FEASIBILITY AND COST ANALYIS OF COMPOSTING CAMPUS DINING FOOD WASTE IN CAL POLY'S COMPOST FACILITY

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2015

TITLE : Feasibility and Cost Analysis of Composting Campus Dining Food Waste in Cal Poly's Compost Facility

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ACKNOWLEDGEMENTS

I would first of all like to thank my parents for supporting me throughout my educational career and giving me courage throughout my life.

Secondly I would like to thank all of my professors from the BRAE department for giving me the skills and knowledge required to complete my senior project. I would especially like to thank my advisor Greg Schwartz since my project required me to have extensive knowledge of topics discussed in Dr. Schwartz's classes.

Next I would like to thank Ellen Curtis from Campus Dining for providing me with the information needed to complete this project.

Lastly I would like to thank Kevin Piper, head of Cal Poly's Agricultural Operations for providing me with the information needed to complete this project

ABSTRACT

Composting helps our environment and promotes healthy soil, which decreases the need for fertilizer, pesticides, and supplemental water. Reducing the amount of food waste in landfills has significant environmental, economic, and social benefits. The main goal of this project and a sustainable campus involves increasing awareness of environmentally sustainable developments such as Cal Poly's compost facility. This senior project discusses the feasibility, cost analysis, and evaluation of Campus Dining's food waste in Cal Poly's compost facility. If Cal Poly were to incorporate Campus Dining food waste into their compost facility, Cal Poly would be saving $16,185 a year on tipping fees alone. In addition, the composted food waste could generate a revenue of $2,250 per year for a total offset of $18,435 per year. Cal Poly would not start making a profit until the 9th year, and without consideration of non-market costs and benefits, it is not possible to recommend implementing food waste in Cal Poly's compost facility. If in the future, mandates change for Cal Poly, composting of food waste could be examined.

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Background

Cal Poly defines sustainability as "The concept of meeting the needs of the present without compromising the ability of future generations to meet their needs." (Elliot, 2014). The goal of a sustainable campus involves balancing, the needs of the community, and the needs for environmental protection. Cal Poly has strived to become a more sustainable community with solid waste recycling. Reducing the amount of food waste thrown into landfills has significant environmental, economic, and social benefits.

One major factor that affects the environment is the methane that food waste produces when disposed of in a landfill; methane is a potent greenhouse gas with 21 times the global warming potential of carbon dioxide (EPA, 2014). Due to this very harmful gas, today, most everyone is conscious about keeping the environment clean and green. One step to achieve this goal is to reuse food waste rather than discarding it into landfills. Not only does composting food waste help our environment but it also promotes healthy soil, which decreases the need for fertilizer, pesticides, and supplemental water (EPA, 2014). Composting returns nutrients to the eco-system and replenishes Earths soil ultimately leading to a more sustainable campus.

The main markets of finished composted material are the agriculture, and landscape industries. With agriculture being very prominent at Cal Poly, it is clear that composting can have a big impact on this community. Some immediate economic benefits include lower disposal costs and labor costs. It would be more sustainable to Cal Poly if Campus Dining food waste were sent for composting to Cal Poly's facility rather than to the local landfill or to Santa Maria's compost facility.

Objectives

The first phase of this senior project will consist of researching composting and the benefits of it. The second phase of this senior project will be to contact personnel to quantify costs, and amount of waste sent off campus for disposal of food waste. The third phase of this project will be to conduct an evaluation of sending campus dining food waste to Cal Poly's composting facility. The fourth phase will involve a feasibility study. The operation must in turn be profitable and the costs of running the operation must not exceed current cost. The main objective of this project will be to promote a more sustainable future.

LITERATURE REVIEW

Composting

The first step to integrating campus dining food waste into Cal Poly's composting facility is to understand how composting works. "Composting is a process used to convert organic waste materials, both vegetable and animal, to rich, humus-like soil amendment used in agriculture" (Bradley, 1990). Compost is organic material that can be used as an amendment in soil or as a medium to improve the development of plants. It is the end product of decayed organic matter that is used to fertilize soil. The specific type of composting process considered for this project will be aerated windrow composting.

Aerated windrow composting is the aerobic decomposition of organic matter. In aerobic decomposition, microorganisms that use oxygen, feed on organic matter. The microorganisms use the nutrients present such as phosphorous, nitrogen, and carbon. During composting energy is gained from the oxidation of organic matter and is released in the form of heat (Earth-Kind, 2009). In this process oxygen is consumed and carbon dioxide is released. One of the most important aspects of decomposition of organic matter in composting piles is the microbial activity. If microbial growth is slowed down or halted, the composting process is directly affected as well. In aerated windrow composting, mixed organic waste is placed into rows of long piles usually between 5-8 feet tall with a base between 10-20 feet, and placed 14-16 feet apart called a windrow, "The turned windrow approach calls for stacking the material to be composted into a pile that has the shape of a windrow with a more-or-less triangular cross-section" (Bradley, 1990). As seen in Figures 1 and 2.

Figure 1. Compost Facility on Cal Poly Campus, CA (Google Maps. 2015)

Figure 2: Engel and Gray compost factory

The windrows are turned periodically in order to aerate and generate sufficient heat to maintain an internal temperature of about 140 degrees Fahrenheit. This maintained temperature ensures that the microbial activity is not slowed down or halted. Typically windrow composting accommodates large volumes of diverse wastes including, animal wastes, yard trimmings, bulking agents, and food waste. The standards for composting processes are shown in the table below (Richard, 1992).

Table 1: Composting process standards, (Richard, 1992).

Condition	**Reasonable Range**	**Preferred Range**
Carbon-to-nitrogen ratio (C:N)	20:1 - 40:1	25:1 - 30:1
Moisture content (%)	45-65	50-60
Oxygen concentrations (%)	> 5	>5
Particle size (diameter - centimeters)	0.5 - 5.0	0.5 - 2.5
pH	5.5 - 8.0	5.5 - 8.0
Temperature (º C)	43 - 66	54 - 60

When composting, it is essential to keep the windrows in the conditions stated above. There are four elements necessary for composting: nutrients, oxygen, moisture, and temperature (Earth-Kind, 2009). Efficient decomposition requires aeration, particle size, moisture, and sufficient sources of carbon and nitrogen. All organic matter consists of substantial amounts of carbon combined with a small amount of nitrogen; in order to have a good end product, the preferred range of carbon to nitrogen ratio should be 25:1. Having a good carbon to nitrogen ratio keeps the compost from having odor problems and produces the most fertile compost, which results in a good end product. Shown below is the formula on how to calculate C: N ratio.

$$C:N = \frac{weight\ of\ Carbon\ in\ A + weight\ of\ Carbon\ in\ B + \cdots}{weight\ of\ Nitrogen\ in\ A + weight\ of\ Nitrogen\ in\ B + \cdots}$$

If there is too much carbon present the process will be slowed down and incomplete; if there is not enough carbon, problems may occur such as leachate or ammonia volatilization. Leachate is water that has or will percolate through the soil and leach out the constituents. It is important to prevent leachate because it can lead to contamination of the groundwater, which may present risks to human health.

Maintaining a moisture content of 55-60% is an important factor in keeping a compost pile functioning, and maintaining optimal conditions for microbes. In order to control moisture, bulking agents are needed to process the feedstock in an aerobically and efficiently. Bulking agents provide porosity to the material; some examples include sawdust, and wood chips (Francis, 2014). Moisture content can be tested with a simple squeeze test, by taking a handful of compost and squeezing to see if water is released, or with a simple calculation shown below (Francis, 2014).

$$Moisture\ Content = \frac{Weight\ of\ wet\ sample - Weight\ of\ dry\ sample}{Weight\ of\ dry\ sample} \times 100$$

Oxygen is crucial in the composting process; oxygen feeds the aerobic bacteria and thus speeds up the composting process. In the absence of oxygen the chemistry of the compost changes and results in foul odors. Odor management is the most common problem that facilities deal with when composting. Failure to address the odors may lead to complaints and the closure of a facility. However preventing odors is simple; maintain aerobic conditions by having oxygen concentrations greater than 5% (Francis, 2014). Doing so will prevent the compost from going anaerobic and producing foul odors. When considering composting, particle size matters, smaller particles decompose quicker than larger particles thus speeding the process up. The particle size of compost should be between 0.5”-2.5” centimeters diameter, at this size the compost can decompose correctly and efficiently.

High temperatures are essential in aerobic composting; it is due to these high temperatures between 54-60 degrees Celsius that the destruction of pathogenic organisms and weed seeds occurs. Maintaining this temperature is very important because if the pathogenic organisms are not destroyed it can be very hazardous to humans. There are multiple ways of determining good conditions for composting; there are calculations that can be done and guidelines to follow. However most experienced composters will argue the best way to determine if the end product will be good is by conducting a feel test. If no water is visible and a sheen is clearly visible, the moisture content will be around 55-60% which is the ideal starting point in composting. This process is widely used amongst experienced composters.

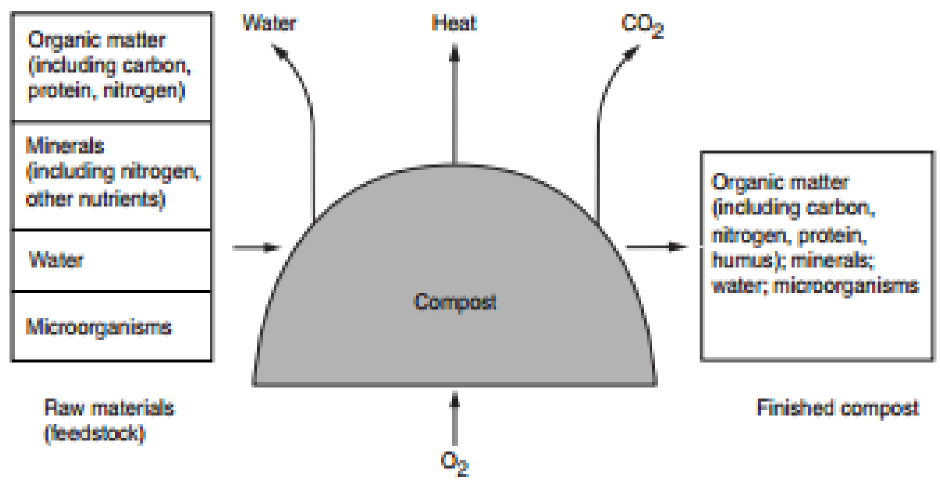

Figure 3: Composting Process (Richard, 1992).

Food Waste in Composting

Reducing the amount of food waste in landfills has major economic, social, and environmental benefits. Landfills are a major source of human-related methane in the United States, accounting for more than 20 percent of all methane emissions (EPA 2014). With the reduction of food waste in landfills, there will be a significant drop in methane produced from landfills. This reduction of a very potent greenhouse gas can have a huge impact on the environment. Not only will diverting the food waste from landfills benefit the environment but it will also benefit the economy. Diverting food waste to Cal Poly's compost facility will create a valuable soil amendment for local agricultural uses, and will also lower disposal costs. Adding compost to nutrient deprived soil used in agriculture; the farm industry can see immediate benefits in crop yields and quality.

Pathogen Susceptibility

Following health and safety codes are very important when considering the hazards that are associated with composting. Possible concerns with composting are the potentials for human pathogens and vectors. When dealing with a large-scale compost facility it is crucial that all health and safety codes are followed in order to get rid of pathogens. There are several organisms of concern that are generally associated with pathogens in food: such as Salmonella, Listeria, and E.coli. These food borne illnesses make up more than 90% of all illnesses caused by food (Marler, 2015). Introducing Campus Dining food waste will increase the risk of pathogens, which also increase the risk of contracting these diseases. Campus dining food waste consists of all kinds of meats and vegetables all of which have the risk of containing many pathogens. In order to eliminate pathogens it is crucial to keep the windrows at an internal temperature of at least 140 degrees Fahrenheit for a period of 15 consecutive days (Piper, 2015). It is due to these high temperatures that the destruction of pathogenic organisms occurs. Maintaining this temperature will help ensure that pathogens will be eliminated and help ensure the health and safety of others.

Vector and Odor Susceptibility

Another health and safety factor that needs to be addressed when composting is the susceptibility to vectors and odors. When composting high volumes of food waste, there can be some concerns such as leachate, odors, and vectors. Leachate is liquid formed by water percolating through the compost pile and extracting dissolved or suspended materials from compost (Bradley, 1990). Odors are the most common problem when considering composting. Due to poor odor control, large-scale facilities have been shut down due to complaints. However odor can be managed with prevention and treatment.

Figure 4: Leachate formed due to large scale composting

Vectors such as insects and rodents can be a problem when including food waste in composting, however, most problems can be minimized if the proper precautions are taken. Practicing good sanitation practices such as keeping grass and weeds mowed, keeping area free of trash and debris, draining any areas of standing water not related to waste handling, and keeping fresh piles covered and active, are all ways to prevent vectors.

Economic and Environmental Benefits

All around the country landfills are reaching their limit, and composting provides a partial solution to this issue. There are many benefits of composting, not only does composting reduce the amount of waste sent to landfills but it also reduces the emission of greenhouse gases, and promotes higher yields of agricultural crops (EPA, 2011). Composting reduces the need for fertilizer, pesticides, and most importantly water. It is a marketable commodity which can in turn be profitable. When composting in a large-scale facility it is important to remember a significant tipping fee charge can be avoided and profits can even be earned by selling the end product to consumers. Sending Campus Dining food waste to Cal Poly's facility as opposed to other facilities can be a smarter financial decision. If Cal Poly incorporated food waste into their composting facility they would not only save money on tipping fees but also generate more income from the higher yield of their compost facility.

Using composted soil as opposed to chemically enhanced fertilizers can make lasting improvements in the environment for generations to come. Natural composted soil releases nutrients and improves the structure of the soil, which over time will make healthy and strong plants. Most importantly natural composted fertilizers are renewable, biodegradable, environmentally friendly and sustainable.

PROCEDURES AND METHODS

Objective

Reducing the amount of food waste in landfills has significant environmental, economic, and social benefits. The scope of this project was to determine if it is feasible to include Campus Dining food waste in Cal Poly's compost facility. Instead of delivering the food waste to landfills and other local composting facilities, a cost analysis was also done to see how much money could be saved if Campus Dining food waste was diverted to Cal Poly's compost facility as opposed to the Engel and Gray compost facility.

Project Constraints

The total cost of incorporating Campus Dining food waste into Cal Poly's compost facility must not exceed the current costs. It is important that regulations and public needs are met.

Cost of Operations and Maintenance

The cost for Engel and Gray to pick up the food waste is $65 a ton. Cal Poly is currently diverting 249 tons of waste a year. At a rate of $65 a ton, Cal Poly is spending upwards of $20,000 a year to transport food waste to Engel and Gray. Cost and volume are directly related in this case, if the volume of the food waste were to increase, the cost would increase as well. According to Ellen Curtis, Director Of Marketing and Communications in Cal Poly, in 2010/11 fiscal years alone, 128 tons of food waste was converted to compost, and in 2013/14, that number nearly doubled to 249 tons. Shown in Figure 5 is a graph of how many tons is diverted to Engel and Gray's compost facility monthly in between 2009-2011. It clearly shows that there are Tons of food waste being picked up which results in tipping fee costs.

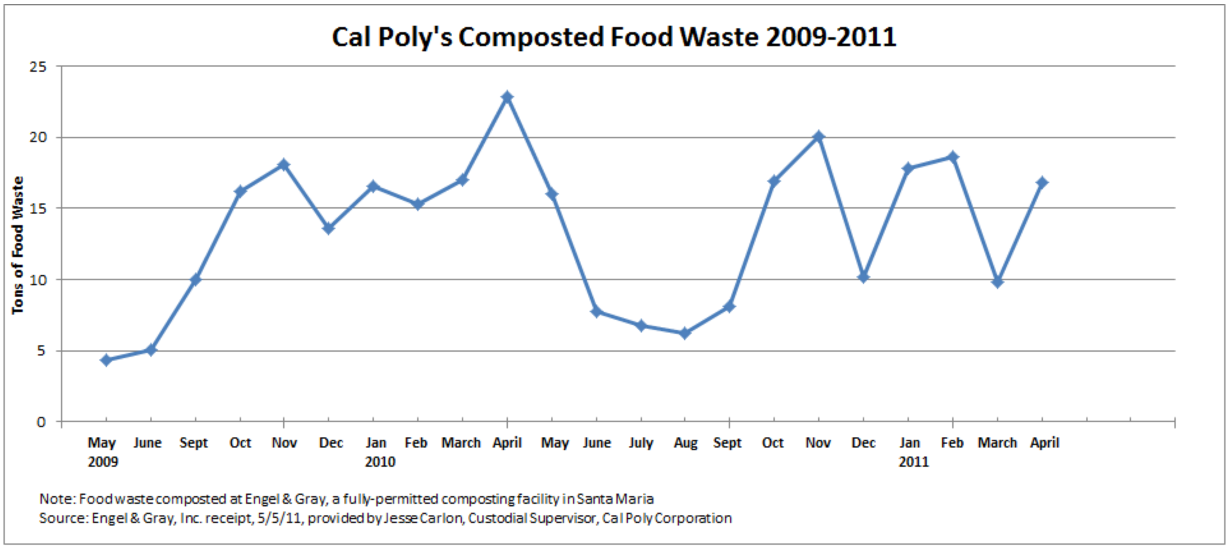

Figure 5: Cal Poly's food waste in tons per month, 2009-2011

Cal Poly is currently spending tens of thousands of dollars diverting food waste to Engel and Gray's compost facility. Cal Poly could not only save money on tipping fees alone, but they can also turn the finished composted product for a profit. Economically, when not considering overhead costs, it makes sense to divert Campus Dining's food waste to Cal Poly's own compost facility.

Table 2: Tipping fee breakdown costs (Curtis, 2015)

Fiscal Year	Tons of Food diverted	Cost per Ton	Total Cost
2009/2010	140	$65	$9,100
2010/2011	128	$65	$8,320
2013/2014	249	$65	$16,185

With Cal Poly holding sustainability as an integral part of its operations, it does not come as a surprise that within a few years, the tons of food diverted from landfills to composting facilities has dramatically increased. Due to the dramatic increase in volume of food waste, tipping fee costs incrementally increase as well.

It should be noted that this is only the cost of the tipping fees and does not take into account for the costs for staffing, specific trash bins, special compostable trash bin liners. Maintenance costs include the cost to hire full time custodians to collect the compost bins and take them out to the Engel and Gray containers, cost for special trash bins, and trash bin liners. Food waste is constantly being collected throughout the day in large venues and once a night from small venues. In terms of hiring more staff to collect the waste, Cal Poly already has 5 full time employees and part of their duty is collecting the compost bins and taking them out to the Engel and Gray container so there is no additional cost (Curtis, 2015).

Table 3: Additional Costs of diverting Food Waste (Curtis, 2015)

	Cost Per One	Quantity	Annual Cost
Trash Bins	$500	96	$48,000
Trash Bin Liners	$0.13	105,120	$13,665

Current Facility Profit

Cal Poly's compost facility gathers all its materials from Cal Poly's feedstock every Monday and Friday, and places the material into specific piles Tuesday, Wednesday, and Thursday, which makes this facility a full time operation. According to Kevin Piper, head of Agricultural Operations at Cal Poly, the total capacity of the compost facility at any given time is around 7 million lbs. of waste. They are currently only picking up waste from the poultry, and dairy units, leaving out a very nutrient rich feedstock, food waste.

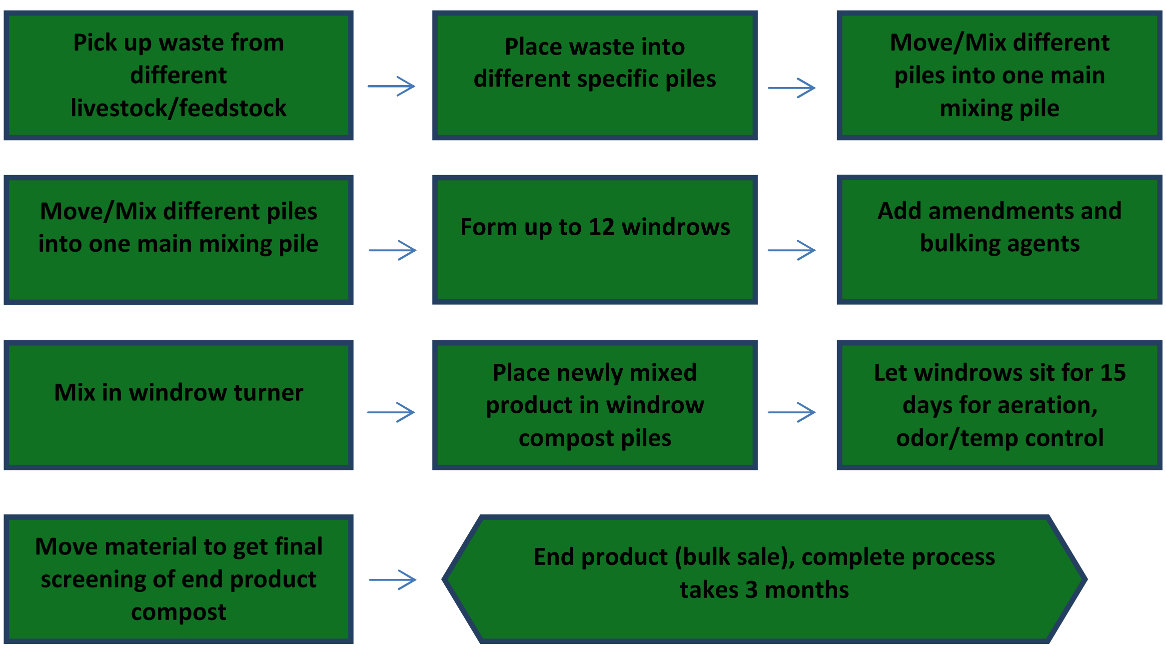

Figure 6: Process flow diagram for Cal Poly's compost facility

Cal Poly's facility currently mixes material into large trapezoidal piles called aerated windrows, in 15-day cycles with 5 minimum turns per cycle, with this method, the windrows can maintain a temperature of 131 degrees which helps with pathogen reduction. Kevin has stated, with transportation needs and the need to turn the windrows 5 times per cycle, the facility needs 1 full time staff and two part time student staff members operating the facility at all times.

The compost facility is currently 38,400 square feet, with the limited size of the facility, they currently lay their windrows in 10 ft. wide piles, 4-5 ft. tall, 160 yards long with 12 rows at a time. Due to the limited space of the facility, if food waste were incorporated to Cal Poly's facility, the net final product per year would increase by 150 tons per year. Cal Poly currently makes a profit of about $31,500 per year; the composting of food waste would add $2,250 per year. The value of the final product on a per ton basis is $30 a ton, while the cost to produce is about $15 a ton.

$$500{,}000\ lbs\ \times 60\%\ reduction = 300{,}000\ Lbs = 150\ tons\ \times \$15/ton$$
$$= \$2{,}250/yr\ Potential\ profit$$

Rules and Regulations

All organic material management is regulated with siting, permitting, and management, at state level, except for animal manures and bio solids. Before operating, compost facilities must be approved by the EPA. Examples of permitting process include: detailed facility designs, operating plans, description of incoming materials, and potential environmental releases. Permit requirements vary among states; in California composting operations regulatory requirements are very demanding.

Site Selection for Composting

When deciding on site selection for composting there are a lot of things to keep in mind. It is crucial to choose a site that is within full compliance with California's Composting Operation and Facility Siting and Design Standards, which states, "Compostable materials handling operations and facilities sited on intermediate cover on a solid waste landfill shall locate operations areas on foundation substrate that is stabilized, either by natural or mechanical compaction, to minimize differential settlement, ponding, soil liquefaction, or failure of pads or structural foundations" (Section 17865. Siting On Landfills). It is also important to select a site in a manner that prevents possible pollution. One of the biggest difficulties when composting is finding a site that is within regulations and does not disturb the public. Commonly compost facilities are best suited for remote areas with a lot of land due to the negative impacts compost facilities have such as vectors, noise, odors, dust, and traffic.

Figure 7: Windrow turner at Cal Poly compost facility

The site should generally be paved with concrete or asphalt in order to avoid groundwater contamination. Cal Poly's compost facility currently sits on 38,400 sq-ft of land. The cost of paving an area that large would be $445,000. Having paved grounds provides a good environment for composting due to the prevention of foreign materials entering windrows.

However the Cal Poly Compost Facility was carefully selected and placed on top of a hill. The grade of Cal Poly's composting site is designed to allow the liquid leachate to flow away from the creek and into a drainage pond, thus concrete would not be needed. This site was very carefully selected as to avoid cross contamination.

When dealing with raw materials such as food waste, it is important to keep in mind the vectors that will inevitably be present. Approximately the same area needed for the composting process should be available for the curing process. With high amounts of food waste added, there will need to be an expansion of Cal Poly's compost facility. Currently Cal Poly has enough space for 12 windrows.

One thing to keep in mind when considering the site of a compost facility is transportation. Transporting waste a long distance is uneconomical; minimizing transportation cost is crucial in economic management. Setting up the composting operation close to the source of the waste is not only economical but also convenient.

Stationary In-vessel System

The stationary vessel (SV) composter is an advanced control system that optimizes compost stabilization and pathogen reduction rates using its unique aeration design (ECS, 2015). It is a stationary system made with site built insulated concrete vessels; these vessels have stainless steel doors and interiors, with aluminum exterior covers. The SV composter is predominately suited for medium to large scale composting, located in odor sensitive sites such as Cal Poly's compost facility. Shown in the figure below are SV Composters. The stationary vessels can be built up to any size, which is convenient for Cal Poly due to the limited space the compost facility currently has.

Figure 8: SV Composter located in Granby, Canada (ECS, 2015)

This type of system provides the best pathogen, odor, and vector control, and has the smallest footprint compared to other composting technologies (ECS, 2015). The unique aeration design helps capture and dramatically decrease greenhouse gas and odor emissions. The special aeration system provides a controlled airflow in order to maintain uniform biomass temperatures. The aeration system shown in the figure below is designed to conserve energy with adaptive control strategies.

Figure 9: Fan room for SV Composters (ECS, 2015)

ECS claims the operating costs will be low due to low labor requirements, and energy costs. The vessels can be filled with front-end loaders, which is convenient and cost effective. Since the labor requirements do not exceed the current labor requirements, it will not be taken into consideration. This system is best suited for Cal Poly's circumstances; incorporating food waste into this system would negate all the pathogen and vector problems that Cal Poly would face. According to ECS the costs that could accommodate 4,000 tons per year would cost approximately $900,000 including building costs. We estimate that for a 250 ton per year operation the capital cost would be $150,000.

RESULTS

In order for Campus Dining food waste to be implemented, Cal Poly's Compost facility would need to be redesigned and be pre-approved by the United States Environmental Protection Agency. The cost of building SV Composters would be approximately $150,000. The money that Cal Poly would be saving annually in tipping fees is $16,185 and additional potential profits from sales of $2,250 per year for a total annual revenue of $18,435. At this rate it would take Cal Poly 9 years until they start making a profit. The payback period will be $15,195 at the end of the 9th year, and $34,350 at the end of the 10th year. Ignoring labor costs and overhead costs, due to them remaining the same.

Year	Annual Revenue	Cummulative Revenue	Capital Cost Balance
0	-	-	$ (150,000)
1	$ 18,435	$ 18,435	$ (131,565)
2	$ 18,435	$ 36,870	$ (113,130)
3	$ 18,435	$ 55,305	$ (94,695)
4	$ 18,435	$ 73,740	$ (76,260)
5	$ 18,435	$ 92,175	$ (57,825)
6	$ 18,435	$ 110,610	$ (39,390)
7	$ 18,435	$ 129,045	$ (20,955)
8	$ 18,435	$ 147,480	$ (2,520)
9	$ 18,435	$ 165,915	$ 15,915
10	$ 18,435	$ 184,350	$ 34,350

Figure 10: Cost Analysis of Implementing Food Waste

Although there is a possibility of making a profit, the time that it will take to start making a profit, and without consideration of non-market costs and benefits, it is not possible to recommend implementing food waste in Cal Poly's compost facility. The SV composters are however very appealing due to the pathogen, vector, and odor problems being virtually nonexistent. Having an SV composter unit would potentially solve all vector, pathogen, and odor problems that are associated with food waste composting. In addition, there would be no further contamination with Cal Poly's current compost facility. Though in the long run it does seem to be feasible to incorporate the food waste into the SV composters, during this time, there is no incentive to do so. Agricultural Operations Director Kevin Piper has expressed that there has been no desire to include Campus dining food waste to the facility due to the changes that have to be done to the facility.

Money is not the only factor that comes into play, time seems to be the biggest dilemma, and seeing as how the compost facility is a small factor in Cal Poly's agricultural operations, there is no incentive to increase the scale of composting. When composting food waste, there are regulations that need to be closely followed due to vectors and diseases. A permit must be acquired before any facility can start incorporating food waste in their compost due to these rules and regulations Cal Poly has not incorporated food waste in their compost facility.

DISCUSSION

Time is a key component in the possibility of incorporating Campus Dining food waste in Cal Poly's compost facility. The time needed to redesign the facility and obtain the permits required to be able to incorporate food waste in Cal Poly's facility is not available. Cal Poly composting is not the top priority in the universities agricultural operations.

Unless there are government mandates placed, there will be no incentive to increase the facilities operations. However composting food waste is becoming more common due to national and state incentives that are being placed which promote recycling and extend landfill capacities. Something that should be considered is that composting is only one of the numerous things that Cal Poly's Agricultural Operations has to deal with.

When determining whether or not to incorporate Campus Dining food waste in Cal Poly's compost facility, one big factor that should be considered is the vector susceptibility that comes along with composting food waste. Vector control is a big dilemma that compost facilities have to deal with. If food waste is incorporated into Cal Poly's facility, odors, vectors, and leachate are all problems that need to be dealt with. Paving the ground at the current site would help with the leachate problem, however the cost of paving the site is expensive.

There are however many different alternatives to diverting food waste to landfills. Campus dining has also been diverting food scraps from landfills to Engel and Gray's compost facility, which has resulted in a 9% increase in landfill diversion. The university has even gone as far as creating the Cal Poly Compost project, which consists of nine student interns. The student interns have developed informative tours, and implemented new student orientation programs, which have instituted zero waste practices at WOW, SOAR, and Open House. A very simple but effective alternative is conservation. Using fewer resources ultimately reduces waste, which may seem like a minute difference, however if everybody used less resources, the impact would be great. Building more on-campus housing, installing energy-conserving infrastructures, upgrading old facilities with high efficiency water and energy features, and providing more recycling bins all are alternatives that can make our campus more sustainable.

Taking this initiative to promote zero waste practices can have a great positive impact in our environment. Sustainability is crucial because all the choices and actions that are taken today will affect everything in the future. Reducing the bulk of greenhouse gases can have a significant positive impact on the environment. In the end, sustainability is the most important factor.

RECOMMENDATIONS

Looking for sustainable alternatives can be challenging, but taking an initiative and making the first step could ultimately lead to a more sustainable environment. Sustainability is defined by Cal Poly as the ability of the natural and social systems to survive and thrive together to meet current and future needs. Cal Poly recognizes that practicing sustainability can be challenging with the scope and complexity of the universities culture. Although including Campus Dining food waste in Cal Poly's compost facility does seem feasible, it is not likely that it will be implemented anytime soon. Food waste composting requires a full Compostable Materials Handling Facility Permit, and the time that is needed to renovate the facility in order to obtain the permit would take years. If Cal Poly were to consider the SV composter, they are looking at a turnover rate of 9 years before they make a profit. Although it may seem like a long time, in the long run, it may be a good investment.

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APPENDIX A

HOW PROJECT MEETS REQUIREMENTS FOR THE ASM MAJOR

ASM Project Requirements

The ASM project must include a problem solving experience that incorporates the application of technology and the organizational skills of business and management, and quantitative, analytical problem solving. This project addresses these issues as follows.

Application of Agricultural Technology. This project involves the application of mechanical systems of composting, power transmission, and fabrication technologies of windrow turners.

Application of Business and/or Management Skills The project involves business/management skills in the areas of compost management, cost and productivity analyses of Cal Poly's compost facility, and labor considerations.

Quantitative, Analytical Problem Solving. Will include the cost analysis and feasibility study of using campus dining food waste in Cal Poly's composting facility.

Capstone Project Experience

The ASM project must incorporate knowledge and skills acquired in earlier coursework (Major, Support and/or GE courses). This project incorporates knowledge/ skills from these key courses.

- BRAE 129 Lab Skills/Safety
- BRAE 133 Engineering Graphics
- BRAE 151 AutoCAD
- BRAE 142 Machinery Management
- BRAE 301 Hydraulic/Mechanical Power Systems
- BRAE 321 Ag Safety
- BRAE 343/344 Mechanical & Fabrication Systems
- BRAE 402 Ag Materials
- BRAE 418/419 Ag Systems Management
- BRAE 348 Energy For a Sustainable Society
- BRAE 448 Bioconversions
- ENGL 148 Technical Writing
- AGB 212 Agriculture Economics

ASM Approach

Agricultural Systems Management involves the development of solutions to technological, business or management problems associated with agricultural or related industries. A systems approach, interdisciplinary experience, and agricultural training in specialized areas are common features of this type of problem solving. While technical in nature, this approach must also have a clear and present emphasis on planning and management of time, people, and other resources.
This project addresses these issues as follows.

Systems Approach. The project involves the integration of multiple functions (mixing, picking up food waste, making sure all standards are met), and the integration of machine/operator/compost husbandry systems to provide an improved profitable waste management solution for Cal Poly.

Interdisciplinary Features. The project touches on aspects of mechanical systems, agricultural safety, waste management, and bio resources.

Specialized Agricultural Knowledge. The project applies specialized knowledge in the areas of mechanical and fabrication systems, agricultural safety, and bio resource systems.

Project Parameters and Constraints
This project addresses a significant number of the categories of constraints listed below.

Physical. There must be enough room in Cal Poly's compost facility to accommodate the extra waste. There also must be the right equipment to ensure that health and safety standards are met.

Economic. The operation will be able to reduce the size of Cal Poly's traditional waste containers and reduce the frequency of daily pick ups

Environmental. The benefit of this project will be to reduce the amount of methane a very potent greenhouse gas; recycling food waste diverts organic materials from landfills thus reducing emissions

Sustainability. New turnout must decrease the amount of food waste in landfills and more food waste in Cal Poly's facility allowing for less tipping fee costs

Manufacturability. Finished composting product must meet compost quality standards and be readily available for consumers to purchase

Health and Safety. Pathogens and vectors must be controlled. Food waste composting must improve safety, health and sanitation.

Ethical. Must overcome obstacles such as odors, capacity, and public perception

Social. The intent of this project wasn't to create a social impact, but to change Cal Poly's cultural practice. An unintended consequence is that more people will need to be trained to manage the compost facility.

Political. Reduced air pollution. Better air quality as well as public perception.

Aesthetic. The finished machine was spray painted with high quality automotive paint to provide a professional appearance. A two-tone color scheme was used to provide contrast and high visibility around moving parts.

Other - Productivity. The operation must in turn be profitable and the costs of running the operation must not exceed current costs.