Life Cycle Comparison of Disposable and Compostable Food Delivery Materials within Grenfell Campus

Kevin Lam
Grenfell Campus
Memorial University of Newfoundland

1.0 – Introduction

Everyday millions of disposable plates, cups and utensils are used in fast food establishments, cafeterias, restaurants and homes worldwide. These single-use disposable plates, cups and utensils, when made of polystyrene or plastic, do not biodegrade and decompose like fruit, vegetables or meat; they only breakdown into smaller pieces on a physical level. This lack of decomposition means that these products persist and accumulate in landfills consuming the available space and contaminate the surrounding area. With an ever growing global population, the disposable waste generated annually is increasing and landfills worldwide are rapidly filling. Therefore, more landfills are needed sooner but they are expensive to create, they consume a large amount of usable space and can harm the environment. In order to reduce the dependence on landfills, the waste can be diverted through recycling programs, reducing human consumption and purchasing reusable and/or compostable materials. These methods of waste reduction would be implemented at the municipal level but it would be possible to change provincial and state legislation so that municipalities would be required to do so rather than of their own volition. If initiated worldwide then the amount of waste produced by humans would be greatly reduced and the dependence on landfills would decrease.

Recently, Grenfell Campus – Memorial University of Newfoundland (MUN) installed an industrial composter to divert organic waste, such as food scraps, from the landfill and create nutrient rich soil which can be used for various endeavors. This composting program is in its early stages and is currently collecting approximately 200 kilograms of compostable waste per week. One option to increase the amount of compostable waste and decrease the amount of landfill bound waste is to change the type of materials used in the Grenfell cafeteria. Currently, the food vendors in the cafeteria serve food using polystyrene dishes, plastic clamshells and disposable cutlery to the students, staff and faculty of Grenfell. This use of disposable materials is contributing to the landfill bound waste and negatively affects the local environment and the image of Grenfell as an environmental school. Within the context of this paper, polystyrene refers to Styrofoam products however Styrofoam is a brand name of the material polystyrene.

Alternative materials such as compostable plates and cutlery would reduce the amount of waste going to the landfill however these materials pose unknown economic and environmental costs which may make them an impractical alternative. For example, a nine inch compostable plate made of sugarcane by-products costs $58.00 per 500 units plus taxes, shipping and handling and is shipped from Asia while a polystyrene nine inch plate is $43.53 per 500 units plus taxes, shipping and handling and is shipped in from the United States. The initial cost of the sugarcane plate is higher than the polystyrene plate and must be shipped further which adds to the carbon footprint of the material making it less desirable. However, the sugarcane plates are

made out of sugarcane stalks; a waste from other industries, that are turned into a paper-like pulp called bagasse which is then used to make the plates and is compostable in industrial composters (Ecoproducts, 2011) while polystyrene plates are made out of petroleum which is a non-renewable resource that does not decompose.

The first objective of my independent project is to do a life-cycle comparison between the disposable and compostable materials being used in order to determine the economic and environmental costs of switching from disposable to compostable food delivery materials in Grenfell's cafeteria. The life-cycle comparison includes (1) the materials used to manufacture the products, (2) the distance traveled from the manufacturer to Grenfell Campus, (3) the amount of water used, carbon dioxide emitted and electricity used to produce and transport the objects and (4) the financial and environmental costs of landfill-bound disposable materials and composter-bound compostable materials. Comparing the life-cycles of the two material types can be used to evaluate the advantages and disadvantages of using and reduce the amount of bias present in the results. The second objective is to survey the student body's willingness-to-pay to switch from disposable to compostable materials. This survey is necessary because environmentally friendly materials, such as compostable materials, are generally more expensive than disposable materials which represent an increase in operating costs for the vendors. To offset this increase, the vendors would have to increase their prices, apply a green tax or be reimbursed by the school who could add a "cafeteria fee" to what the students already pay for tuition and housing. These options directly affect the students that use the cafeteria so the willingness-to-pay survey can help determine which price alteration option would be best.

2.0 – Product Materials

The destination of the disposable materials is the landfill while the compostable materials will go to the industrial composter. The amount of time necessary for the compostable products to decompose varies on the product type, the material it is made from, the thickness of the material, temperature. Additionally, the compostable products will produce some carbon dioxide during the composting process but in smaller amounts compared to burning.

Depending on the information available, this section will look at what the materials are made out of, how they are produced, where they a commonly manufactured and how far it is from North America, any health or environmental impacts that are significant and describe what will happen in its final destination. See Table 8 for the estimated time it will take for products to decompose in home and industrial composters.

2.1 – Disposable Polystyrene Products

The base material for the disposable food delivery materials is a non-renewable, petroleum-based, styrene monomer that is a lightweight material containing approximately 95% air and is a great insulator. This monomer undergoes polymerization to create polystyrene which can then be used for products ranging from cups to protective packaging items (Green Restaurent Association, 2012). Once the polystyrene plates are used, they are sent to the landfill where they degrade; they break down on a physical level as opposed to a chemical level such as decomposing or biodegrading. This lack of chemical degradation means that these products

accumulate and consume space in landfills. Additional environmental concerns include the amount of oil and water used to produce polystyrene. To produce one pound of polystyrene, 0.003 barrels of oil and roughly 2 US gallons are needed (Environmental Impact, 2011a).

Some short-term health concerns with exposure to styrene include irritation to the mucous membrane and eyes and gastrointestinal impacts. Long-term health concerns include developing headaches, fatigue, weakness, depression, central nervous system dysfunction such as reduced reaction time and memory recall, inability to concentrate and visuomotor speed and accuracy and hearing loss (United States Environmental Protection Agency, 2007).

The expanded polystyrene products used by the food vendors, such as the plates and clamshells, would mostly contain long, linked styrene chains but some of the styrene would remain unlinked in small amounts (Agency for Toxic Substances and Disease Registry, 2011). The plastic forks however are made out of chain of aromatic, solid polystyrene which have a phenol ring present to allow for more rigidity (Encyclopædia Britannica Inc., 2012a). Both materials are capable of leaching into the food if it is placed in a microwave or with sufficiently hot food and can leach into the soil in a landfill.

The locations of the manufacturers for the polystyrene plates, clamshells, bowls and cutlery include various locations throughout the United States, China and Canada according to TRA Cash & Carry and B&B Sales, the current distributors for the food vendors.

2.2 – Sugarcane (Bagasse)

The sugarcane plates are created from a renewable fiber called bagasse; the remaining fibrous material after the sugarcane plant has undergone the sugar extraction process (Encyclopædia Britannica Inc., 2012b). In 2002, the global sugar production was approximately 100 million tonnes and was processed in mainly Asian countries (Meunchang, Panichsakpatana, & Weaver, 2005). In addition to being wildly abundant, bagasse is also a renewable by-product of another industry so instead of using virgin tree resource or a non-renewable substance such as petroleum, bagasse product manufacturing can use down-cycling as a means to reduce waste generation.

One environmental concern is that most bagasse fibre is harvested in Asian countries meaning that the carbon footprint and financial cost to transport the materials to North America is higher compared to the disposable products produced in the United States. This however, is slightly offset by the fact that bagasse is a renewable waste by-product that is being reused to create nutrient rich soil.

After being used, the sugarcane materials will go into the composter where it will turn into soil that can be used to grow new plants. While this process does release carbon dioxide back into the atmosphere from the decomposing process, it is turning into a substance that promotes the growth of plants which absorb carbon dioxide as opposed to ash after being burned as fuel.

2.3 – PLA (corn-based plastic)

Polylactic acid (PLA) plastic is a type of compostable bioplastic that can be made using several starch containing materials. One way to produce this bioplastic is by using the lactic acid made from corn starch and turning it into a plastic-like polymer. It is achieved by fermenting

and condensing the lactic acid thus forming a lactide which is then purified in a distillation process and becomes a polymer that can be used in molds to create different shaped products (World Business Council for Sustainable Development, 2004).

One of the main corporations producing PLA products is NatureWorks, an offshoot of Cargill Dow LLC from Nebraska, USA. The distance traveled for PLA products is shorter than that of the sugarcane products which are mostly produced in Asia.

When PLA plastic is placed in an industrial composter, it will take three to six months, depending on the product, to decompose (see Table 8). Unfortunately, if it is placed in the landfill, it will take an estimate 100 to 1000 years to decompose because of the less than optimal conditions (Scientific American, 2008). Also, corn-based products are becoming a larger concern because of the water requirements needed to grow corn; approximately 6.1 US gallons of water is needed to produce one pound of corn and roughly 2.5 pounds of corn are needed to make one pound of PLA plastic, therefore nearly 15.5 US gallons of water is needed per pound of PLA plastic (Environmental Impact, 2011b). With respect to water usage, PLA plastics use much more water than polystyrene production mentioned above.

2.4 – PSM (potato-based plastic)

Similar to the corn-based plastic, the potato-based plastic is creating using starch but from potato plants. The potato starch also has to undergo several physical and chemical modifications including blending, derivation and graft copolymerization. First, the PSM is blending with various aliphatic polymers, polyvinyl alcohol (PVA) and biopolymers. The derivations include altering the starch chemically by causing a reaction with the hydroxyl group in the starch molecule but still maintaining the biodegradability of the object. One method to bond other chemicals to the potato starch molecule is through graft copolymerization where PLA and poly (ε-caprolactone) (PCL) are bonded (Lu, Xiao, & Xu, 2009).

Similar to sugarcane, the potato starch material needed can be acquired from the "waste" produced by the potato chip and french fry industry. In 2009, Canadian plastic processors and the Government of Canada began the BioPotato Network to help launch the commercialization of potato bioplastics due to the high starch content in potatoes and that every province in Canada is a producer of potatoes to some degree (Canadian Plastics, 2009).

Some environmental concerns with using potato-based materials include a potential increase in farming operations that include the use of fertilizers and pesticides, increased soil erosion due to tilling and deforestation due to increase in agricultural fields.

Once discarded into the composter, the potato starch products would decompose into carbon dioxide, water and other nutrients within three to six weeks (Grassroots, 2010).

2.5 – Lignin-based Products

Lignin-based products vary from wooden cutlery to wax paper bags. Simplistically, these products are made out of residual wood from construction and deconstruction jobs, paper scraps from the production stage, already collapsed trees and recycled paper. The issue with lignin-based products is focused around issues with deforestation; loss in habitats, decreases soil quality and stability, increased soil erosion, decrease in aesthetics, loss of hunting grounds and poorer air

quality. However, being certified by the Forest Stewardship Council and improving paper recycling programs would decrease the dependence on virgin forests and planted woodlots.

2.5.1 – Wood

Wooden cutlery is made out of wood pulp (fibre) that is pressed together into the desired shape with an edible adhesive-type substance to help maintain the shape. Common types of wood used for the cutlery include birch and aspen. Depending on the patent, these utensils can be coated with a confectioners glaze to prevent the "woody" taste (Aspenware Inc., 2011) or it can be uncoated. Despite the coating, these products are still designed as a single-use product.

Wooden cutlery is manufactured across North America therefore the distance traveled for the product to come to Newfoundland depends on which distributor is chosen. One company mentioned in this project, Ecoware Products, is located in Vernon, British Columbia.

2.5.2 – Paper (With and Without Wax)

Paper bags, with or without wax, are also made of lignin but much thinner. Brown paper bags and dry wax bags, typical lunchtime items in North America, are advantageous because they are affordable, consume less space in the landfill and are compostable. The wax used on paper bags is a colourless or white, semi-transparent paraffin wax comprised of a solid straight-chain of hydrocarbons and is made from petroleum products. There are few risks with using wax paper however it is advised to not place it in a microwave or oven as the material can catch fire (Encyclopædia Britannica Inc, 2012c). Many of the paraffin paper products are manufactured in Asia (Alibaba, 2012).

3.0 – Methods

Data collection methods include (1) in-person interviews with the cafeteria vendors, certain product distributors and students, (2) over the phone interviews with a product distributor, (3) communication through electronic mail with product distributors and (4) internet searches for product information, grey literature and primary literature. In-person interviews were conducted with the cafeteria food vendors on February 9th where the respective managers of Martin's Canteen and Pizza Delight gave me their weekly usage and cost per disposable product. On February 10th, I met with the manager of Treats to record their weekly usage per disposable product and the cost of the products. On March 8th, I met with the staff at B&B Sales and TRA Cash and Carry, two wholesale retailers located in Corner Brook, to record the name, quantity and price of their disposable and compostable products that are used and could be used by the vendors, respectively. March 20th was the initial day of the survey and it was completed on March 30th. The students were surveyed based on locations in the school during lunch hours (from 11:30 am to 1:30 pm) and in the evenings (from 6:00 pm to 9:00 pm) which included Couchland, the Library, the Fine Arts Atrium, the Cafeteria and in the hallways. I surveyed members from the following degrees within the University; Sustainable Resource Management, Environmental Chemistry, Psychology, Business, Environmental Biology, Fine Arts – Theatre, Fine Arts – Visual Arts and Environmental Studies (data not recorded). I also spoke to and e-

mailed an employee on March 20th from Canada Green – Natural Products to record the prices and the manufacturer's location for a variety of compostable products that they distribute. . Internet searches provided the cost and materials for compostable products distributed by Canada Green – Natural Products, Grassroots, Ecoware Products and Ecoproducts, respectively. See Appendix I for the list and cost of products used in this paper from these distributors. Additional internet searches provided grey literature sources, such as government information and popular scientific articles, and primary literature searches from academic journals.

Note: The prices for Canada Green are estimates as they have different rates depending on the size of the order or institution purchasing the products and they have a policy that for every box of supplies purchased, $2.00 is taken off of the bottom line of the purchase.

4.0 – Results

Note: the weekly operating costs were based on what I was told by the vendors, the prices for the compostable products are all approximates are I did not incorporate tax, shipping or handling, the weekly operating costs for Pizza Delight using disposable products were calculated using the price of similar products from B&B Sales and the number of surveys completed was 100.

In Table 1, the vendors' weekly operating costs using disposable products is calculated for Martin's Canteen, Pizza Delight and Treats respectively based on their usage. Overall, Martin's Canteen produces the most waste at 5415 units of disposable products used per week and has the highest weekly operating costs at $397.50. Their main type of landfill waste is the nine inch plates and cutlery used in many of their lunch specials. In contrast, Treats produces the lowest amount of waste at 732 units of disposable products used per week with a weekly operating cost of $48.41. This data however does not take into account the amount of paper coffee cups of various sizes used which is their main product. Pizza Delight produces 1111 unites of disposable material waste but their weekly operating costs are unknown because their costs go to the head franchise building in Corner Brook, Newfoundland. As with Martin's, the amount of waste produced by Pizza Delight does not take into account the amount of paper cups used for soda in their specials.

Table 2 gives the compostable product costs per 500 units per distributor, the product materials used and the mean value of those products based on their materials. For example, the six inch paper plates have two main material types from all the distributors; paper and sugarcane. The mean value of paper plates per 500 units equals $48.73 and the mean value of the sugarcane plates per 500 units equals $27.44. The different type of materials used includes paper fibre, sugarcane, wood, corn/plant based, or potato based. The sugarcane material, on average, was less expensive than plant based material particularly for the six inch by six inch by three inch clamshells available from Canada Green and Ecoproducts. The chip fork and the Savaday trays were added onto the list as items of interest because they can fulfill the same function as another product for a better price. The chip forks and Savaday trays could replace the majority of the forks and nine inch plates used, respectively, by students for fries or poutine. This could lead to a decrease in operating costs because the cheapest fork per 500 units equals approximately $20.00 while the cost of the chip fork per 500 units equals $3.57. Also, the Savaday #200 and #300 trays are approximately eighteen and ten dollars cheaper per 500 units, respectively, than the cheapest nine inch plate at $56.99. These two products would not be a complete substitute

for the forks and nine inch plates but it would decrease the amount used therefore reducing the amount purchased weekly which may reduce the vendors' operating costs. Another item of interest is the small snack box from B&B Sales for $78.19 which could substitute for a salad box.

Table 3 shows the weekly vendor operating costs using the mean price per compostable product substitute used. The mean cost of each substitute is divided by product and material. For example, there are two six inch polystyrene plate substitutes that are made out of paper and sugarcane with their mean price of $48.73 and $27.44 located in Table 2, respectively. The weekly vendor operating costs per product were then estimated using the mean price of the product materials resulting in two different costs per product type. The cheaper of the two prices were then added together to calculate the overall weekly vendor operating costs. Martin's Canteen, Pizza Delight and Treats have a weekly operating cost of $473.18, $94.60 and $62.52, respectively.

Table 4 displays the optimal price per compostable substitute per 500 units which results in the smallest change in price for the vendors. For example, the cheapest substitute for the six inch plate is the six inch sugarcane plate is distributed by Canada Green at $23.50 per 500 units. The chip forks and the Savaday #300 tray were included in the table but were not used in the calculations in Table 5 because it was not possible to estimate the number of units used per week for each product.

Table 5 shows the estimate weekly vendor operating costs using the optimal price for the compostable products. The weekly estimate operating costs for Martin's Canteen, Pizza Delight and Treats are $436.54, $87.86 and $58.54 respectively.

Table 6 is a comparison of estimates of the three weekly vendor operating costs using disposable product prices, the mean compostable product prices and the optimal compostable product prices. Currently, Martin's Canteen and Treats spend approximately $397.50 and $48.51, respectively, per week in disposable products. The weekly spending of Pizza Delight is unknown because the bill is sent to the main franchise in Corner Brook. Using the mean compostable product prices, the weekly spending for Martin's Canteen, Pizza Delight and Treats is approximately $473.18, $94.60 and $62.52, respectively. These prices increase the weekly operating costs of Martin's Canteen by $75.68 and of Treats by $14.01. With the optimal compostable product prices, the weekly spending for Martin's Canteen, Pizza Delight and Treats is $436.54, $87.86 and $58.54, respectively. These prices increase the weekly operating costs of Martin's Canteen by $39.04 and of Treats by $10.13.

Table 7 shows the per unit price of the products that the vendors are currently using compared to the compostable alternatives provided by other distributors. For the majority of the products used by the food vendors, the optimally priced compostable alternatives are comparable or better economically compared to disposables currently in use. The few compostable products that are more expensive are the nine inch plates and the cutlery by $0.04 and $0.02 dollars. Despite the small increment in price, these two products are used the most within a given week therefore the change is considerable. For Martin's Canteen, the increase in weekly costs for the nine inch plates at 1750 unites used per week is approximately $66.50 and the increase in weekly costs for cutlery at 1000 forks, 1000 knives and 1000 spoons used per week is approximately $60.00. Ignoring the savings from the other compostable products, the weekly cost to switch to compostable materials for these two products is $126.50. For Pizza Delight, the increase in

weekly costs for the nine inch plates at 625 units used per week is approximately $12.50 and the increase in weekly costs for cutlery at 165 knives and 165 forks used per week is approximately $4.13, equalling a total weekly increase in costs of $16.63 regarding these two products. For Treats, the increase in weekly costs for the nine inch plates at 125 used per week is approximately $7.00 and the increase in weekly costs for cutlery at 100 forks, 100 knives and 100 spoons used per week is approximately $2.75, equalling a total weekly increase in costs of $9.75 regarding these two products.

Figure 1 shows the weekly vendor operating costs using various disposable products. For Martin's Canteen, the first, second and third most costly items for them to use per week are the nine inch polystyrene plate, the twelve ounce polystyrene bowl and the plastic salad clamshell at $126.00, $96.00 and $80.00, respectively. For Pizza Delight, the first and second most costly items for them to use per week are the nine inch polystyrene plate and the polystyrene wrap clamshell at $56.25 and $14.04, respectively. For Treats, the first, second and third most costly products per week are the plastic salad clamshell, the twelve ounce polystyrene bowl and the nine inch polystyrene plate at $23.75, $7.50 and $6.75, respectively.

Figure 2 shows the percent of the responses selected from the 100 Grenfell students that completed the willingness to pay survey. For Question 1, approximately 30% of the students each selected response one, two or three indicating that they ranged from not satisfied to indifferent about the current food delivery system; using disposable products. In Question 2, 62% of the students said that they would prefer a more eco-friendly food delivery system over the current one; start using compostable products. 73% percent of the students in Question 3 said that they would be willing to sort their compostable materials from their non-compostable materials. Question 4 had 46% of the students say that they would be slightly willing to pay more for food to offset the increase in vendor costs associated with switching to compostable products. In Question 5, 24% of the students said that they want only the price of the compostable products to increase while 49% would be more inclined for the price of all products to increase. Lastly, 50% of the students said that they would be willing to pay the new price of the chicken burger platter at Martin's in Question 6 if the price increased due to being served on a compostable plate. 30% of the students also said that they would be willing to spend more than that for the platter should it be placed on a compostable plate.

5.0 – Discussion

5.1 – Weekly Operating Costs

The weekly vendor operating costs using the disposable products is less expensive, economically, compared to the compostable products (see Table 6). The increase in price using the optimal product prices for Martin's Canteen, Pizza Delight and Treats was approximately $30.04, $12.23 and $10.13, respectively. The environmental risks of using the disposable instead of compostable materials is conflicting because in one respect, the disposable products are manufactured closer geographically in the United States compared to the compostable products which are, generally, manufactured in Asia and must travel further. In another respect, the compostable products are renewable materials that are (i) using wastes from another industry such as sugarcane, bagasse and lignin materials or (ii) they are fully compostable materials that

would decompose in the composter compared to the landfill bound, disposable products that were produced using non-renewable petroleum sources which are quickly running out.

The increase in price varied for each vendor based on their most frequently used item. For example, Martin's Canteen used roughly 1750 nine inch plates per week therefore a four cent increase in price for this single product equals approximately $70.00 however there was a decrease for other items such as the twelve ounce bowl and the salad clamshell (6"x6"x3"). A consistent increase in costs was due to the cutlery; every compostable material used was more expensive than the disposable material currently in use but only by two cents (see Table 7).

5.2 – Student Survey Results

The student's willingness-to-pay survey indicated three important trends. Firstly, the students would be more satisfied if compostable materials were being used, secondly, they prefer the price of all products to increase evenly as opposed to only the compostable products increasing and thirdly, they would be willing to pay the new price of the food should it increase (see Figure 2).

6.0 – Conclusion

Overall, the increase in weekly vendor operating costs using the optimally price compostable products is relatively low for each of the three vendors and the average student would prefer and be willing to eat off of compostable materials.

Should the university push for a change in food delivery materials, I suggest doing another more comprehensive survey to confirm these findings and secondly, find a way so that the students do not have to pay for the increase. For example, if sending the waste to the composter saves the school money on landfill-bound waste pickup, then that money should be divided evenly amongst the food vendors so the prices would not have to increase. This would also motivate the students to use the composter more because they would not have to pay for the increase in price for food.

6.1 - Products of Interest

A few additional products that may be beneficial for the vendors to purchase include the two pronged wooden chip fork from Canada Green and the Savaday #300 paper tray from B&B Sales. The chip fork is an item of interest because the per unit price of a chip fork is considerably cheaper than the per unit price of a fork so it can be used for french fries and poutine at Martin's Canteen instead of using a fork thus saving the vendors money. It would not replace the fork entirely but the amount of forks needed per week would decrease drastically therefore they would not need to purchase a box of forks as frequently. The Savaday tray is also of interest because it has a strong construction therefore reliable for fries and poutine but there is little to no economic savings and therefore economically impractical.

7.0 - References

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8.0 - Tables

Table 1 - The weekly amount and cost of disposable products used by cafeteria vendors at Grenfell Campus - MUN and the total number of units used per vendor (See Figure 1).

	Martin's Canteen		Pizza Delight*		Treats	
Disposable Products	**Usage**	**Cost**	**Usage**	**Cost**	**Usage**	**Cost**
6" Polystyrene Plate	175	$17.50			72	$1.96
9" Polystyrene Plate	1750	$126.00	625	$56.25	125	$6.75
Polystyrene Wrap Clamshell (9x6x3)			156	$14.04		
Polystyrene Bowl (12oz)	300	$96.00			82	$4.70
Plastic Salad Clamshell (6x6x3)	100	$80.00			40	$7.50
Plastic Wedge					113	$23.75
Fruit Cup (6oz)	90	$16.83				
Plastic Fork	1000	$20.00	165	$2.47	100	$1.25
Plastic Knife	1000	$20.00	165	$2.47	100	$1.25
Plastic Spoon	1000	$20.00			100	$1.25
Total	5415 units	$396.33	1111 units	$75.23	732 units	$48.41

* = Pizza Delight's weekly operating costs were estimated using the product prices from B&B Sales

Table 2 - Compostable alternatives from six distributors, their price per 500 units, the product material type and the mean price of the product type.

Product (per 500)	Canada Green	Grass roots	Ecoware Products	Eco products	B&B Sales	TRA Cash & Carry	Mean
6" Plate (Paper)		$70.00(7")			$30.20	$46.00 (8")	$48.73
6" Plate (Sugarcane)	$23.50			$31.38			$27.44
9" Plate (Paper)		$110.00			$56.99	$59.04	$75.34
9" Plate (Sugarcane)	$58.00			$57.39			$57.70
Cutlery (Wood)[x]	$28.75		$19.99				$24.37
Cutlery (corn/potato)[x]	$20.00[d]	$59.90[d]		$33.15[c]			$37.68
Chip Forks (wood)	$3.57						$3.57
Soup Bowl & Lid[e] (12oz) WA	$164.06			$184.40			$174.23
Soup Bowl & Lid[e] (12oz) Bioserv	$132.12						$132.12
Sandwich Wedge (plant)	$120.25			$115.00			$117.63
Sandwich Bag					$8.51[a]	$10.99[g]	$9.75
Wrap Clamshell (sugarcane) (9"x6"x3")	$163.78			$148.42			$156.10
Wrap Bag (paper/wax)					$29.97[a]	$10.99[g]	$20.48
Salad Clamshell (sugarcane) (6"x6"x3")	$66.56			$82.87	$78.19[f]		$70.66
Salad Clamshell[f] (plant) (6"x6"x3")	$156.25			$128.29			$142.27
Deli/Fruit Bowl & Lid[e] (8oz)	$90.72			$153.68			$122.20
Deli/Fruit Bowl & Lid[e] (12oz)	$194.70			$162.73			$178.72
Savaday #200 (French Fry Tray - Paper)					$38.14	$42.80	$40.47
Savaday #300 (French Fry Tray - Paper)					$46.78		$46.78

a = wax based b = paper based c = corn based d = potato based e = bowl + lid price
f = small snack box

g = #3 brown paper bag x = multiply by 3 for cost for forks, knives and spoons

Table 3 - Weekly estimate vendor operating costs using the mean price per compostable product substitute used, the total number of units used per week and a weekly cost estimate based on the lowest mean price per product type.

		Martin's Canteen		Pizza Delight		Treats	
Disposable Products	**Compostable Substitute**	**Usage**	**Mean Cost**	**Usage**	**Mean Cost**	**Usage**	**Mean Cost**
6" Polystyrene Plate	6" Plate (Paper)	175	$17.06			72	$7.02
	6" Plate (Sugarcane)	175	$9.61			72	$3.95
9" Polystyrene Plate	9" Plate (Paper)	1750	$263.69	625	$94.18	125	$18.84
	9" Plate (Sugarcane)	1750	$201.95	625	$72.13	125	$14.43
Polystyrene Wrap Clamshell (9x6x3)	Wrap Clamshell (sugarcane) (9"x6"x3")			156	$48.70		
	Paper Bag (#3)			156	$6.39		
Polystyrene Bowl (12oz)	Soup Bowl & Lid[e] (12oz) WA	300	$104.54			82	$28.57
	Soup Bowl & Lid[e] (12oz) Bioserv	300	$79.27			82	$21.67
Plastic Salad Clamshell (6x6x3)	Salad Clamshell (sugarcane) (6"x6"x3")	100	$14.13			40	$5.65
	Salad Clamshell (corn) (6"x6"x3")	100	$28.45			40	$11.38
Plastic Wedge	Sandwich Wedge (corn)					113	$26.58
	Sandwich Bag (paper/wax)					113	$2.20
Fruit Cup (6oz)	Deli/Fruit Bowl & Lid[e] (8oz)	90	$22.00				
	Deli/Fruit Bowl & Lid[e] (12oz)	90	$32.17				
Plastic Fork	Cutlery (Wood)	1000	$48.74	165	$8.04	100	$4.87
	Cutlery (plant/potato)	1000	$75.36	165	$12.43	100	$7.54
	Chip Forks (wood)	1000	$7.14				
Plastic Knife	Cutlery (Wood)	1000	$48.74	165	$8.04	100	$4.87
	Cutlery (plant/potato)	1000	$75.36	165	$12.43	100	$7.54
Plastic Spoon	Cutlery (Wood)	1000	$48.74			100	$4.87
	Cutlery (plant/potato)	1000	$75.36			100	$7.54
Weekly Mean Compostable Operating Costs		5415 units	$473.18	1111 units	$94.60	732 units	$62.52

e = bowl and lid price

Table 4 - Optimal price per compostable product substitute per 500 units

Product (per 500)	Canada Green	Grassroots	Ecoware Products	Ecoproducts	B&B Sales	TRA Cash & Carry
6" Plate (Sugarcane)	$23.50					
9" Plate (Paper)					$56.99	
Cutlery (Wood)[x]	$20.00[b]		$19.99			
Soup Bowl & Lid[e] (12oz) Bioserv	$132.12					
Sandwich Bag (paper/wax)					$8.51[a]	
Wrap Paper Bag (#3)						$10.99
Salad Clamshell (sugarcane - 6"x6"x3")	$66.56					
Deli/Fruit Bowl & Lid[e] (8oz)	$90.72					
Items of Interest						
Chip Forks (wood)	$3.57					
Savaday #300 (French Fry Tray - Paper)					$46.78	

a = wax based b = potato starch material e = bowl and lid price x = multiply by 3 for cost of forks, knives and spoons

Table 5 - Estimate cafeteria vendor costs using the optimal price per compostable product substitute and the total number of units used per week

		Martin's Canteen		Pizza Delight		Treats	
Disposable Products	**Optimal Compostable Substitute**	**Number of units**	**Optimal Cost**	**Number of units**	**Optimal Cost**	**Number of units**	**Optimal Cost**
6" Polystyrene Plate	6" Plate (Sugarcane)	175	$8.23			72	$3.38
9" Polystyrene Plate	9" Plate (Paper)	1750	$199.47	625	$71.24	125	$14.25
Polystyrene Wrap Clamshell (9x6x3)	Wrap Paper Bag (#3)			156	$3.43		
Polystyrene Bowl (12oz)	Soup Bowl & Lid[e] (12oz) Bioserv	300	$79.27			82	$21.67
Plastic Salad Clamshell (6x6x3)	Salad Clamshell (sugarcane)	100	$13.31			40	$5.32
Plastic Wedge	Sandwich Bag (paper/wax)					113	$1.92
Fruit Cup (6oz)	Deli/Fruit Bowl & Lid[e] (8oz)	90	$16.33				
Plastic Fork	Cutlery (Wood)[x]	1000	$39.98	165	$6.60	100	$4.00
Plastic Knife	Cutlery (Wood)[x]	1000	$39.98	165	$6.60	100	$4.00
Plastic Spoon	Cutlery (Wood)[x]	1000	$39.98			100	$4.00
Total		5415	$436.54	1111	$87.86	732	$58.54

Table 6 – Weekly operating cost comparison between the current disposable product prices, the mean compostable product prices and the optimal compostable product prices per vendor.

	Martin's Canteen		Pizza Delight		Treats	
Cost Type	**Number of Units**	**Weekly Cost**	**Number of Units**	**Weekly Cost**	**Number of Units**	**Weekly Cost**
Disposable Product Prices	5415 units	$396.33	1111 units	$75.23	732 units	$48.41
Mean Compostable Prices	5415 units	$473.18	1111 units	$94.60	732 units	$62.52
Optimal Compostable Prices	5415 units	$436.54	1111 units	$87.86	732 units	$58.54

Table 7 - Vendor costs per unit per disposable and compostable product used per distributor.

Vendors	Current Disposable Products Used	Compostable Products					
Martin's Canteen		**Canada Green**	**Grassroots**	**Ecoware Products**	**Ecoproducts**	**B&B Sales**	**TRA Cash & Carry**
6" Plate	$0.10[d]	$0.05[h]	$0.14[f]		$0.06[h]	$0.06[i]	$0.09[i]
9" Plate	$0.07[d]	$0.12[h]	$0.22[f]		$0.11[h]	$0.11[i]	$0.12[i]
Bowl (12oz)	$0.32[d]	$0.33[a]			$0.37[a]		
		$0.26[b]					
Salad Clamshell (6x6x3)	$0.80[c]	$0.31[e]			$0.17[h]	$0.16[t]	
		$0.13[h]			$0.26[e]		
Fruit Cup (6oz)	$0.19[c]	$0.18[e]			$0.31[e]		
Cutlery	$0.02[c]	$0.06[g]	$0.12[f]	$0.04[g]	$0.07[e]		
		$0.04[f]					
Pizza Delight*							
9" Plate	$0.09[d]	$0.12[h]	$0.22[f]		$0.11[h]	$0.11[i]	$0.12[i]
Wrap Clamshell (9x6x3)	$0.09[d]	$0.33[h]			$0.30[h]	$0.06[j]	$0.02[i]
Cutlery	$0.01[c]	$0.06[g]	$0.12[f]	$0.04[g]	$0.07[e]		
		$0.04[f]					
Treats							
6" Plate	$0.03[d]	$0.05[h]	$0.14[f]		$0.06[h]	$0.06[i]	$0.09[i]
9" Plate	$0.05[d]	$0.12[h]	$0.22[f]		$0.11[h]	$0.11[i]	$0.12[i]
Bowl (12oz)	$0.06[d]	$0.33[a]					
		$0.26[b]					
Salad Clamshell (6x6x3)	$0.19[c]	$0.31[e]			$0.17[h]		
		$0.13[h]					
Sandwich Wedge	$0.21[c]	$0.24[e]			$0.23[e]	$0.02[j]	$0.02[i]
Cutlery	$0.01[c]	$0.06[g]	$0.12[f]	$0.04[g]	$0.07[e]		
		$0.04[f]					

a = World Art brand b = Bioserv brand c = plastic based d = polystyrene based
e = plant based f = potato based g = wood based
h = sugarcane based i = paper based j = wax based

Table 8 – Estimated time for various compostable food delivery materials and product types to decompose in a home and industrial composter.

Product	Home Composting	Commercial Composting
Sugarcane Fiber/Reed Grass: Plates, Takeout Containers, Bowls, Cups and Trays	2-4 Months	1-3 Months
PLA: Cold Cups, Deli Containers and Straws	6-12 Months	3-6 Months
Corn Starch: Heat-resistant, Non-GMO Utensils	12-24 Months	6-18 Months
Trash / Kitchen Bags	3-6 Months	1-3 Months
PLA: Tasting Spoons and Utensils	12-24 Months	3-6 Months

Source: World Centric. 2012. Retrieved on April 10, 2012 from http://www.worldcentric.org/biocompostables/plant-fiber

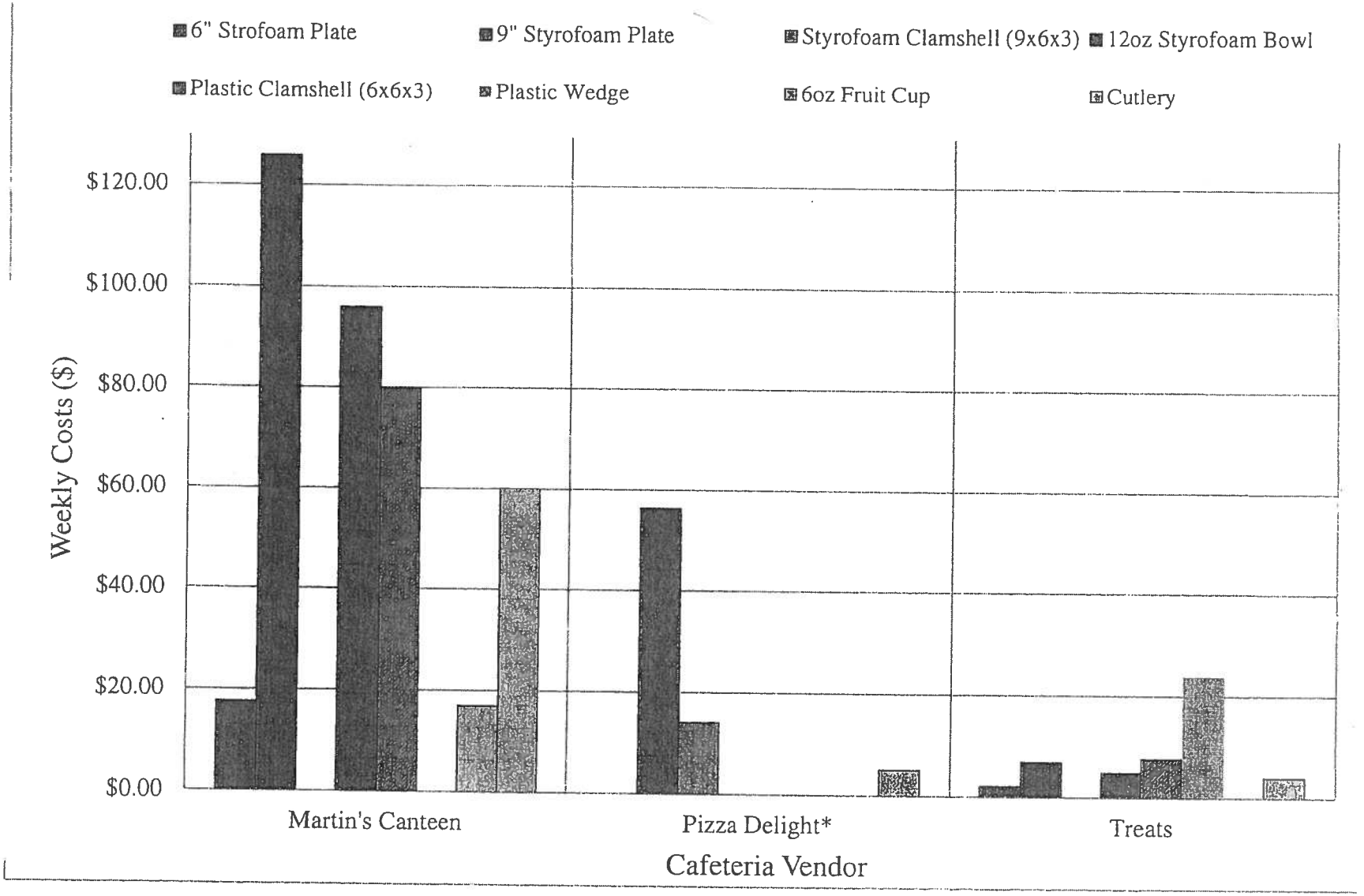

Figure 1 – Weekly vendor operating costs per disposable product per vendor (See Table 1).

* - Pizza Delight weekly operating costs were calculated using prices from B&B Sales.

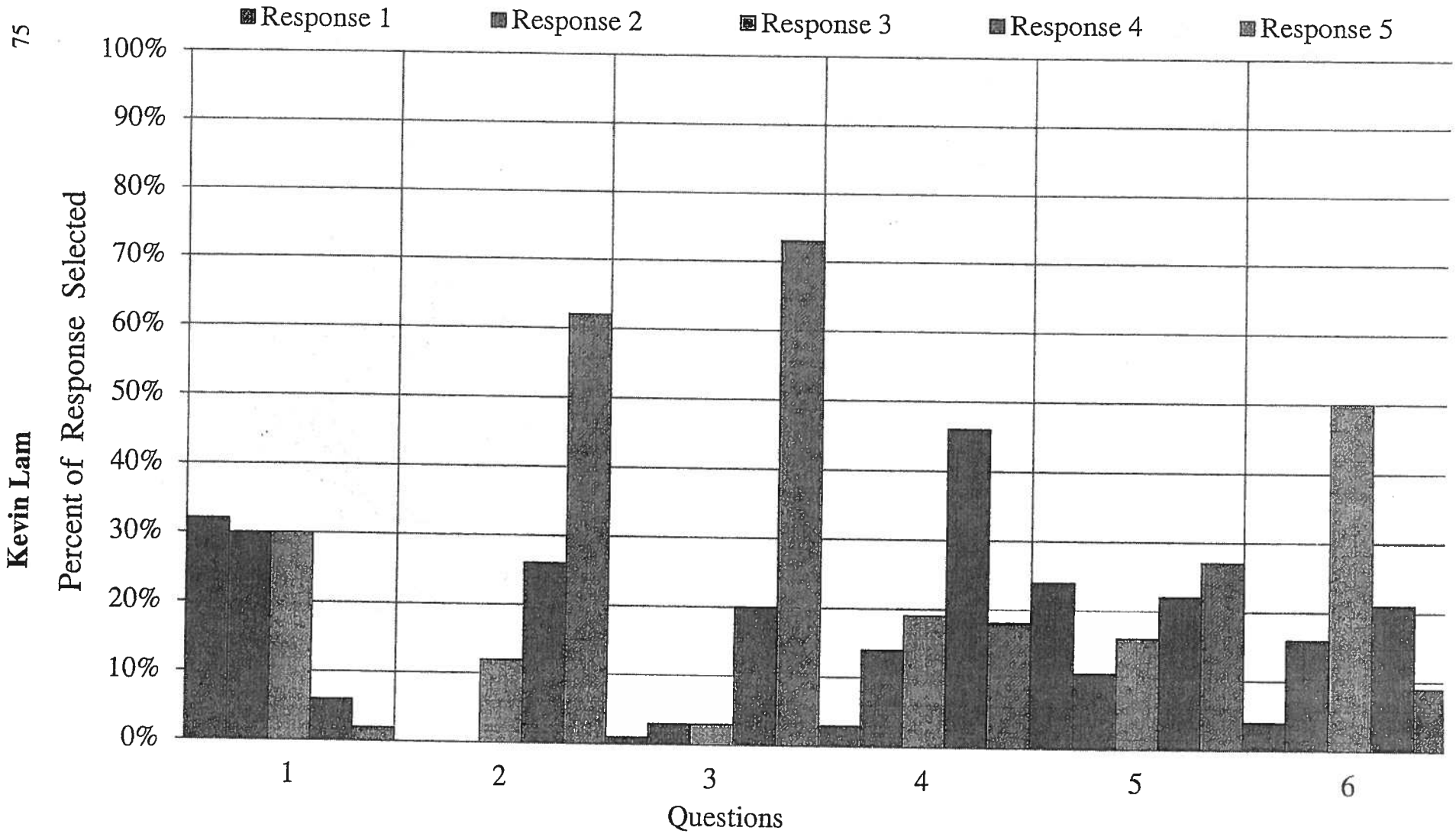

Figure 2 – Percent of the response selected for questions one through six in the Grenfell Campus student survey (see Appendix II for survey questions).

Appendix I – Product Information per Distributor
Disposable Products from Local Distributors

B&B Sales	
Product	**Cost**
6" Plate (Polystyrene)	$44.79 per 1000
9" Plate (Polystyrene)	$43.53 per 500
Wrap Clamshell (Polystyrene - 9"x6"x3")	$44.13 per 500
Salad Clamshell (Plastic - 6"x6"x3")	$128.77 per 500
Sandwich Wedge (Plastic)	$101.68 per 500
Cutlery* (Plastic)	$14.95 per 1000

Website URL: http://www.tra.ns.ca/Home_05.asp

TRA Cash & Carry	
Product	**Cost**
6" Plate (Polystyrene)	$2.29 per 50
9" Plate (Polystyrene)	$7.39 per 125
Soup Bowl & Lid (Plastic – 12oz)	$3.94 per 25
Salad Clamshell (Plastic - 6"x6"x3")	$28.85 per 125
Sandwich Wedge (Plastic)	$26.67 per 125
Cutlery* (Plastic)	$12.99 per 1000

Website URL: http://www.bandbsales.net/

Compostable Products

Canada Green – Natural Products	
Product	**Cost**
6" Plate (Sugarcane)	$47.00 per 1000
9" Plate (Sugarcane)	$58.00 per 500
Cutlery* (Wood)	$57.50 per 1000
Cutlery* (PSM)	~$40.00 per 1000
Chip Forks (Wood)	$71.34 per 10 000
Soup Bowl & Lid (World Art - 12oz)	$98.00 & $66.06 (lid) per 500
Soup Bowl & Lid (Bioserv - 12oz)	$66.06 & $66.06 (lid) per 500
Sandwich Wedge	$120.25 per 500
Wrap Clamshell (Sugarcane - 9"x6"x3")	$65.51 per 200
Salad Clamshell (PLA clam – 6"x6"x3")	$75.00 per 240
Salad Clamshell (Sugarcane – 6"x6"x3")	$66.56 per 500
Deli/Fruit Bowl & Lid (PLA - 8oz)	$77.44 & $104.00 per 1000
Deli/Fruit Bowl & Lid (PLA - 12oz)	$122.84 & $71.86 per 500

Website URL: http://www.cagreen.ca/index.php

Grassroots	
Product	**Cost**
6" Plate (Tater Ware Plate)	$140.00 per 1000 (7")
9" Plate (Tater Ware Plate)	$110.00 per 500
Cutlery* (Potato Starch)	$5.99 per 50

Website URL: http://www.grassrootsstore.com/default.asp

Ecoware Products	
Product	**Cost**
Cutlery* (Wood)	$39.99 per 1000

Website URL: http://www.ecowareproducts.com/

Ecoproducts	
Product	**Cost**
6" Plate (Sugarcane)	$62.76 per 1000
9" Plate (Sugarcane)	$57.39 per 500
Cutlery* (PLA)	$66.29 per 1000
Soup Bowl & Lid (World Art – 8oz)	$124.06 & $86.78 (L) per 1000
Soup Bowl & Lid (World Art - 12oz)	$82.90 & 101.50 (L) per 500
Sandwich Wedge	$115.00 per 500
Wrap Clamshell (Sugarcane - 9"x6"x3")	$74.21 per 250
Salad Clamshell (Sugarcane – 6"x6"x3")	$82.87 per 500
Salad Clamshell (PLA – 6"x6"x3")	$61.58 per 240
Deli/Fruit Bowl & Lid (PLA - 8oz)	$82.39 & $71.29 (L) per 500
Deli/Fruit Bowl & Lid (PLA - 12oz)	$91.44 & $71.29 (L) per 500

Website URL: http://www.ecoproducts.com/

B&B Sales	
Product	**Cost**
6" Plate (Paper)	$60.40 per 1000
9" Plate (Paper)	$56.99 per 500
Sandwich Sleeve (Wax)	$17.01 per 1000
Wrap Sleeve (Wax)	$59.93 per 1000
Salad Box (small snack box - paper)	$62.55 per 400
Savaday #200 (French Fry Tray - Paper)	$38.14 per 500
Savaday #300 (French Fry Tray - Paper)	$46.78 per 500

Website URL: http://www.bandbsales.net/

TRA Cash and Carry	
Product	**Cost**
6" Plate (Paper)	$11.50 per 125 (8")
9" Plate (Paper)	$14.76 per 125
Sandwich Bag (Paper)	$10.99 per 500
Wrap Bag (Paper)	$10.99 per 500
Savaday #200 (French Fry Tray – Paper)	$10.70 per 125

Website URL: http://www.tra.ns.ca/Home_05.asp

Appendix II – Student Willingness to Pay Survey

Background Information

Recently, Grenfell Campus began using the new industrial composter to reduce its waste generation. However, current food service practices largely rely on single serve, disposable materials such as polystyrene plates and plastic cutlery that end up in the landfill. Grenfell could further decrease its landfill bound waste by switching to compostable or reusable food delivery materials such as paper or ceramic plates and wood or metal cutlery. Although switching to compostable or reusable materials would reduce our waste production, the institution's waste disposal costs and our carbon footprint, the switch represents an increased operating cost for the vendors. Vendors will be less likely to adopt compostable or reusable materials because of this cost.

One way to increase vendor participation in the use of green materials is to subsidize the switch by providing the vendors with an incentive. An incentive can be implemented in a number of ways. For example, the vendors could increase costs across the board, apply a green tax to food that is served on a compostable product or their operating costs could be supplemented by the GCSU which would collect a Green Fee from the students. The various strategies translate to a smaller incremental cost to everyone if a user fee is placed on all of the products (i.e. green fee or cafeteria fee) or a larger incremental cost for food served on compostable products.

Privacy

The results of this survey will be kept in confidence and only for the purpose of my independent project.

Goals of the survey: The goals of this survey are to (i) determine the food delivery material preferences (i.e. compostable vs. disposable) of Grenfell food service users and (ii) determine their "willingness to pay" for a switch from conventional disposable materials to "greener" compostable/reusable materials. This data is for my SRM 4950 – Independent Research Project.

For each question, please circle the answer which best applies to you.

1. Are you satisfied with the current food delivery system used at Grenfell Campus? (i.e. using polystyrene plates and plastic cutlery)

Not satisfied		Indifferent		Satisfied
1	2	3	4	5

2. Would you prefer a more eco-friendly food delivery system over the current one? (i.e. using biodegradable plates and cutlery)

No		Indifferent		Yes
1	2	3	4	5

3. Are you willing to sort your compostable and non-compostable products?

No		Indifferent		Yes
1	2	3	4	5

4. Would you be willing to pay more for foods to offset the increase in vendor costs associated with switching to **compostable** materials?

No		Indifferent		Yes
1	2	3	4	5

5. Do you prefer an increase in price only for those items that utilize compostable materials or a slight increase in price for all the items available at the food vendors?

Compostable Only		Indifferent		All Products
1	2	3	4	5

6. **For example**: The current price of a chicken burger platter at Martin's is $6.99 plus tax. Placing this product on a compostable plate will increase the price to approximately $7.20. Would you be willing to pay:

(Original Price)		(New Price)	(Extra 5%)	(Extra 10%)
$6.99	in-between	$7.20	$7.35	$7.69
1	2	3	4	5

Appendix III – Brands

Brand Name	Item	Location (if applicable)
World Art	bowls	Unknown
Bioserv	bowls	Unknown
Savaday	french fry trays	Nova Scotia
Solo	wax paper, polystyrene cups	United States
Genpak	polystyrene bowls	North America
Fibracam	polystyrene bowls	North America
Compliments	polystyrene plates	North America
Ecoware Products	wooden cutlery	Canada