, you can now find bins all around campus that are segmented as garbage, paper, recyclable containers, and food scraps. This report looks closer at the details of the food scrap bins around campus. Currently, every food scrap bin is lined with a plastic bag which is thrown in the garbage after the contents are emptied. This produces unwanted waste going into the landfill. To minimize this, UBC sustainability committee has considered a bin washer to eliminate the need for a bag, using a paper bag liner, and using compostable plastic bags while making changes to the UBC composting facility to be capable of composting compostable plastic.

This report looks at many questions about the proposed changes. Does the use and disposal of compostable bags for food scraps have less environmental impact than using plastic bags and then throwing them out? What would the impacts be of switching from one system to another, or simply not lining composting bins altogether? Are people more likely to compost with or without bags? We look at the life cycle impacts of several food scrap bags (including plastic, paper, and compostable), with a focus on life cycle GHG emissions.

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## WORK BREAKDOWN STRUCTURE

Robert: Abstract, Introduction, Formatting

Benjamin: Environmental Impacts

Ramin: Economic Impacts

Peter: Social Impacts

Blake: Impacts and Indicators, Conclusion, Formatting

# 1.0 INTRODUCTION

Inspiration towards sustainability, through a reduction of waste in our landfills, is one of the goals of the UBC Sustainability Committee. The purpose of this report is to investigate the different options for the composting of food scraps at UBC's Vancouver campus. Each option is plausible but we will focus on deciphering if the use and disposal of compostable bags for food scraps has less of an environmental impact (especially GHGs) than using plastic bags and then throwing them out. People may or may not be more inclined to compost their food scraps if they knew that UBC was going to use compostable bags as opposed to plastic bags. An evaluation of the possibility of using compostable plastic bags will be presented through a triple-bottom-line analysis that reviews the environmental, economic, and social impact of the proposition.

# 2.0 IMPACTS AND INDICATORS

When analysing the use of compostable bags, we must take into account the triple bottom line of the proposed project: The economic, environmental and social factors. The focus of this project is almost entirely focused on the environmental and social aspects, aiming to change people's opinions on composting, and provide a beneficial impact on the environment. The economic costs of this project may not be as important as the other two, as its goal is to provide environmental benefit, regardless of the cost. However, it is worthwhile to analyze the economic impact, as a cheaper solution will be more desirable for the stakeholder involved.

# 3.0 TRIPLE-BOTTOM-LINE ANALYSIS

## 3.1 Environmental Impact

Many people believe that compostable plastic is better than conventional plastic because of its ability to degrade by biological processes during composting to yield CO2, water, inorganic compounds, and biomass. In addition, its renewable material is more environmentally friendly compared to conventional plastic which its raw materials are oil and natural gas. However, further study needs to be done to determine whether compostable plastic can be the complete substitute for conventional plastic.

### 3.1.1 Purpose & Methods

This study will determine if traditional plastic bag can be replaced with compostable plastic bag. Life Cycle Assessment (LCA) calculations is used to determine the impact of compostable plastic to the environment. Based on US Environmental Protection Agency, LCA is a systematic set of procedures for compiling and examining the inputs and outputs of materials and energy and the associated environmental impacts directly attributable to the functioning of a product or service system throughout its life cycle.

## 3.1.2 Results

### a) Greenhouse Gases

Carbon dioxide ($CO_2$) is the gas that causes global warming, but the biological process during composting of compostable plastic bags will produce $CO_2$. Ironically, conventional recyclable plastic bag will not produce carbon dioxide since it will not degrade in the landfill.

**Table 1**. Total LCA cradle-to-grave CO2 equivalent (in mg) ofr the production, use, and disposal of 1000 grocery bags

| | **Paper bag with "worst case scenario" of methane emissions** | **Paper bag with "sequestered scenario" of carbon dioxide emissions** | **Recyclable Plastic Bag** | **Degradable plastic bag With 100% aerobic decomposition in landfill** | **Degradable plastic bag with 50% aerobic & 50% anaerobic decomposition in landfill** |
|---|---|---|---|---|---|
| **20 year $CO_2$ equivalent** | 447,350,000 | 76,650,000 | 21,350,000 | 109,300,000 | 221,300,000 |
| **100 year $CO_2$ equivalent** | 202,200,000 | 65,490,000 | 18,850,000 | 99,300,000 | 134,800,000 |
| **500 year $CO_2$ equivalent** | 90,410,000 | 60,910,000 | 17,850,000 | 87,320,000 | 92,100,000 |

The table shows that conventional recyclable plastic bag has the lowest level of $CO_2$. In addition, the $CO_2$ of degradable plastic bag is 9 times of the level of recyclable plastic bag.

**b) Energy**

| Energy in MJ | Paper Bag | Recyclable plastic bag | Degradable plastic bag |
|---|---|---|---|
| **Coal** | 320 | 65 | 161 |
| **Oil** | 207 | 206 | 353 |
| **Gas** | 391 | 186 | 705 |
| **Total** | 922 | 457 | 1219 |

**Table 2**. The amount of fossil fuels and feedstocks, express as energy, required for the production, use, and disposal of 1000 grocery bags

The table shows that recyclable plastic bag has the smallest consumption of fossil fuels and feedstock. The consumption of fossil fuels and feedstocks of the paper bag is more than 2 times of the recyclable plastic bag, while degradable plastic bag uses more than 2.5 times of the consumption of plastic bag.

| | Paper Bag | Recyclable Plastic Bag | Degradable Plastic bag |
|---|---|---|---|
| **Electrical Energy MJ** | 649 | 148 | 325 |

**Table 3**. Electrical energy required for the production, use, and disposal of 1000 bags

The table concludes that recyclable plastic bag uses less electrical energy than paper bag and degradable plastic bag. The electrical energy consumption of paper bag is 4 times of the consumption of recyclable plastic bag and degradable plastic bag uses 2 times the amount of electrical energy that is required by recyclable plastic bag.

**c) Acid Rain**

Most of the facilities that disposes grocery bags are still using coal powered electricity generating plants. These plants produce sulfur and nitrogen oxides that cause the acid rain.

| Acid Rain Emission (mg) | Paper Bag | Recyclable Plastic Bag | Degradable Plastic Bag |
|---|---|---|---|
| **SOX** | 579,000 | 75,800 | 413,000 |
| **NOX** | 264,000 | 68,100 | 456,000 |

**Table 4**. Acid rain emission from all operations to dispose 1000 grocery bags

Based on the table, recyclable plastic bags produce the least sulfur and nitrogen oxides emissions. Also, emission of the paper bag is ten times of the emission of recyclable plastic bag, while degradable plastic bags produce five times higher emission than recyclable plastic bags

## 3.1.3 Environmental Impact Conclusion

The plan by UBC to replace the conventional plastic bag to the compostable plastic bag seems still a long way to go. Based on the results of Life Cycle Assessment above, it clearly shows that compostable plastic bag is not a perfect replacement of traditional plastic bag. In addition, replacing conventional plastic bag with compostable plastic bag will not decrease the amount of waste in the landfill. This is because compostable plastic bag will only breakdown in large composting facility (Killinger, 2007).

## 3.2 Economic Impact

The regular plastic bags are still popular and used very often. However, the introduction of compostable bags slowly replaces it. Government organizations as well as public associations are trying to invest into a sustainable future by reducing the waste. UBC has installed compostable around the campus only for public use. The bin liners are currently not provided for students by UBC housing, and according to their website, they currently have no plans on extending it further.

### 3.2.1 Purpose

This part is aimed to compare the price of compostable bags with regular ones. Different types of data is compared in order to isolate the average price it costs UBC to purchase.

### 3.2.2 Methods

The first step used was to determine the economic viability of plastic and compostable bags. By comparing several data, we were able to calculate the approximate cost it takes UBC to maintain the current level of waste management.

### 3.2.3 Results

**Table 5.** Price comparison of garbage bags

| **Type of Bag** | **Size (Kitchen Use)** | **Size (Curbside)** |
|---|---|---|
| **Compostable** | $5.99 for 20 bags | $5.99 for 10 bags |
| **Plastic** | $3.99 for 20 bags | $3.99 for 10 bags |

* Results are based from Canadian Tire Prices for a specific brand named “ Glad”

It should be noted that UBC purchases compostable bags at a lower rate than shown here due to several discounts offered.

**Table 6.** Weight comparison of garbage bags

| Type of bag | Average weight for 1 bag |
|---|---|
| **Compostable** | 12g |
| **Plastic** | 17g |

As we can see, compostable bags tend to be lighter, making it easier for transportation and storage. Assuming ten thousand bags are needed monthly, 10000x12=120 kg compared to 170 kg, saving 30% of space and reducing labour work required.

### 3.2.4 Economic Impact Conclusion

Based on the results, it can be concluded that compostable bags are quite expensive compared to regular plastic bags. Additionally, compostable bags require transportation from UBC to the landfills located on the south part of Vancouver. This increases the overall cost and makes it challenging for people to obtain. However, it should be noted that on the long term period, compostable bags cover its costs by reducing the waste.

## 3.3 Social Impact

One aspect of sustainability to consider is the social impact of the approach taken towards sustainability. For example, we may consider such questions as how would people react to sustainable alternatives to plastic bag linings when they are replaced with biodegradable ones. Another such question could delve into the psychology of passersby who happen upon advertisements of sustainability and observe if such signs incline them towards being more environmentally minded.

### 3.3.1 Purpose

The purpose of analyzing social impact is to better observe the impact of switching from one system to another and understand the shift in order to cater more towards being socially acceptable and welcoming. The reasoning behind catering such intentions towards the people is because we desire to discover the most optimal solution for sustainability as well as increase awareness.

### 3.3.2 Methods

Our main method of determining the social impacts surrounding plastic bags and sustainability, we started a poll with two questions: the first asking whether one would throw compost into a public waste bin with no plastic lining, and the second asking whether one would prefer a sustainable, biodegradable bag over a simple plastic one. Both polls were created using Google Forms, and shared with multiple groups at UBC over a multimedia platform such as Facebook.

### 3.3.3 Results

The poll received 73 responses. The first question inquired by the poll asked about whether one would compost in a public waste bin that did not necessarily have a plastic bag lining. 49.3% replied "Yes"  that it would not matter if the waste bin had a plastic bag lining. 20.5% replied "No" that it mattered to them that the waste bin had a plastic bag lining. 30.1% replied that it did not matter either way.

Summarily we can understand that about 69.8% reported to not being deterred by the absence of a plastic bag lining. This showed that the common psychology of those who discard compost remained largely unaffected socially when it came to public waste bins. Considerations such as public sanitation were decidedly not a great disincentive for those who compost.

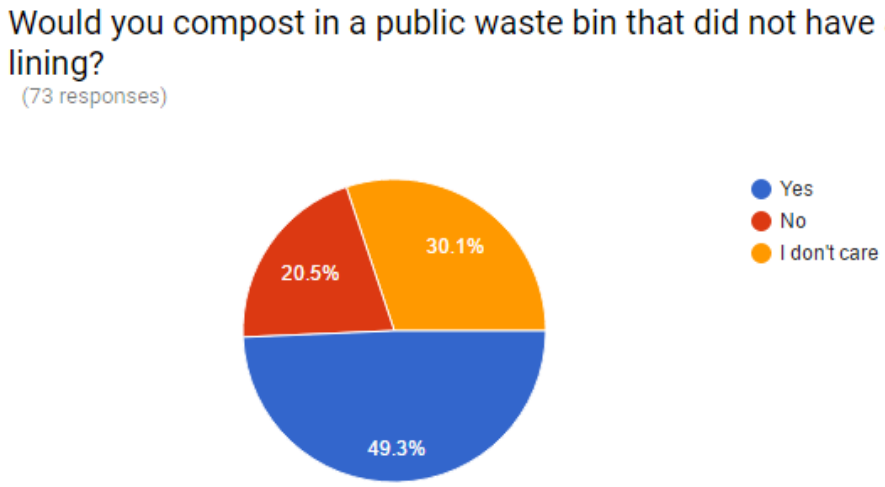


**Figure 1. The above shows a pi chart delineating the different proportions accorded to the different psychological perspectives of those who compost**

The second question asked the question whether, if given the choice, one would prefer to compost in a waste bin with a biodegradable plastic lining or whether it would not matter at all. A strong majority, about 69.9%, reported to prefer to compost in a waste bin with a biodegradable plastic bag. 24.7% reported to not care while a mere 5.4% reported to preferring a waste bin with no bag lining.

The results of the second poll were interesting as it showed that despite the great overwhelming majority of the first poll of people who would compost in a waste bin without a plastic bag, it was still preferable to have access to one that did have a lining. Furthermore, a vast consensus of the people who have taken the poll stated that they would take the choice of being environmentally conscious and use a waste bin with a biodegradable plastic bag.

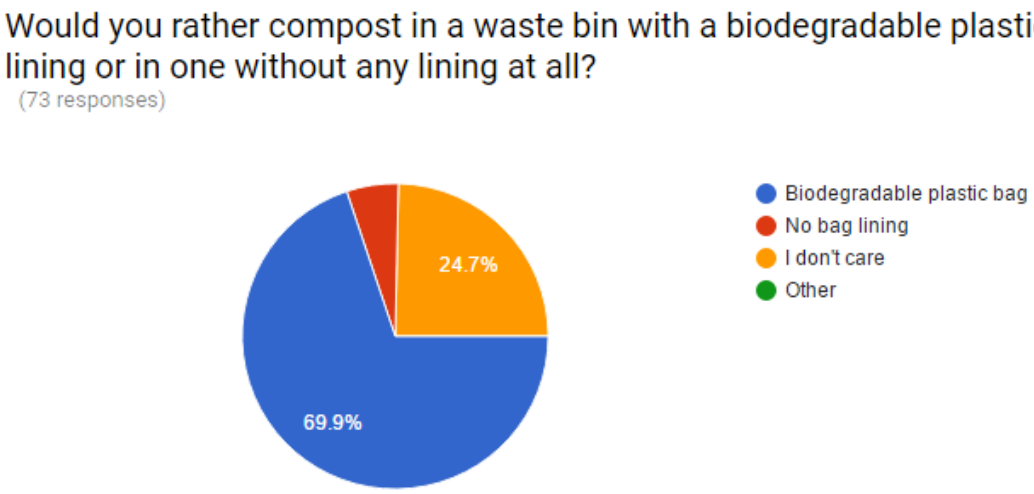


**Figure 2. The above divides the participants of the poll into a chart according to their answers to the poll of whether one would prefer a biodegradable plastic bag lining**

## 3.3.4 Social Impact Conclusion

In our investigation into the psychology of people on composting, we understood that it did not greatly matter whether a bag had plastic lining or not and also that, given the choice, it was preferable that the bag had a plastic lining and was biodegradable.

However, the poll specifically addressed only public waste bins, and it should not account for private use waste bins where users may be more conscious of the sanitation hazard of simply composting without a plastic lining.

Ultimately, we may conclude that the social impact of bag lining should not be a strong consideration in the triple bottom line. However, as there is a general worldly push towards sustainability, we can also conclude that creating a biodegradable plastic bin lining will presumably push more people towards the more sustainable option, incentivizing our own push towards creating biodegradable plastic bin linings.

## 4.0 Conclusion and Recommendations

Economically, the compostable bags have a higher cost than the traditional plastic bags. However, this cost differential may be a result of the social view on the compostable bags. Currently, using plastic bags is the social norm, which influences manufacturers to not only produce more bags, but also at a cheaper price. One potential impact of this project would be the change in social attitudes towards compostable bags, perhaps bring the compostable bags to the same level as plastic bags in terms of cost. Similarly, when analyzing the environmental impacts of compostable bags vs plastic bags, we found that in the measuring of sulfur and nitrogen produced, electrical energy needed, and CO2 produced, the compostable bags were worse than their plastic counterparts in all three categories. However, this may stem from the same issue as the economic impact. Compostable bags are not currently the norm for use, so there is less motivation for companies to attempt to improve them. Our recommendation for the issue of plastic bags vs compostable is that, despite the temporary disadvantages, it may be best to "bite the economic bullet" until we can change the social attitudes of those at UBC and potentially all of Vancouver.

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# APSC 261/262 Sustainability Project Outline

This term you will conduct a triple bottom line assessment of one or more products, materials, technologies, practices, concepts or programs, currently or potentially in use at UBC. Traditionally the “bottom line” in corporate decision making is determined only by financial costs and revenues. “Triple” bottom line refers to decision making that takes into account social, environmental, and economic impacts (both negative impacts, or costs, and positive impacts, or benefits). Increasingly companies, municipalities, and other organizations are employing triple bottom line assessment to choose what products to buy, what technologies to use, and what their strategic direction should be. This assessment can be very detailed – for instance, calculating the energy used in the entire life-cycle of a product – or more basic – checking whether a product is fair-trade certified or not. Given restrictions on time, resources and available information it’s never possible to catalogue ALL relevant social, economic and environmental impacts. However, even a limited study can expose a great deal of information that can direct decision making, especially when that information is social or environmental, which is usually overshadowed by economic concerns.

UBC strives to be a global leader in campus sustainability, which is reflected in many of its sustainability policies, programs, strategies and initiatives. The APSC 261/2 Sustainability Project is part of this larger vision, and ties into the UBC SEEDS (Social Ecological Economic Development Studies) Program. UBC SEEDS aims to create a more sustainable campus in terms of building design, water and energy practices, food systems, climate change, waste management and more. It connects faculty, students, and staff to work together on projects that address real campus sustainability issues and translates these issues into applied learning projects. By participating in this project, your work will be reviewed for implementation by your targeted community, and will be published in the UBC SEEDS online library and UBC’s cIRcle repository.

The specific objective of APSC 261/2 Sustainability Project is to inform those making changes to the operation of units at UBC. This term, the units include the UBC Free Store; UBC Access and Diversity; UBC Sustainability and Engineering; UBC Human Resources; and UBC Common Energy. No matter which unit your investigation relates to, your challenge is to do the detailed assessment and hard thinking that will enable the relevant stakeholders to make informed decisions about enhancing the sustainable operation of their unit. The results of your assessments will be reviewed and discussed by the stakeholders, with the most promising recommendations potentially acted upon.