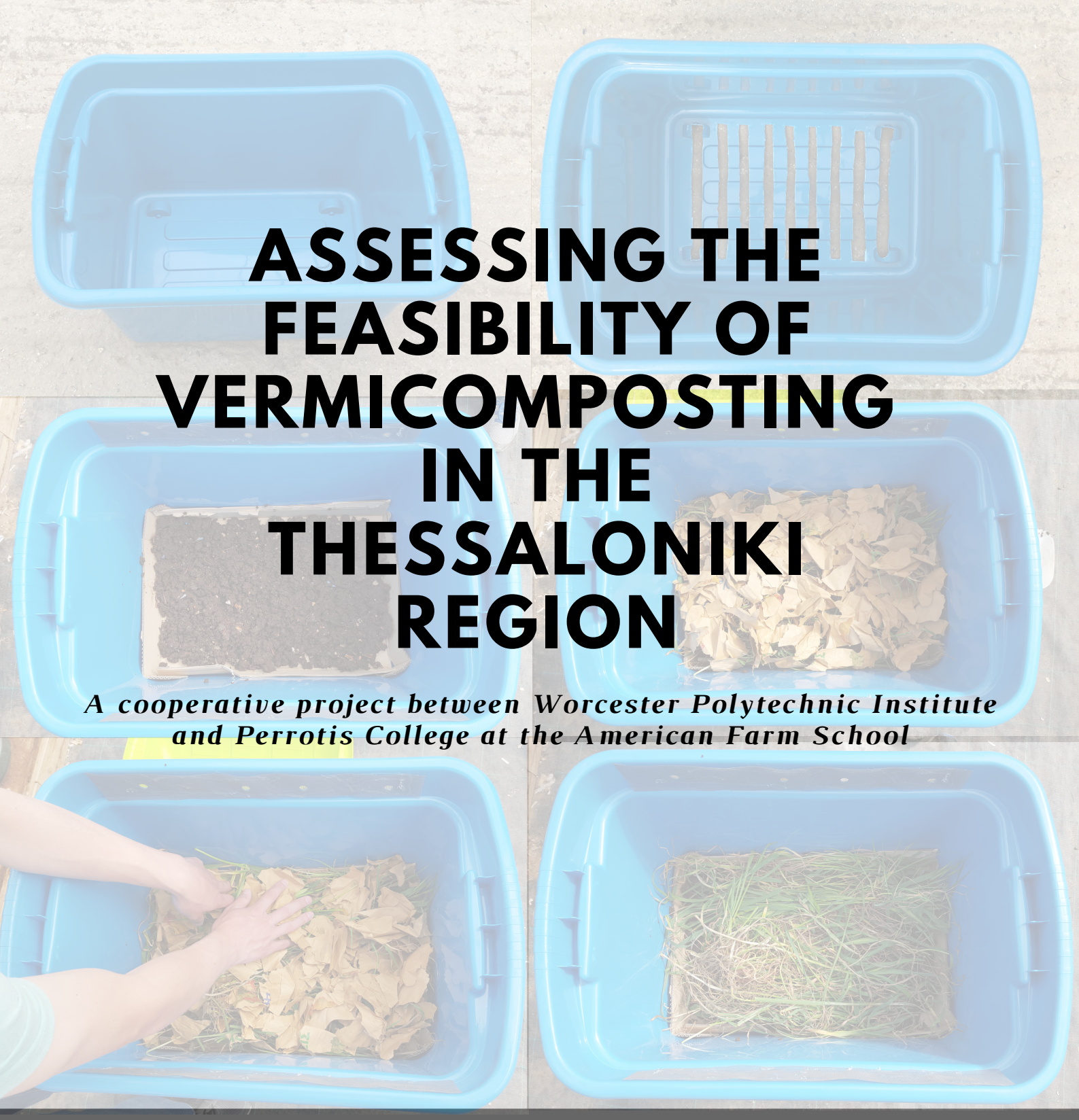

ASSESSING THE FEASIBILITY OF VERMICOMPOSTING IN THE THESSALONIKI REGION

A cooperative project between Worcester Polytechnic Institute and Perrotis College at the American Farm School

By:
Gina Capobianco
Stephanie Cappelli
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INTERACTIVE QUALIFYING PROJECT

An Interactive Qualifying Project
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfilment of the requirements for the
degree of Bachelor of Science

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Date: May 3rd, 2017

Submitted to:

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A rise in landfill and organic waste regulation has strained Greece's economic and environmental status. The European Union's (EU) 1999 directive has cost Greece millions in fines for not properly managing organic waste. Our project aimed to assess the implementation of vermicomposting as a way to mitigate these economic consequences. By way of case studies, surveys, and interviews at three scales of focus—individual, institutional, and municipal—we have assessed interest in vermicomposting and the possibilities for an alternative waste management program.

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ACKNOWLEDGEMENTS

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We would also like to express our gratitude to everyone who participated in our case studies and interviews. Dean Rotsios and Mrs. Tsaparikou, thank you for letting us interview you and for allowing us to put a vermicomposter at your house. It was always delightful meeting with both of you, and you had a tremendous impact on our project. Also, we would like to thank Mr. Tsaparikou who was involved with our interviews and translating.

We also appreciate all of the assistance we received from F-Zone. We especially would like to thank Ms. Ioannidou, the kitchen and staff manager, for all of her cooperation on the project. She was pertinent in moving our project forward in the campus kitchen. She allowed us to collect food scraps and also gave us extremely useful information in an interview.

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Finally, we are grateful to our advisors, Professors Robert Hersh and Michael Elmes, for their dedication to the success of our project. They have been instrumental in guiding us towards creating a project goal that was both feasible and significant. We also would like to thank our research librarian Laura Robinson for all of her help and expertise.

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INTRODUCTION

Waste management proves to be a challenge for municipalities and individuals alike with both environmental and economic concerns. From an economic standpoint, improper waste management cost Greece 10 million euro in 2014 alone (Curia, 2014). It also degrades the natural environment since around a million tons a year of greenhouse gas emissions go into the atmosphere from Greece's waste practices (ETC/SCP, 2011). Landfills in Greece contribute to the generation of greenhouse gases and around half are unsanitary because the system does not protect the peripheral environment from being damaged from harmful chemicals; therefore they are illegal according to the European Union (EU) (Ezeah & Byrne, 2014).

If proper waste management strategies were implemented, Greece could potentially reduce waste in their landfills and work towards fulfilling the EU directive. Vermicomposting, the practice of composting food waste with the help of worms, is a possible answer to this issue. Vermicomposting provides a method to reduce waste in Greece's landfills since food waste takes up a significant portion of the waste stream (Papachristou et. al, 2008).

Since nearly a third of Thessaloniki's waste stream is made up of food waste, vermicomposting systems can be established on many scales in order to divert that portion of the waste stream from reaching the landfill (Papachristou, et. al., 2008). Currently, our partner, Dr. Christos Vasilikiotis, has designs for a continuous flow vermicomposter (C. Vasilikiotis, personal communication, January 26, 2017). Using his knowledge of vermicomposter design, we plan on creating a design that is effective and affordable for household use.

Vermicomposting is currently a very strong method for degrading organic waste but it is still not known how to promote it within urban communities. Some cities and states have implemented municipal-wide programs (NYC Compost Project, 2017; Protection, 2017; Sullivan, 2011), but it is not well known how to motivate residents to participate in the use of such systems. In order to implement a successful vermicomposting program in the Thessaloniki region, our study aimed to understand stakeholder's perceptions, optimal design criteria, and program support.

To achieve our goal of assessing how vermicomposting can be implemented as a food waste reduction technique, our team created three objectives for assessing the feasibility of vermicomposting in the Thessaloniki region of Greece on three different scales. First, we conducted case studies of two American Farm School resident users to explore the feasibility of vermicomposting at the household level. Second, to better understand vermicomposting at the institutional level we studied how the food service company at AFS managed food waste and how a vermicomposting system might be implemented. Third, to understand the feasibility of vermicomposting at the municipal level, we collaborated with the municipality of Pilea-Hortiatis to understand the parameters necessary to implement a vermicomposting program. Together, these objectives helped us understand the complexities of vermicomposting initiatives.

Figure 1: Team Photo with Dr. Christos Vasilikiotis

BACKGROUND

Food Waste Management in Greece

Worldwide, methane contributes up to 18% of greenhouse gas emissions, with 6 to 13% of production coming from landfills (Christopoulos, 2005). Food waste specifically is the leading producer of methane in landfills (EEA, 2013; Sinha, 2010; Ezeah & Byrne, 2014; Iacovidou, Ohandija, Gronow, & Voulvoulis, 2012). Greece contributes to these numbers most prominently from its urban communities. However, Greece's fiscal crisis has made it difficult for municipalities to initiate programs to reverse these environmental trends. The Greek fiscal crisis has caused the Greek economy to crash as the government has had to pay back its debts. This has not allowed for extra municipal or regional funding to establish environmentally sustainable programs. Investments, public and private,have decreased due to these economic pressures and unfavorable development conditions (Kotios, Saratsis, & Galanos, 2012).

Greek Food Waste

Under EU directive 1999/31/EC, countries in the European Union must reduce their biodegradable waste, or waste capable of degrading through bacterial processes such as organics and paper products, by percentage weight. The directive calls for a phased approach based on 1995 biodegradable levels (Council of the EU, 1999). As shown in Figure 2, by 2010 a reduction to 75% of 1995 levels was required, with a further 25% by 2013 and an additional 15% by 2020. However, Greece has not met these targets (EEA, 2013).

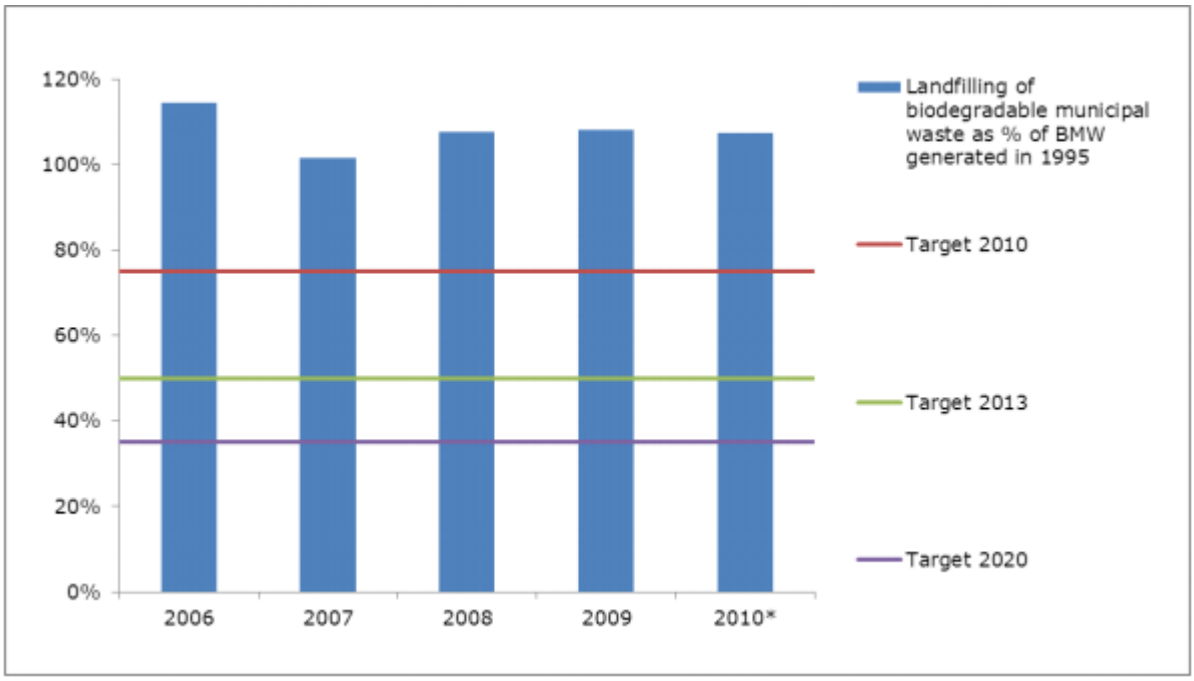

Figure 2: Percentage Biodegradable Municipal Waste (EEA 2013)

This graph depicts that Greece needed to reduce biodegradable wastes by close to 30% in 2010 to comply with that year's stage of the directive. In 2010, roughly 80% of Greek municipal solid waste (MSW) was comprised of biodegradable municipal wastes that are addressed in the landfill directive including 39.7% food waste (Ezeah & Byrne, 2014).

The greater Thessaloniki region, specifically the suburban municipality of Pilea-Hortiatis, is one area affected by this directive. In 2014, 40% of Municipal Solid Waste consisted of organic waste, most of that being food wastes. The average person in 2014 for this municipality threw away 0.176 ton of organic waste that year (Municipality of Pilea-Hortiatis, personal communication, April 19, 2017). With 70,210 residents from the 2011 census (OASTH, 2011), this means around 12,000 tons of organic waste were thrown away in Pilea-Hortiatis in 2014.

Consequences of Limited Food Waste Recycling

EU directive 1999/31/EC also outlines closing and mitigating the effects of unsanitary landfills. Unsanitary landfills are classified as landfills that do not meet the proper environmental regulations including: location, leachate management, soil and water protection, emission control, land stability, hazards, and barriers (Council of the EU, 1999). According to Ezeah and Byrne (2014), up to 47% of landfills in Greece were unsanitary and therefore illegal dump sites as of 2010. By 2014, 223 illegal landfills were closed; however, they had not been cleaned to meet environmental regulations so were still noncompliant (Curia, 2014). These noncompliance examples in Greece have detrimental environmental and economic impacts for the state.

In landfills, decomposing food wastes have a direct correlation with the increase of methane emissions, a significant greenhouse gas (EEA, 2013; Sinha, 2010; Ezeah & Byrne 2014; Iacovidou, et. al., 2012). Methane is 21 times more potent than carbon dioxide for greenhouse gas emissions, drastically affecting the environment (Christopoulos, 2005).

Greece has averaged a net weight of one million tons of carbon dioxide per year in greenhouse gas emissions based on their landfilling practices (ETC/SCP, 2011). The methane produced from landfills may also cause fire hazards since it is a highly volatile substance (Iacovidou, et. al., 2012). Additionally, percolation of harmful chemicals through soils and decomposition byproducts in the form of landfill leachate may cause environmental degradation of water bodies (Iacovidou, et. al., 2012; Sinha, 2010). The chances for this environmental damage are further increased by the number of illegal dumping sites in Greece, some of which dump garbage from cliffs or directly into bodies of water (Ezeah & Byrne, 2014).

Noncompliance with the landfill directive has economic consequences for Greece. For local economies, tourism may be impacted from dumping practices. Using the sea for dumping can cause unappealing sights and could make beaches unsafe for recreation, possibly driving tourists away. (Ezeah & Byrne, 2014). Therefore, the landfill directive was created in part to counteract the environmental damages caused by biodegradable wastes (Iacovidou, et. al., 2012). Due to its noncompliance, Greece is subject to significant penalties under the European Court of Justice (EC, 2013; Harris, 2016). In the case of the European Commission v. Greece, C-378/13, as of 2014 Greece owed a lump sum of 10 million euros and 14 million euros for each six month period thereafter of noncompliance (Curia, 2014). With the current Greek economic crisis, these added economic and legal concerns cannot be adequately dealt with.

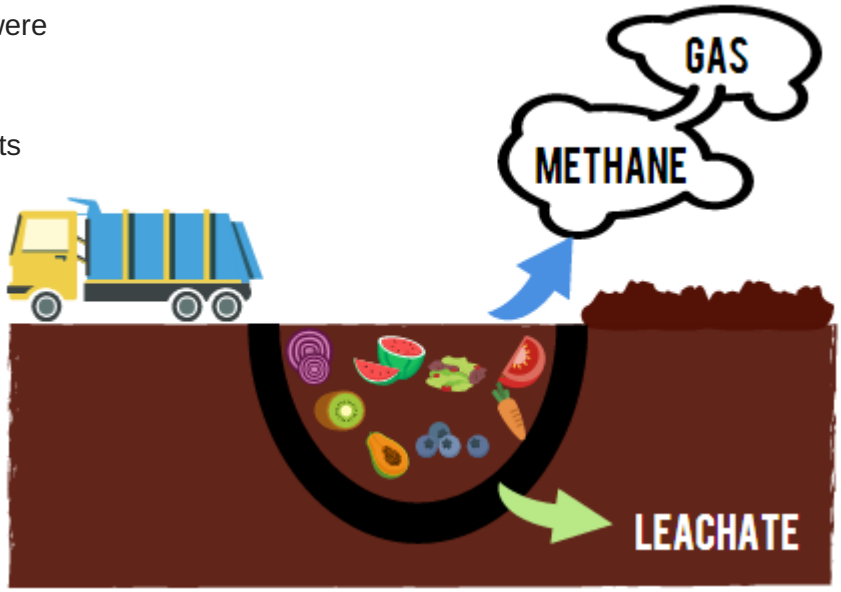

Figure 3: Environmental Harm from Organic Waste in Landfills

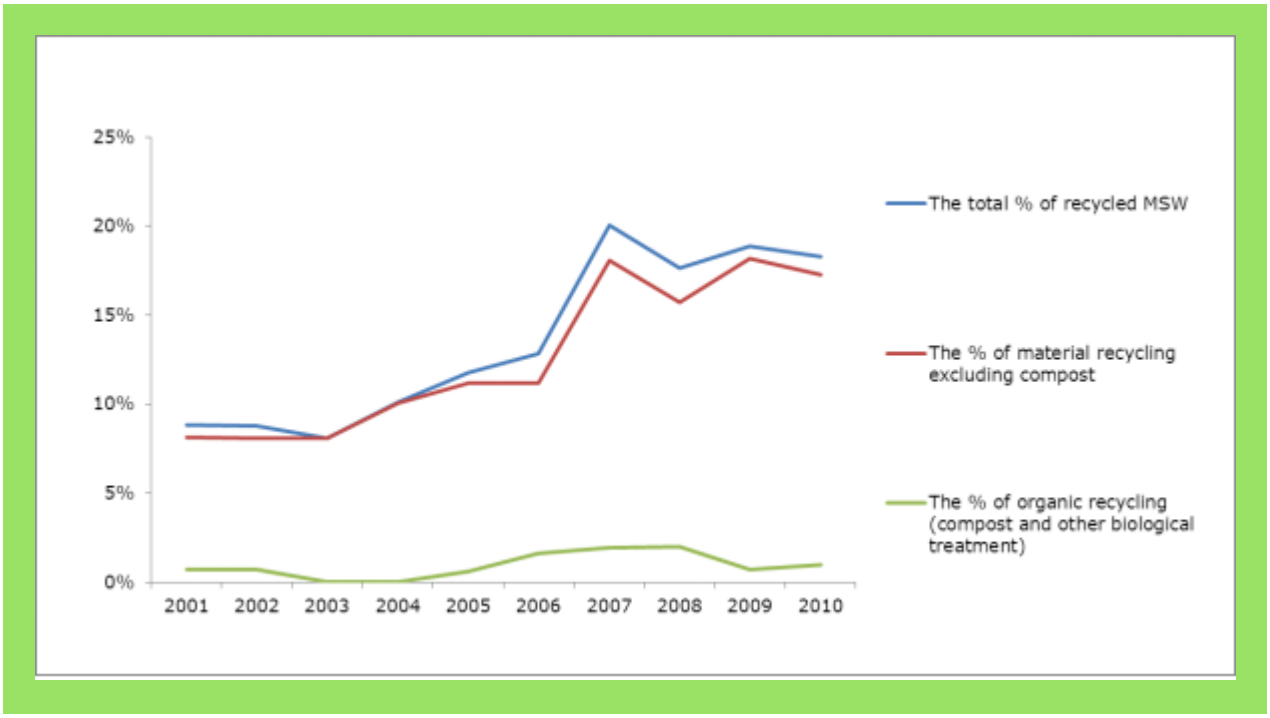

Figure 4: Recycling of MSW in Greece (Eurostat, 2012)

Waste Management Practices in Greece

In order to meet the directive's standards, Greece started the Hellenic Recovery Recycling Corporation in 2003 (EEA, 2013). This initiative has drastically increased their recycling rate in the last decade, as shown in Figure 4. However, the organic recycling rate is still very low, rounding out to a mere 2% (EEA, 2013).

In 2014, a suburban municipality of Thessaloniki, Pilea-Hortiatis, recycled 2,905,880 kg and landfilled 29,530,560 kg. This was a rise of 16.7% in their recycling from the previous year, but still only a 9.0% recycling rate for 2014 (The Municipality of Pilea-Hortiatis, 2015).

To decrease food waste in the next stages of meeting the directive, Greece is implementing facilities to reduce biodegradable wastes. At the forefront of this program are MBTs or mechanical biological treatment system. Figure 5 shows how the waste flows through the system. Five MBT facilities are online and seven are planned around Greece (EEA, 2013; Ezeah & Byrne, 2014). These plants contributed heavily to the spike in recycled material around 2007, shown in Figure 4 (EEA, 2013; Eurostat, 2012). This initiative is a large scale project that does not include community involvement; it takes time to construct and has high startup and maintenance costs. These programs mainly helped increase recycling rates rather than decrease overall food waste (Ezeah & Byrne, 2014).

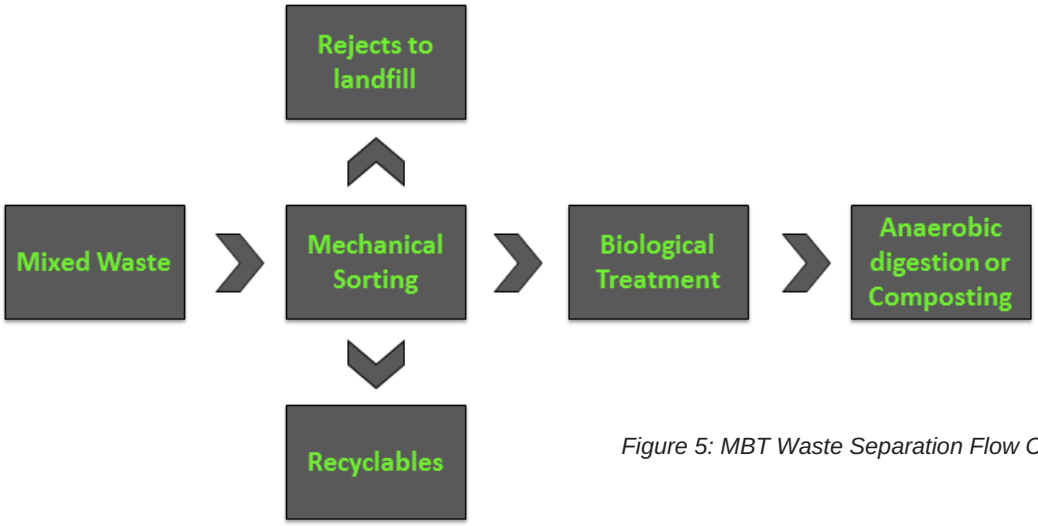

Figure 5: MBT Waste Separation Flow Chart

Food waste management has not been a focus of biodegradable waste management in Greece due to many factors. Greek populations lack adequate education on food waste matters, especially on food waste reduction initiatives. Consultants and other experts that could help provide solutions are often underutilized. There are few programs to speak of because available money goes to other areas like closing landfills or other programs like recycling (Lasaridi, 2009). In order to effectively manage food waste, a method that is feasible and efficient must be explored.

Vermicomposting and Designs

Introduction to Vermicomposting

One possible solution to reduce organic waste is to consider a strategy called vermicomposting. Vermicomposting is similar to traditional composting, but with the addition of compost worms which utilizes their unique digestive system. The worms naturally condition the soil with their movement. Their excretion, otherwise known as vermicast, contains high levels of nutrients and microbial activity which enhances the environment and surrounding microorganisms' ability to conduct chemical degradation (Adhikary, 2012; Ali, et. al., 2015; S. Abbasi, Nayeem-Shah, T. Abbasi, 2015). *Eisenia fetida*, also known as the red wiggler worm, is the primary worm used for vermicomposting because of its worldwide accessibility, physical fortitude, and advantages for pest control (Munroe, 2007).
Figure 6 shows a pictorial representation of the full process.

Compared to traditional composting, vermicomposting produces better quality fertilizer, has a lower risk of pathogens, and has the ability to reduce municipal waste generation in a shorter amount of time (Lleó et al., 2013). According to a study on the use of earthworms in sustainable development programs, researchers found that, "Earthworm participation enhances natural biodegradation and decomposition from 60 to 80% over conventional aerobic & anaerobic composting (Sinha, 2010, pp. 157)." However, since vermicomposting relies heavily on the survival on the worms, maintaining the worms and their environment is necessary for the entire system to function (Rajeev, Pooja, Ademir, Ibrahim, & Sulaiman, 2011). For example, pH is one of the limiting factors that determine the survival of the worms. Table 1 provides insight into the differences between composting and vermicomposting.

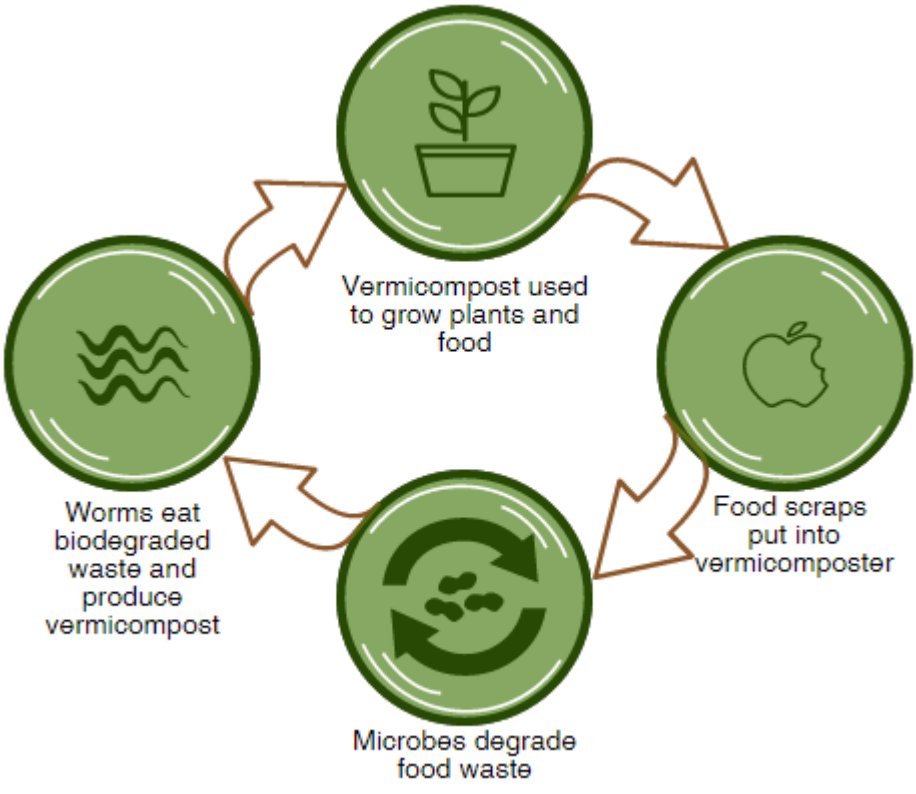

Figure 6: Diagram of Vermicomposting Process

Table 1: Comparison of composting to vermicomposting (Singh et al., 2011, pp. 724)

Parameter	Composting	Vermicomposting
Waste Characteristics	Sorted organic fraction of MSW, preferable with same rate of decomposition	Any organic waste which is not appreciably oily, spicy, salty or hard, and that do not have excess alkalinity or acidity
Particle Size	Between 25 and 75 mm for optimum results	Between 25 and 50 mm for optimum results
C/N Ratio	Between 20 and 50. Release of ammonia and impeding of biological activity at lower ratios. Nitrogen as a limiting nutrient at higher ratios	30:1 preferred
Moisture Content	55% optimum	40 - 55% preferable: cover the tank with wet sack and sprinkle water as required
pH	No requirement of any specific pH	Vermi-beds have to be maintained at favorable pH
Process Involved	Thermophilic stage must be attained	No thermophilic stage is required
Time Duration	Microorganisms decompose substrate and it takes a longer period to mature	Microorganisms and earthworms combine their activities to transform the substrate. Matures relatively faster than compost
Texture	Compost is coarser textured	Vermicomposts are finer textured
Fate of Heavy Metals & Pathogens	Risk of heavy metals in the compost, may have chances of pathogens	Heavy metals are removed and accumulated within worm bodies, pathogen free

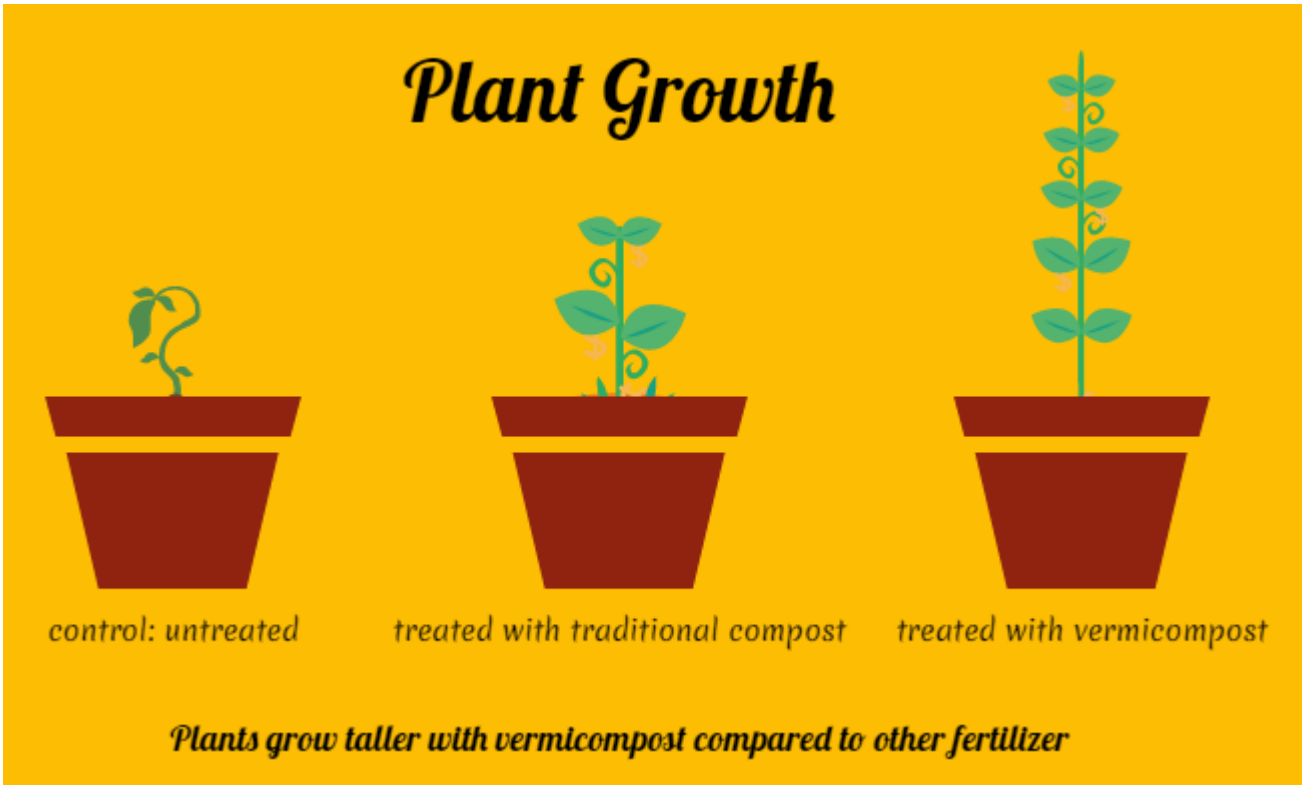

Figure 7: Plant Growth (Atiyeh et al., 2002)

The vermicast or the product of vermicomposting can be used as a soil amendment for fertilizer in agriculture or household gardening (Nagavallemma et al., 2004). Multiple studies have shown that with the addition of vermicast, which has mixtures of byproducts such as the produced liquid leachate and humic acid, the overall growth and health of the crop is increased (Atiyeh, Lee, Edwards, Arancon, & Metzger, 2002; Quaik, Hossain, & Ibrahim, 2016).

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Vermicomposting Design Introduction

Vermicomposting is a technique for food waste reduction that has many different designs that have emerged through research and do-it-yourself projects. Although there are many types of designs, conditional parameters are mostly constant across different designs. These conditions help achieve the best function and end product. They can be found summarized in Table 2. Greece has temperature ranges that correlate to these ideal conditions, making the climate a good choice for outdoor vermicomposting. Other conditions such as the pH and the moisture levels can be adjusted based on maintenance. Food waste can affect pH levels based on the acidity of the food. Moisture

evels can be handled through the application of damp bedding, which is paper and cardboard products used as a carbon source. Proper ventilation in designs is key parameter as aerobic bacteria cause minimal smells in the system, while improper ventilation can promote anaerobic bacteria growth and thereby odors (Abbasi, et al., 2009). Finally, the waste to size ratio is one of the most important parameters in deciding the scaling for the vermicomposting system. All of these parameters can then help determine the design that works best for a household and the rest will then be adjusted based on the user.

The typical bin setup includes the addition of multiple layers within the main container. The initial bottom layer in the setup is a cardboard piece that is used to mainly hold the contents of the vermicomposter in the bin (GreenShortz, 2015). The layer above this is damp strips of paper called bedding which provides a starting environment for the worms (Abundant Earth, 2017). The worms and food waste are then added on top of the bedding followed by another layer of damp bedding. This setup is said to be the least odorous and most time effective method for getting the bin going and keeping the worms from dying. The typical vermicomposter will take a month to reach a point where there will be consistent production of vermicast (Abundant Earth, 2017). During this time, the worm population will adjust to the environment in regards to the number of worms that can survive off the food and bacteria in the system will multiply to break down the waste for the worms to digest (Bentley, 2013).

Vertical Bin Vermicomposting

Commercial vertical bin vermicomposting systems have many designs that are made of different materials and are widely used across different application. They are typically made from from rubber tubs or wooden containers. Rubber tubs are the most common container for a vermicomposting bin and are highly regarded across internet forums. The bin design uses vertical trays which enables worms to move up, allowing the bottom trays to be removed and stacked on top after being emptied. This allows for a constant addition of food to the top, but requires that the bins be lifted and replaced monthly. The advantage of

Parameter	Ideal Condition	Source
Temperature	10° – 26.7° C	*Hemerling, Pan, Bhalla, Kedia, 2016*
pH	5 - 8	*Hemerling, Pan, Bhalla, Kedia, 2016*
Moisture Level	Damp, no standing water	*Cocran 2017*
Air Flow	Good ventilation	*Cocran 2017*
Depth of System	30 – 46 cm	*Hemerling, Pan, Bhalla, Kedia, 2016*
Waste to Size Ratio	4.88 kg/m^2	*CompostJunkie, 2012*

Table 2: Ideal Parameters for Vermicomposting

using rubber bins comes from the need to reconfigure the bins as wooden models can be very heavy and difficult for people to move (Compostjunkie, 2012; Grant, 2016). Wood models are advantageous in that it allows for more aeration to the compost which reduces the smell that anaerobic bacteria can cause (Wood Worm Farms, 2017). Liquid fertilizer may also be collected in these models using a collection bin underneath with a spigot. The main disadvantage of this system is a tray must be completely turned into vermicast before it can be harvested, a process that can take up to a month after finishing filling that tray with food waste (GreenShortz, 2015). The overall schematic of this design is shown in Figures 8 and 9.

Figure 8: Vertical Bin Diagram (Halifax Garden Network, 2011)

Continuous Flow Vermicomposting

Another popular design found mostly on community forums and do-it-yourself pages is the continuous flow vermicomposter. This vermicomposter is one container where the whole process occurs, instead of the multiple tray design that was discussed in the previous section.

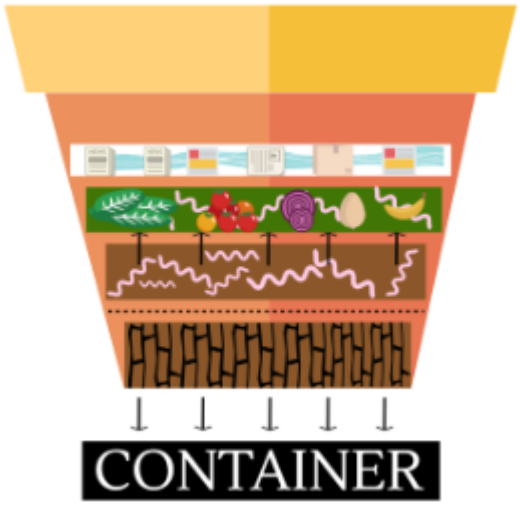


Figure 10: Continuous Flow Diagram (Buzzle, 2016)

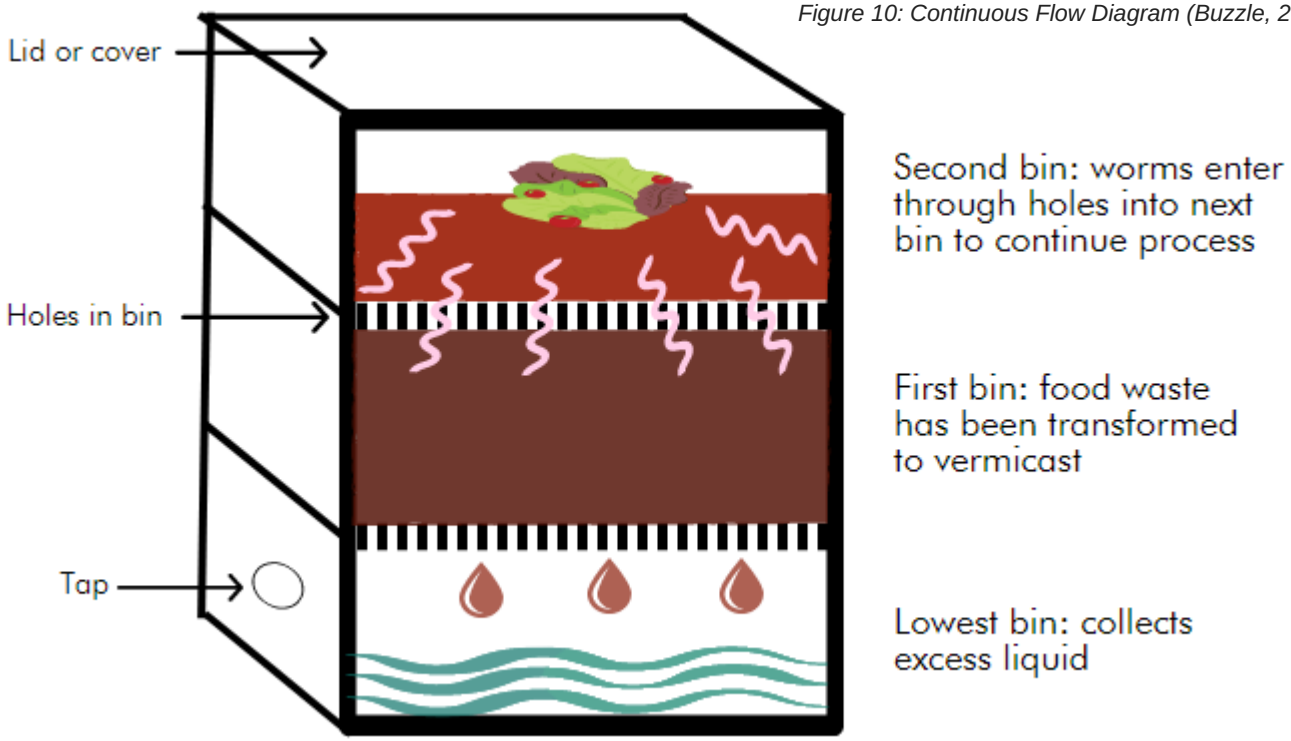


Figure 9: Worm Bin Diagram (Advanced Household Worm Farming, 2011)

Once the system is setup, the overall process allows food waste to continuously be added to the top while the bottom layer becomes vermicast and can be taken out. This design minimizes the need to wait for complete decomposition and also allows vermicast to be continuously harvested, as observed by a user, Derren Rosbach (D. Rosbach, personal communication, January 31, 2017). The collection of vermicast typically requires a tray or rake as vermicast clumps at the bottom of the bin. This system requires that something pull the vermicast out of the vermicomposter and into a bucket underneath (GreenShortz, 2016). The mechanism for this design can be seen in Figure 10.

According to community forums, the design of continuous flow vermicomposting systems is cheap and can be done with the repurposing of trash bins or scrap wood (Plumiebear, 2010). The disadvantage of this design is its ability to scale as it would require a large surface area (Chaoui, 2010). However, the worm population will adapt to the size and amount of food waste present. According to Derren Rosbach, the population of worms in the system will utilize a negative feedback loop where the worms will reduce reproduction when there is a limiting food supply. By doing this they cap the population and have the ability to expand to reach an appropriate number for the food that is available (D. Rosbach, personal communication, January 31, 2017).

Future Application of Vermicomposting

Over the last few years, vermicomposting has expanded beyond agricultural applications, and researchers have realized the potential of vermicomposting to reduce municipal solid waste (S. Abbasi et al., 2015). A study done in an urban residential area in India found a 60% reduction in volume of organic waste in just about a month with optimal environmental conditions for the worms (Chardhair, 2011).

In another case, a student team along with their advisors, established multiple communal vermicomposting sites in an informal settlement in Santo Domingo, Dominican Republic (EPA, 2012). Even though the project couldn't quantify the reduction in waste due to time constraints, the team was able to establish a communal ambiance surrounding vermicomposting and observed less organic waste in the area. Other examples of vermicomposting programs are seen on university campuses.

The University of Texas in the United States and the Puncak Alam Campus of Universiti Technolgi MARA in Malaysia have both implemented vermicomposting systems on their respective campuses. Compostable food waste from the cafeterias at both universities was vermicomposted and used to provide fertilizer for their respective campus gardens (Montoya, Waliczek, & Gandonou, 2016; Baki et al., 2015). As seen through these case studies, vermicomposting has the potential to reduce food waste that accumulates in landfills and contributes to greenhouse gas emissions (Sinha, 2010).

Composting and Vermicomposting Initiatives

Government Policy on Waste Management Programs

Vermicomposting and other organic waste collection programs are by no means new ways to combat the global waste management problem. Successful programs can be implemented through strong government policy, incentives, and public education and awareness. Within the framework of government policy, intervention can be centralized or decentralized. San Francisco provides a strong example for how centralized government policy can gradually implement an organic waste management program (Sullivan, 2011).

Figure 11: Three Stream Recycling in San Francisco, CA (Farm, 2009)

In 2009, the mayor of San Francisco announced mandatory recycling and composting, a directive that is still in place today to reach the city's goal of zero waste by 2020. Being the first city in North America to adopt three-stream collection, including organic food waste, San Francisco became a model for many cities to follow. According to the mayor, "You have to have policies in place, a municipality ready to take the initiative and a willing partner. We had all three – you have to have all those ingredients to get it to go" (Sullivan, 2011, pp. 28). Additionally, a vermicomposting initiative in Connecticut provides another example where strong government involvement produces a successful program. The Department of Environmental Protection provided $36,500 in grants to fund this program which included providing subsidized composting bins and community education (Protection, 2017).

Under the umbrella of decentralized compost initiatives, São Paulo, Brazil assessed interest in an individual program (Siqueira & Assad, 2015). According to the article, decentralized programs are favored over centralized systems in developing countries due to lack of funding and infrastructure. However, the country also lacked funds for incentives that typically encourage participation in small-scale programs (Siqueira & Assad, 2015). New York City (NYC) currently has both centralized and decentralized composting programs in order to maximize participation. The NYC Department of Sanitation has multiple composting centers throughout all the boroughs where residents can drop off their food waste for it to be locally composted. The department also has a program where residents can buy backyard compost or worm compost bins on an individual basis (NYC Compost Project, 2017).

School Cafeteria Waste Management

School cafeterias are a prominent source of concentrated food waste. An audit done at three schools in Florida determined an average waste of 102.3 g/student/day, and 81.5% of this value was comprised of organic waste (Wilkie, Graunke, & Cornejo, 2015). Although the total waste differed from each school depending on multiple variables such as the age of students and food availability, the waste could still mostly be prevented from going into landfills. Five categories were set up to evaluate the food waste: food, milk, aluminum and glass, paper, and plastic.

(U.S. Department of Agriculture, 2011)

Food waste was the largest category at about half of the overall waste, so reducing food waste would have the biggest impact on the total waste stream (Wilkie et. al, 2015). The first step in reducing overall cafeteria waste is establishing an effective separating system (Sherman, 1997). In order to divert waste from the landfills, waste needs to be separated into groups that can either be recycled or composted.

Cafeteria vendors can work in conjunction with university programs in order to reduce overall waste. Texas State University conducted an economic analysis on vermicomposting with vermicast being sold for profit. The study used primarily food waste from a cafeteria salad bar to feed the worms. By creating a program that focused on reducing food waste for a profit, students learned real-world entrepreneur skills while also learning the importance of waste management (Montoya et. al, 2016).

Public Responsibility and Education

Public education and awareness is essential for any composting or vermicomposting system to become successful. A study conducted by Babiak (2011) highlighted reasons for companies to implement environmental practices. Exploring the two possible motives that “doing good is the right thing,” or “doing good is good business,” the study focused on major league sports teams in the United States.

Babiak (2011) concluded that many executives engage in environmental and social responsibility because of institutional pressures of being a “good citizen.” Additionally, the study uncovered that many executives believe environmental accountability to be a societal norm (Babiak & Trendafilova, 2011). Based on these findings, it could be found that individuals participate in vermicomposting, backyard composting, or even recycling because it is the right thing to do. However, most of the successful programs include incentives or disincentives that favor participation in such programs (NYC Compost, Project 2017; Protection, 2017; Sullivan, 2011).

Regarding public education, cities can implement a variety of strategies to inform citizens. One potential obstacle for a big city to overcome is diversity. In San Francisco, officials produced pictograms and multilingual signs to inform residents on proper recycling procedures (Sullivan, 2011). Information sessions are also an effective way to educate the public; São Paulo implemented this practice to inform citizens of correct procedures for properly maintaining a compost system on their own (Siqueira & Assad, 2015). Community involvement is a key factor in the success of vermicomposting programs. The State of Connecticut invited local schools to have an educational day on vermicomposting. The activities were hands-on, and students could feed the worms and look through microscopes to observe insects (Protection, 2017). Another successful method of public education is by way of Internet utilization. The City of Lawrence, Kansas has updated their website to include information on their worm composting initiative. The website has eye-catching visuals that help educate citizens and also give tips on troubleshooting their bin (City of Lawrence, 2016).

Figure 12: New York City Compost Project (NY City Lens, 2016)

METHODS

Through a feasibility assessment, this project analyzed the possibility of vermicomposting on three different scales in the Thessaloniki region of Greece: individual, institutional, and municipal level initiatives. These objectives helped the team draw conclusions and provide recommendations to expand vermicomposting for future programs.

1. Determining the feasibility of a household vermicomposting system
    a. Vermicomposter Design
    b. Assessing User Interaction Through Case Studies

2. Understanding the requirements for an institutional level vermicomposting system
    a. Campus Food Service
    b. American Farm School (AFS) Community Attitudes

3. Exploring the parameters required for implementing a municipal program
    a. Municipality Preferences
    b. User Preferences

Determine the Feasibility of a Household Vermicomposting System

Vermicomposting Design

Through research, we discovered many important parameters required in a vermicomposting system as well as several different designs for household vermicomposting systems. The design parameters that we prioritized were cost, simplicity of use, space, simplicity to build, and maintenance level. With this in mind, we built a continuous flow vermicomposting system with a manual for household use, found in Appendix A. The design was conceived by us and inspired from research and recommendations from our partner, Professor Vasilikiotis. The other vermicomposting bin we used for our study was a commercially available vertical bin vermicomposting system, which included its own manual and was available at Perrotis College.

When deciding what material to use as the main body of the system, we wanted to maximize the surface area as a key parameter for this design. We chose a children's toy chest due to its low cost, large surface area, its round roof for outdoor weather, child appeal, and the convenience to acquire. To scrape out the vermicast at the bottom, we also bought a cheap garden rake. These purchases totaled €13.50. We then collected wooden pallets on campus to build a cheap base to suspend the vermicomposter from to allow for a collection bucket to be placed under it. Our partner provided us with a drill, hammer, saw, razor, and wire mesh. The use of simple tools was instrumental to our project as it was our hope to create a design that would be easy for most people to follow and implement. The construction of the vermicomposter took approximately two hours to complete. The stand design was made in a triangle fashion to support the container while leaving the bottom open for the rake. The drill was used make holes in the tub to allow airflow, while the wire mesh was glued on to stop any insects from getting into the system.

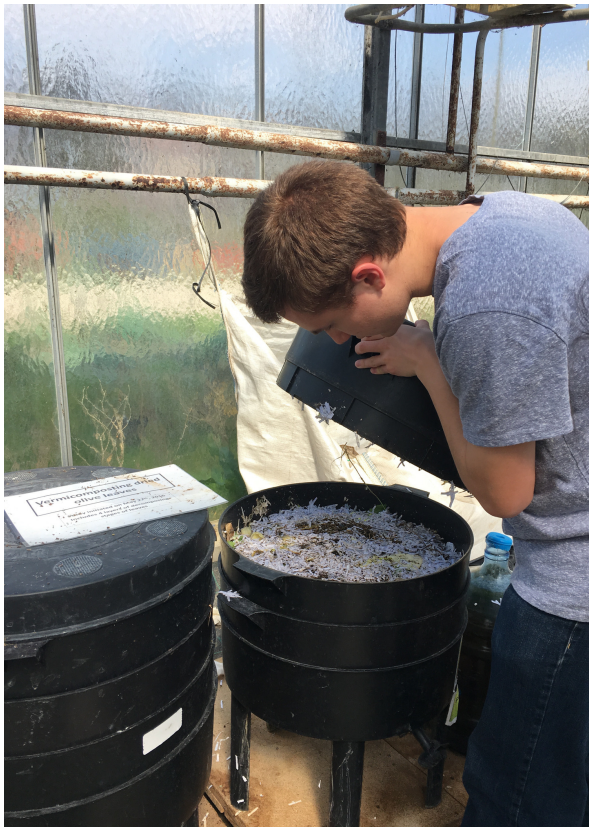


Figure 13: Observing a Vermicomposter

Assessing User Interaction

To begin our relationship with the households of the AFS campus, we sent out emails with the help of our partner to the faculty members who reside within homes on campus. The intent of our initial outreach to the campus was to establish a relationship with the residents in order to explain our project and inquire if any of them would be willing to participate in our case study. Following responses from two different families, we received their consent to interview the users for their preferences and attitudes toward vermicomposting, which can be seen in Appendix B.

Figure 14: Establishing a Vermicomposter

These case studies involved setting up vermicomposting bins in each of their homes and showing them how to implement and run the vermicomposter. We gave a commercial bin to one of the families and a vermicomposter of our own design to another family. Along with the vermicomposters, we gave them a manual on how to run them effectively. This led us to giving a professional guide that came with the commercial bin and us creating our own guide to see if the families found it useful. One of our objectives is to create educational materials and this comparison of the guides and user interaction with them will allow us to further develop the best manual educational material.

During the initial setup we also provided them with a checklist, a journal, and a manual on how to use the vermicomposter. The checklist and journaling were used to gauge the level of interest and document the interaction between the user and the vermicomposting bin. The checklist is a simple method to see how many times the user interacted with the vermicomposting bin. It included different tasks that they could check off if completed such as watering the system, adding food waste, smelling odor, and pests trying to enter the system. The journaling was meant to document any thoughts or incidents while using the bin, including taking pictures. This was designed to be open ended so the user could be comfortable documenting their experiences and we could assess their level of interest. We determined the best method of journal collection based on the preference of the participants and gave a hard copy of the prompt and daily checklist. The checklist and overview of the journaling can be seen in Appendix C. We conducted an exit interview with the participants after the first week with the bin to get a better understanding of their experience. This exit interview focused on their new perception of vermicomposting and any suggestions on improvements to the designs, user manuals, and overall documentation program. The overview of the documenting program and exit interview questions can be seen in Appendices C and D respectively.

Due to time constraints, the case study was only able to cover the first week that the users had the bin. Despite this time constraint, the first week is when the system is new and just beginning which gives insight into the user's initial thoughts and the difficulty adapting to the system. With the short time period, we did not expect the users to have the opportunity to face most of the potential challenges vermicomposting entails such as using vermicast, the appearance of vermin, and odor issues. We also understand our method of picking participants lent itself to biases as we addressed the email in English to a small sample population of residents already heavily invested in agricultural education and with personal ties to our partner. Due to this convenient method, we were more likely to gain participants. We tried to gain richness in our data through our recording methodology as we gained insight into the entirety of the experience with vermicomposting of participants.

Understanding the Requirements for an Institutional Level Vermicomposting System

Campus Food Service

Another opportunity we explored was trying to involve the vendor that provides cafeteria food to the American Farm School named F-Zone, an affiliate of PAP Corp, in aiding the development of vermicomposting on campus. Currently our partner, Professor Vasilikiotis, has multiple vermicomposting units in the greenhouse on campus and with the addition of a food waste source from the cafeteria, there is a potential for the AFS to produce less food waste. In the past, a student completing their dissertation tried to accomplish a similar goal, but the cafeteria only supplied a small variety of food scraps when directed to. When the student did received food scraps, it was on an inconsistent basis (C. Vasilikiotis, personal communication, January 26, 2017; Alexandros, 2017). These findings indicate the challenges in working with a business to create a successful system, but the cafeteria supplying a limited variety in food scraps on an inconsistent basis indicated the challenges in implementing a system to accomplish this. It is typical for habits to take time to change and part of our project is trying to start the process for this change to occur.

To figure out how to approach and start this objective, we first came in contact with the manager of the F-Zone food service providers on campus using proper channels through Professor Vasilikiotis. We had an initial informal meeting to introduce ourselves and our project. Within this meeting, the manager agreed to cooperate with us and allowed for a collection system to be place outside of the kitchen. The initial strategy was a simple trash can with a sign, seen in Appendix E and Figure 15, which shows various food items that are appropriate and inappropriate for

Figure 15: Vermicomposting Input Guide

vermicomposting. Workers vermicomposting. Workers would put food waste from the day into the trash can which a team member would then collect for the vermicomposter in the greenhouse. The food waste that we received from this method was weighed and recorded for a few days to assess the initial trial. We then interviewed the manager for insight into their current practices on waste management. In this interview we wanted to delve more into their interest in collaborating on this project and their willingness to continue aiding this process even when our project ends and other groups take over. We also wanted to see if there was an incentive for the company to collaborate on this potential program and possible methods to best separate the food waste. The full interview schedule can be seen in Appendix F.

We did not have time to conduct a waste audit of the cafeteria waste, which would have been beneficial in knowing the maximum weight of vermicompostable waste that can be generated, as well as the percentage by weight that can be saved from entering landfills. Other limitations included timing as Easter Holiday and an audit occurred during the middle of our time here. Due to this time constraint we could not fit in interviews with the cooks or more trials of trying to get their food scraps. We were also concerned with overstepping our boundaries as outsiders, especially foreigners, coming into a business and changing processes for the benefit of our project. To mediate this, we took precautions with our partner to take proper channels to talk with and interview kitchen staff.

American Farm School Community Attitudes

When considering a new institutional program, we wanted to gauge community attitudes toward environmental sustainability programs and food waste reduction initiatives. This was an initial survey of the community to discern if community members felt strongly about these subjects before advancing in program planning. To accomplish this, we included in a survey of community members questions related to perceptions on recycling, environmental sustainability practices, and food waste reduction. This survey was sent to faculty, staff, and Perrotis College students through a Google survey form link and this AFS survey may be found in Appendix G. This type of survey is a convenience survey because of the sampling methodology used to obtain responses, which can lead to population biases. However, this sampling method was acceptable for gaining an initial general perspective on community attitudes.

Figure 16: Cafeteria Food Waste Collection Site

Exploring the Parameters Required for Implementing a Municipal Program

Municipality Preferences

In order to properly assess the possibility of a vermicomposting program in a municipality, our team learned more about the municipality officials' interest in environmental practices. Our team focused our efforts on the municipality of Pilea-Hortiatis since Professor Vasilikiotis had contacts in their administration. Respecting the hierarchy in Greek local politics, Professor Vasilikiotis first met with Pilea-Hortiatis municipality officials to confirm interest and introduce our project. Next, our entire group met with the officials, while Professor Vasilikiotis also attended to translate and clarify any questions they had. In this meeting, our group presented the questions we prepared, found in Appendix H, to gauge the municipality's current waste management practices. This analysis included their practices regarding organic waste, their interest in environmental sustainability, and their interest in a vermicomposting program. The officials present at the meeting offered to send the questions throughout their department in order to receive the most complete answers. Once we could understand how the municipality felt toward environmentally sustainable practices, we could discuss vermicomposting programs specifically. To pursue more interviews and get the support of the municipality, we needed to acquire consent of the mayor. Therefore, we wrote a proposal letter to the mayor, given and edited by the advisor to the mayor, explaining our goals and objectives for the project. This proposal can be found in Appendix I. The overall schedule of our interaction with the municipality can be found in the table below. The interaction that we had with the municipality is an important aspect of our process that will be further analyzed in our findings.

ΔΗΜΟΣ
ΠΥΛΑΙΑΣ-ΧΟΡΤΙΑΤΗ

Figure 17: Pilea-Hortiatis Municipality Logo

Table 3: Municipality Project Timelime

Date	Task Completed
3/24/17	Dr. Vasilikiotis visits with a municipality official in the Parks and Recreation Division of Pilea, who previously worked at the AFS, to discuss our project.
3/27/17	WPI team & Dr. Vasilikiotis visit Parks and Recreation Division of Pilea to discuss project goals. A questionnaire was provided at this meeting.
3/27/17	Our group used the information from our meeting to craft a survey to send to the residents of the municipality, and a proposal to the mayor.
3/28/17	Our group revised the proposal and survey based on Dr. Vasilikiotis' comments.
3/30/17	Dr. Vasilikiotis modified the documents and had us further edit them so that they could be sent to a municipality official to be corrected.
3/31/17	We sent Dr. Vasilikiotis the revised version of the proposal to send to the municipality official.
4/6/17	The municipality official returned the proposal with comments regarding increasing the political nature and municipality support.
4/7/17	Our group revised the proposal based on the municipality official's comments and sent it back to Dr. Vasilikiotis.
4/10/17	Dr. Vasilikiotis revised our latest version and sent it back to us to view before he sent it to the municipality official.
4/11/17	Dr. Vasilikiotis sent the email back to the municipality official for approval.
4/18/17	The municipality official sent the email to the mayor's advisor over Easter Break. She also sent him the questionnaire from our first meeting.
4/19/17	Dr. Vasilikiotis sent our group the filled out questionnaire.

The municipality also asked us to develop pamphlets and educational material that would allow for users to successfully use and build the vermicomposters. To further help keep the program successful after we leave, we posted how to construct vermicomposters and also how to troubleshoot and operate the various designs that could then be posted on their website. An integral part of our project was exploring avenues for expansion of vermicomposting throughout Thessaloniki. In these pamphlets and guides, we included basic facts on why vermicomposting is useful, how to construct a system, and how to manage and troubleshoot common problems. Through these guides, we hoped to make the process easy to follow in order to maximize participation. The materials that we created may be found in Appendix J.

Figure 18: Putting Food in a Vermicomposter

Figure 19: Adding Bedding to a Vermicomposter

User Preferences

To understand the requirements for implementing a municipal level program, our group used a survey method to determine the preferences surrounding the construction and use of vermicomposters for Greek residents. The ideal population for this survey would have been municipality residents; however, due to time constraints when working through the hierarchical system within the municipality, we decided to survey American Farm School faculty, staff, and Perrotis College students. While students are not a good representation of the group that we are interested in for installing vermicomposters, they are an important group for analyzing the future population's opinion on environmental awareness and practices. The same survey was used to collect municipal data and, previously, in campus attitudes. This survey was a convenience sample of the American Farm School community because we sent out a link through email. Using a convenience sample has some disadvantages such as sampling bias and acquiring responses that are not representative of the entire population. However, in our case we wanted to gain basic insights into perceptions of vermicomposting and sustainability programs, and the opportunity to work with the American Farm School to set up a survey was deemed the most opportunistic option. To do this, we made a survey that can be found in Appendix G that allowed us to gain an understanding of what would inspire individual residents to use vermicomposting systems and also what designs they would find most desirable. Our survey gathered information on aspects such as food waste habits, what the respondent believes their impact will be by using a vermicomposter, and also what they believe is the best design for a vermicomposter.

In order to effectively interpret our survey data, we employed a variety of analysis methods. Regarding vermicomposting interest, we compiled answers into

Excel to understand trends relating to items such as gardening, time spent gardening, and fertilizer use. When analyzing possible concerns, we coded responses to determine the most frequent concern. In order to assess opinions about design appeal, we calculated a weighted average of each design's score. This process allowed us to distinguish the highest and lowest rated designs. Additionally, we analyzed design parameters with a weighted sum based on ranking of importance and frequency of use. For each listed response, we assigned the first parameter a weight of five, the next a four, and so on. If the parameter was not listed in their rank, it was assigned a zero. This method highlighted which parameters are most and least important to potential users.

Figure 20: American Farm School Logo

FINDINGS

Individual Level

Construction of a vermicomposter can be done by a novice user with simple, inexpensive materials.

Research that we conducted before coming to Greece helped us determine a design that would be easy for both us and other novice users to construct. Many Do-It-Yourself discussion boards on the Internet helped us develop the final design that we constructed. These creative innovations along with knowledge gained from an interview with Dr. Rosbach, a WPI professor who was a recent vermicomposting user, developed into our final design. Aspects gained from these sources include: continuous flow process, rake system, and plastic container. We then created the base idea from our own team's experimentation and engineering expertise.

While our process for the construction of the vermicomposting system was described in the methods and Appendix J; the findings and experiences that we had during the construction were important for helping us make a manual for the construction of the vermicomposter and further developing our recommendations on how to build it after our initial attempt. These products can be seen in Appendix J and are an acknowledgement of the iterative process for developing the educational materials. During the process, we noted that the most difficult step of the construction was cutting the slits in the bottom of the vermicomposter, since the tools that we had for this were a serrated knife and a pair of scissors. As for future developments of the process, we would recommend using a different tool, such as a Dremel, to cut the strips and make the process easier.

Ultimately, the overall finding from this construction was that a simple vermicomposter could be constructed with a price of only €13.50 with the addition of leftover wooden pallets. It was unclear to us how difficult it may be for an average person to find pallets or other desired materials for this project; however, if a municipality sponsored such a program, it would become easier to acquire wooden pallets. The municipality that we interviewed, Pilea-Hortiatis, has stated that they have an excess of pallets that can be used to further a possible initiative with vermicomposting programs. Therefore, vermicomposters could be obtained for a reasonable price. Concurrently, despite the initial capital cost, a municipality could save money overall by subsidizing the vermicomposters to reduce the amount of waste that they need to move to landfills.

Figure 21: Assembling Vermicomposter

Figure 22: Cutting Strips From the bottom of the vermicomposter

For Pilea-Hortiatis, waste is charged by the truck load so an effective reduction of food waste would reduce the trucks traveling to the landfill, thereby saving money. Since we found a relatively cheap solution to building vermicomposters, the capital cost should be able to reduce the overall operating cost for a municipality. Another important cost to consider was labor costs. The municipality may benefit from setting up kits for the assembly of the systems so that the labor is not set on the city but instead those who do the program.

The two vermicomposting case studies had similar findings and showed that once the users started they found that their initial concerns were not an issue.

Dean Rotsios' family was one of the two families that participated in the case studies to examine the perspectives and experiences of an individual vermicompost user. His interview transcripts may be found in Appendices K and L. Despite their busy schedule, he and his family were frequently involved in using the vermicomposter. Through the eight days that he had the vermicomposter, the system was fed everyday and he added water the sixth day into using it, as can be seen in Appendix M. His son and wife were involved in feeding it after each meal as well and none of them were concerned with the smell that the vermicomposter produced. During the short time that he had it, he found no problems and did not have to reference the provided manual for help. He used the chart of the correct and incorrect foods, found in Appendix E, to put food waste into the vermicomposter and found that he did not need to use the educational materials provided beyond this need. The initial training taught him enough to recognize the appropriate moisture level needed in the vermicomposter along with how food should be placed under the bedding. An aspect that exemplified the level of interest he had in the vermicomposter was when he said that one of the days he checked the tap to see if there was liquid being produced already. This action was something we said could be done a few weeks into using a vermicomposter, but the attention to this detail already showed his interest in seeing the vermicomposter work.

One of the biggest problems that he noticed was that he filled up the vermicomposter to nearly the top of the bin. An interesting finding that Dean Rotsios thought was significant to our project was the realization that he produced a lot more food waste than he previously believed his family of three would. With the waste that they produced for a week, they ended up filling the entire bin. The waste that was put in was a good variety that included vegetables, egg shells, fruit, and coffee. Upon inspection of the vermicomposter we found that there was not a sufficient amount of worms for the waste that was placed in the vermicomposter.

Figure 23: Dean Rotsios' Vermicomposter After One Week

We advised him to stop feeding the system until more of the food was decomposed. We were concerned by the large number of ants within the system, but it did not concern him as long as they were just in the system and it wasn't detrimental to the worms.

The design and application of the vermicomposter was satisfactory to his family's needs and was simple enough for them to use. Dean Rotsios was glad that the vermicomposter was light enough to move so that the area around it could be cleaned. The maintenance of the system was something that he had concerns about before we set up the system with him but he noted no problems with the design and expressed a desire to continue using the vermicomposter.

Mrs. Tsaparikou's was the second family that participated in our other case study. Her interview transcripts may be found in Appendices N and O. She discovered that using the vermicomposter was not difficult for her as it was located close enough to the kitchen and she could insert the waste in every time she finished cooking.

She expressed that it would be a good idea to have a bin in the kitchen where you could collect all of the waste from a meal and later bring it out to the vermicomposter. Her husband was not extensively involved with the vermicomposter, but was educated in how to run it and knew the correct waste to put in. Unlike Dean Rotsios, she did not involve her family in the use of the vermicomposter beyond them knowing what it was. Her home responsibilities include cooking and gardening, so it was natural for her to become the primary vermicompost user. Her husband and sons are not as involved in these activities; therefore, they were not as involved in using the vermicomposter.

During the time that her family had the vermicomposter, they did not read the manual because they believed that the training that we gave them was enough to properly run it. An important finding that came from speaking with Mrs. Tsaparikou and her husband was that there was confusion about whether or not olive leaves, hard boiled eggs, and grass clippings could be added to the vermicomposter. This finding was important for us to further develop educational materials for training and in our manual. When we inspected the bin that was at her house, we found a similar problem to Dean Rotsios' bin. There were not enough worms in the system and there were a lot of ants that had entered as well. While she was not currently concerned with the ants that had entered into her system, she was concerned that in the summer there might be more ants and possibly mice trying to get into the system.

She did not experience any problems with the vermicomposter in the week that their family had it but she did acknowledge that her only concern was the amount of food that was already in the vermicomposter. Mrs. Tsaparikou and her husband were not concerned by anything that occurred with the vermicomposter but were concerned about the size of the bin since it was already half full after the first week. As with the other case study, we decided that it would be a good idea to have her stop feeding the bin for a week or two to enable the worm population to grow and match the amount of waste that was put in.

Upon review of her checklist answers, as seen in Appendix P, Mrs. Tsaparikou took detailed notes of what food waste she put into the vermicomposter. While she did not journal about her experience with the vermicomposter, it was evident that she put much thought into her vermicomposter everyday.

An important note was that she did not water the vermicomposter any time during the week. When we inspected the vermicomposter, it was very dry, so we recommended that she water the system more often for the overall health of the system. Another important finding with Mrs. Tsaparikou was that she enjoyed vermicomposting, but she would like a bigger, more rustic wooden bin that would look better in her yard and support more food waste. This shows her serious desires to vermicompost, even when she did not particularly like the bin we had. She wanted to further develop her experience with vermicomposting so that it could become part of her lifestyle.

Figure 24: Mrs. Tsaparikou's Vermicomposter After One Week

Figure 25: Establishing Dean Rotsios' Vermicomposter

Comparing the two case studies brings to light many important themes that further enhance our findings Both vermicomposters had similar issues such as an infestation of ants as well as a low worm population The low population of worms was due to the initial low quantity of worms we put into the system because of improper measurements. Despite this, the worms survived and were eating just at a rate that would be proportional to their small size and lack of ample bacteria. This problem will continue for few weeks until the systems are normalized and acclimated. Training for future families should contain a warning that this may happen.

An important finding that could be used to promote vermicomposting in the future was the idea that both families produced a lot more waste than they previously thought that they would. This idea was important because it could show that people are not as aware of what they waste and through trials like these, they can have their mindsets changed. When people have to personally deal with food waste, action is promoted and mindsets can change.

Institutional Level

F-Zone is a company focused on sustainable practices and is interested in pursuing our vermicomposting program.

Based on F-Zone's current practices, it became evident that they have an interest in environmental sustainability, including our vermicomposting initiative. F-Zone's parent company, PAP Corp, has hotels that have been awarded the "Green Key," which recognizes them for environmental sustainability. For example, they recycle their wastewater to be used for their groundskeeping and landscaping. Additionally, the hotels use energy efficiently by requiring the keycard to allow guests access to electricity. Based on these practices and our communication with Ms. Ioannidou, found in Appendix Q, F-Zone was open to implementing sustainable programs in their cafeteria at the American Farm School.

In regard to their kitchen practices, the manager, Sylvia Ioannidou explained that their cafeteria has essentially perfected their food orders so they can order an accurate amount. Thanks to years of experience, Ms. Ioannidou understands the complexity of satisfying over 400 students' appetite. Through practices such as using leftovers and getting student feedback, they successfully cook accurate amounts of food. However, F-Zone does not currently have a system to dispose of their kitchen scraps, such as orange peels, fruit cores, and vegetable scraps. Since F-Zone already recycles and produces little food waste, Ms. Ioannidou would be interested in a program that deals with the prep waste.

Ms. Ioannidou liked the idea of the vermicomposting program since it can help the American Farm School. Additionally, she explained that she would be interested in the idea of advertising F-Zone's involvement in this project. Through a simple waste audit, F-Zone could publicize how much waste they are preventing from going into landfills. This data may be put on their website or posters for promotional purposes which may enhance the overall image of both F-Zone and the American Farm School.

Figure 26: Food Waste Obtained From F-Zone

Campus-Wide programs must gain the support of the manager and do not necessarily need to be incentivized to be successful.

Since F-Zone is a separate entity from the American Farm School, they have their own interests and procedures. Ultimately it is up to the manager, Sylvia Ioannidou, to make decisions regarding F-Zone's involvement in different programs. Ms. Ioannidou's responsibilities include managing the catering, creating menus, and training the staff. The initial lack of knowledge regarding F-Zone's management system can explain why our preliminary collection bin was not as effective. The first collection strategy was a trash can outside of the kitchen and we did receive eggshells one day and mixed vegetable scraps another as seen in Figure 26, but after those incidents, the trash can was filled with plastic and ignored. Since we did not communicate our goals and objectives with Ms. Ioannidou until after the collection was set up, she did not fully understand our project, and therefore could not adequately inform her staff. However, after our communication with Ms. Ioannidou, she assured us that she would promote our project, since it is her job to train the workers and make sure things are done correctly.

Although our background research showed that incentives are typically necessary for a successful environmental initiative, we have found that was not the case for a program with the food provider on campus. Ms. Ioannidou was very interested in promoting environmental programs, and she wanted her employees to learn about them as well. When asked how to make the process easier for employees, she responded that she would rather have her employees take an extra step in their routine. Ms. Ioannidou felt this process was best so that her employees can recognize that they were doing something different, and appreciate that their efforts were environmentally-friendly.

The American Farm School has a strong environmental sustainability culture.

Both Dean Rotsios and Mrs. Tsaparikou mentioned in their in-depth interviews before starting the vermicomposting program how important environmental sustainability and recycling are to them and their families. Mrs. Tsaparikou made a point to say that she recycles everything: glass, paper, aluminum, and clothes. It was the next step for her to recycle food waste as well through vermicomposting. Dean Rotsios also expressed similar views on the value of recycling and environmental sustainability practices for his family and also for the AFS community:

"...I think this is a philosophy over time to give to our students... to our families... The school that you see [AFS] has done huge steps toward this [environmentally friendly] direction. I mean there are still cities and schools in Greece that will not recycle for example...It's not obvious to other schools, so yes I consider myself to the extent of the environment in which I live, to do efforts and to pass this [sentiment] to our students as well." ~Dean Rotsios

Other faculty, staff, and college students share this environmental consciousness, as found in the AFS survey. Fifty-three community members answered the survey; however, all questions were optional. The configuration of these community members can be seen in Figure 27 based on 52 responses.

Of the 51 responses, 50 community members agreed or strongly agreed with the statement 'Recycling is important', or 98.0%. For 'AFS has successful recycling initiatives,' 40 of the 53 responses agreed or strongly agreed equating to 75.5%. This shows an appreciation for recycling at AFS. In determining environmental sustainability habits, we asked survey participants to identify all of the ways in which they practiced sustainability. Figure 28 shows the results of the 53 responses. The two others were "Learn my children how to practice in the future" and "Leftovers become dog food".

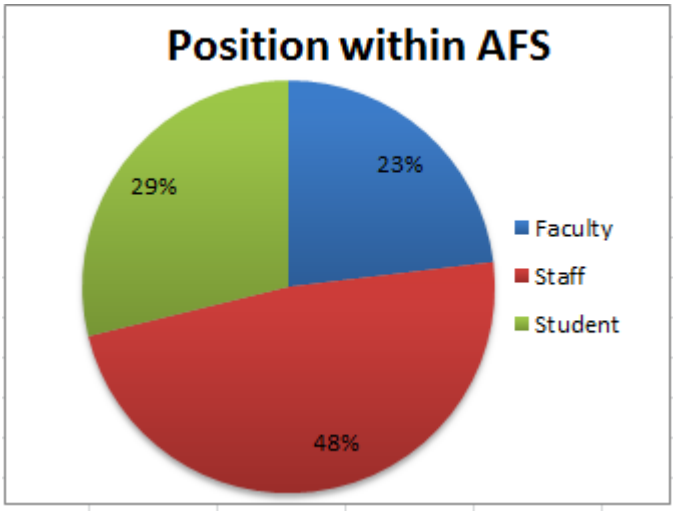


Figure 27: Graph of AFS Groups From Survey

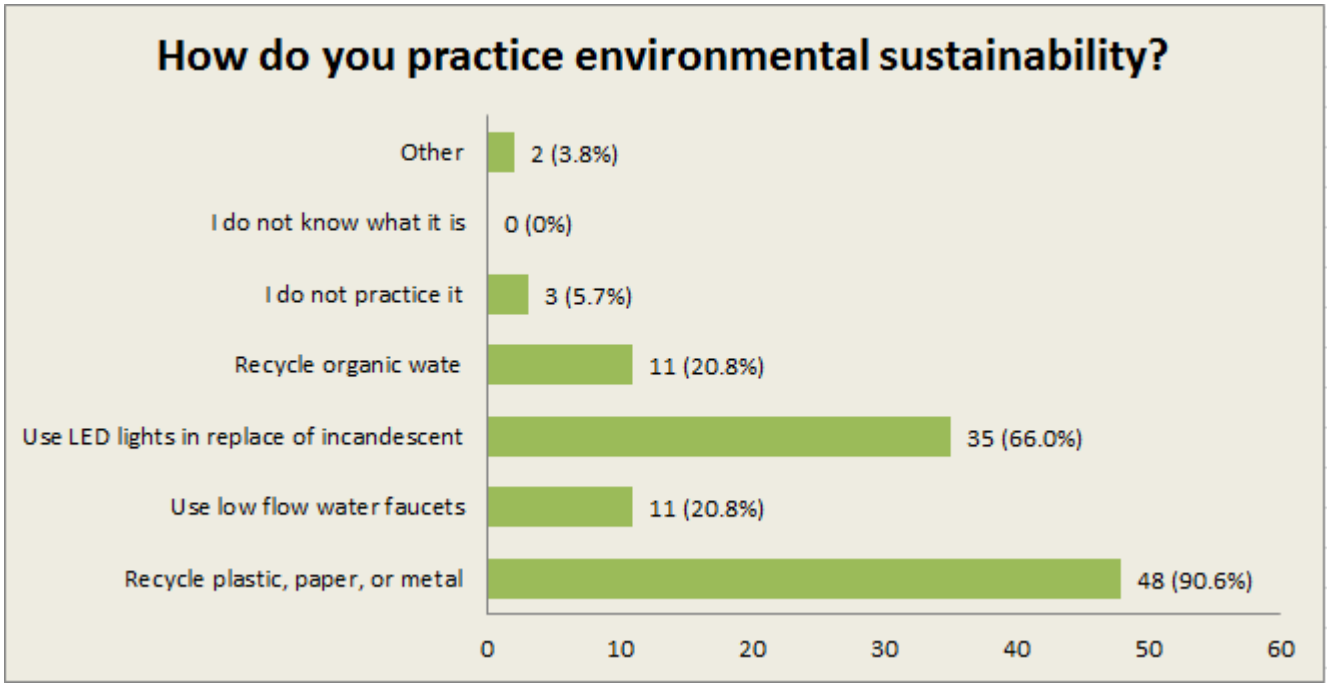


Figure 28: Graph of Environmental Sustainability Practice Frequencies

Most community members practiced some form of environmental sustainability, with recycling being the most common form of participation.

AFS members want to see new initiatives for environmental sustainability. When seeing if AFS community members would be 'willing to participate in a new food waste reduction program', 45 of the 53 responses agreed or strongly agreed, or 84.9% of those polled. This statistic shows a willingness of community members to further engage in environmental activism. Two community members stated later in the survey that the F-Zone kitchen would be a good place for vermicomposters, a strategy for a food waste reduction program. When prompted to where to place a vermicomposter, they said:

"Close to where food [waste] is produced: probably outside the restaurant if F-zone were to participate. It would be nice to have one in the elementary school, too." ~Faculty Member

"Next to the cafeterias." ~Student

This shows the initiative of some community members to think of environmental activism and new programs in terms of the institution rather than on an individual basis.

Municipal Level

There is interest in and a need for the municipality of Pilea-Hortiatis to adopt a food waste reduction method.

Through meetings and a questionnaire with municipality officials, found in Appendices R and S, we gained insight into the current municipal solid waste (MSW) management situation and their need to implement a food waste reduction program. Pilea-Hortiatis estimated that the municipality produces 30,732 tons of solid waste, 93% of which goes to sanitary landfills after being processed while 6.6% is recycled and sent to a Material Recovery Facility (MRF). The other 0.4% was electronics that were sent to specific separation and recovery centers. The municipality was involved in many avenues of recycling and also worked with alternative waste management or social organizations. Examples of the recycling efforts include separate glass collection and recycling of packaging materials with aid from the Greek Development Company-Recycling SA. Figure 29 depicts the composition of MSW on data from 2014.

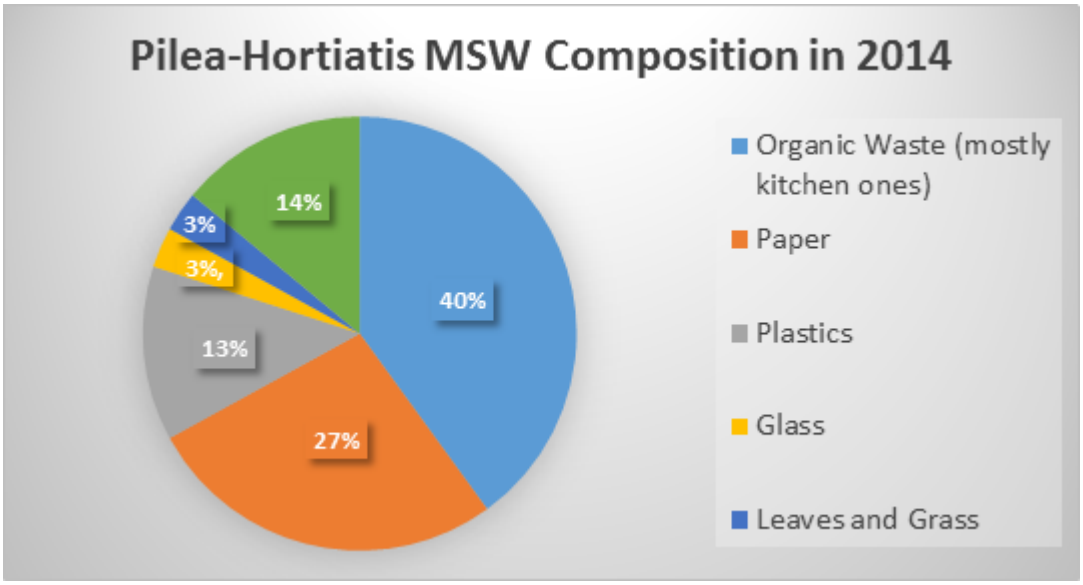


Figure 29: Graph of Pilea-Hortiatis Municipal Solid Waste Composition in 2014

According to the municipality, Pilea-Hortiatis does not face any major issues with their waste management, but they recognize the negative effects of improper municipal waste by citing “wildfires in forested areas,” and the spreading of “infectious pathogens to underground waters.” This aligned with our background research on environmental issues around organic waste degradation. The National Waste Management Plan for Greece has set specific goals at the municipality level. The goal’s main objective is to increase recycling rates and one specific goal we learned from by the municipality questionnaire is to have separate collection of organic waste with a “minimum target of 40% of MSW total weight.” The answer received from the municipality when asked the cost of their management of MSW was the following:

"Regarding the MSW management cost, it amounts to almost 4,4 million euros, including cost of collection, cost of transportation (to sanitary landfill and to material recovery facility) and distribution cost to Regional Organization of MSW management." ~Pilea-Hortiatis Municipality Official

Total cost of MSW management per ton amounts to €135.21 while total cost of MSW management per citizen amounts to €62.79. With Pilea-Hortiatis’ striving to and currently practicing environmentally friendly MSW management, vermicomposting can be added as another waste reduction program to reduce waste going to landfills which would possibly reduce costs.

We are unable to discern the state of Pilea-Hortiatis’ composting program.

From the Pilea-Hortiatis’ website and questionnaire, we know there was a composting program available to citizens. In 2010, the municipality collaborated with the Department of Agricultural Economy of Aristotle University to conduct a pilot composting program with 20 participants. This led to the development of a composting program where interested citizens attended “informative workshops held at the Town Hall,” then received “practical instructions regarding management process of household waste,” and a “compost bin,” as described by a Pilea-Hortiatis municipality official. There is a description and a page on their website stating the procedure and fact sheet about composting.

We are unaware of the current status of this program. The questionnaire we received from the municipality placed everything about the program in a positive light. The municipality website also makes us believe that the program is still operational. In their Municipal Waste Management Plan for 2016-2020, Pilea-Hortiatis has a plan to give compost bins to 1,000 homes. However, we do not currently know what phase they are in for completing these plans. When discussing with municipality officials the status of the original 20 participants, it was uncertain if they were all still participating or what their perceptions of the program were. We were unable to talk to these original participants because of the approval process for our project by municipal officials and other time constraints related to this.

The Municipality of Pilea-Hortiatis’ would be willing to start a vermicomposting program.

Our initial meeting with two officials from the Parks and Recreation Department, suggested that there was an interest in exploring vermicomposting. One example was their interest in using vermicomposting to dispose of grass clippings from parks and stadiums in the municipality. The mayor’s approval of our project proposal also supported the exploration of vermicomposting within this municipality.

The answer that came in the questionnaire from asking if the municipality had any concerns about initiating a vermicomposting program and whether they think it was possible to have a program at the municipality level was “There are no concerns,” and “Yes, it is possible to have a program like this at municipality level.” However, municipality officials did point out important parameters to address when initiating a program containing new concept to individuals:

"....informing local community for the benefits of a vermicomposting program." ~Pilea-Hortiatis Municipality Official

"...demonstration on how a vermicomposter is working." ~Pilea-Hortiatis Municipality Offiical

"According to local community needs, maybe the operation of call centers which could support residents (e.g. answers to common questions; solutions to indicative operational problems) would be helpful." ~Pilea-Hortiatis Municipality Official

The municipality suggests that at the beginning of a vermicomposting program, “ [a] single vermicomposter per property and a drop off waste point per neighborhood,” could be employed to make it convenient for the initial plan. The drop off points would be managed by the Municipality’s Directorate of Environment and Recycling and the unused compost would be used in public settlements. Officials from the municipality also suggested including the participants from the compost pilot program and allowing them to stand as “ambassadors.” A concern the municipality brought up was placing inappropriate items into the waste containers. For example, they mentioned finding non-recyclables in recycling containers. This was why when asked if a waste audit would be beneficial, municipality officials responded with “At least at the beginning of such a program, it would be necessary to conduct a waste audit,” so there can be a measurement of change.

Most households produce food waste that is viable for a vermicomposting system.

According to the 50 responses from the AFS survey on the number of days per week meals are prepared at home, the majority of people did prepare meals at least a few times per week at home with the distribution displayed in Figure 30. The highest frequency choice was 2 to 3 days per week, but choices with more days per week were close behind with 0 to 1 days per week being by far the least chosen option. These results suggest that many households produce food waste from preparing meals at home on a regular basis. Of the 49 responses we received on the number of people within the respondent’s household, the most frequent choice was 3 to 4. The whole distribution can be seen in Figure 31. These household sizes can provide enough food waste to sustain a vermicomposter, especially when taking into consideration the amount of times per weeks an average household will prepare meals.

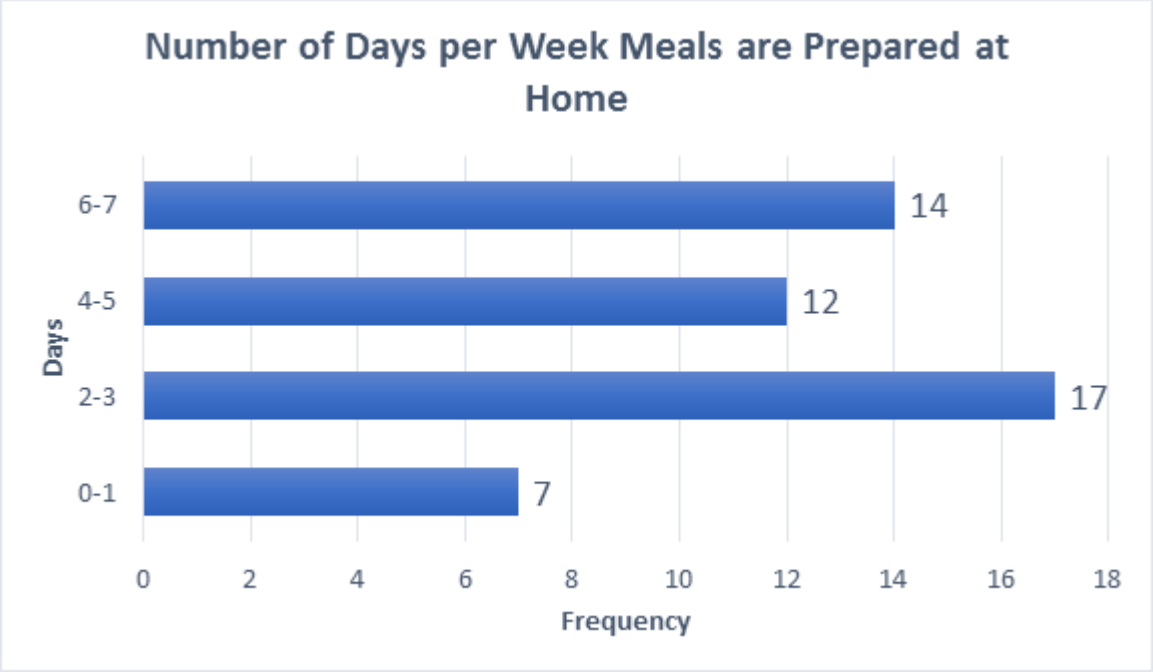


Figure 30: Graph of Meals Prepared at Home

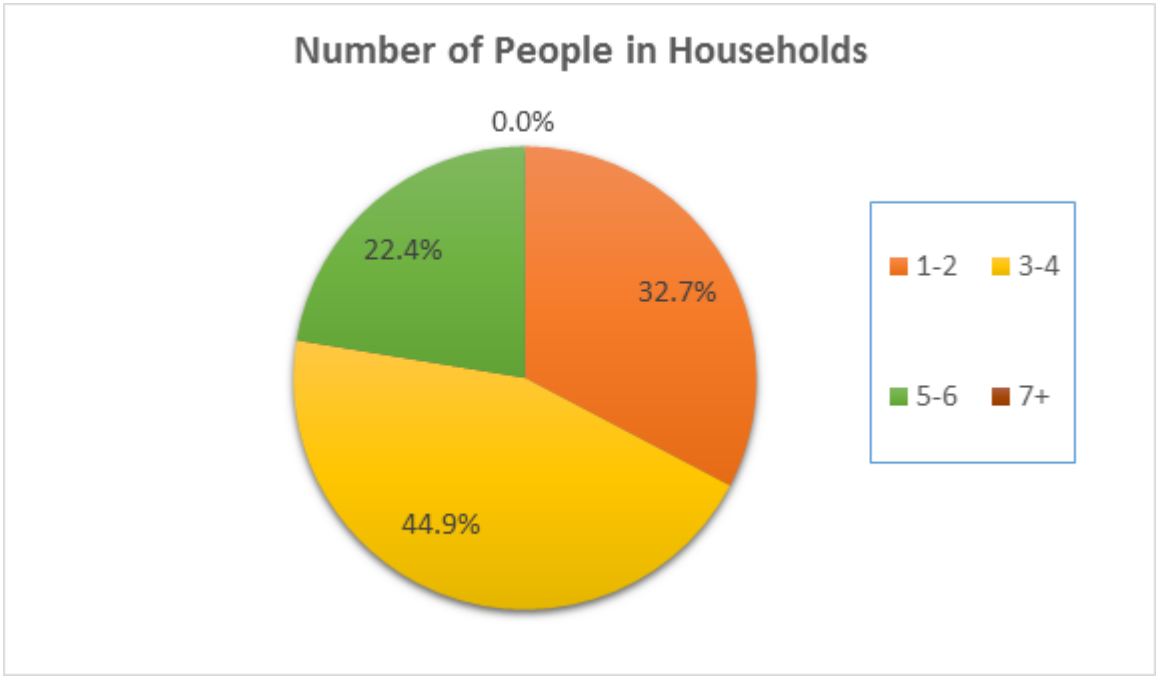


Figure 31: Graph of Household Data

Based off our survey, most people did prepare some meals at home for multiple people, which shows that there is the possibility to incorporate a vermicomposting system to divert food waste from landfills. However, food waste recycling is not a common practice in households. Throwing away food waste in a trash can, which would enter landfills, was the most common method of disposing food waste, as 74% of the 50 respondents of our survey do so.

From the survey, only 20.8% of respondents practiced some form of organic waste recycling, with composting as the most common practice. These results show that there would be many challenges in trying to scale vermicomposting to the municipal level as not only vermicomposting, but food waste recycling overall is not commonly practiced in households.

There are differing requirements that need to be addressed before initiating a vermicomposting program.

A survey of 53 AFS community members showed that 29, or 54.7%, were interested or very interested to start vermicomposting after a brief introduction and design questionnaire. We tried to find correlations between vermicomposting interest and motivations for vermicomposting such as gardening and fertilizer habits. However, there were no significant findings for why there was interest in vermicomposting. For cost considerations, 51 people responded to the price they would be willing to pay for a vermicomposter.
Figure 32 shows that the vast majority would want a vermicomposter to cost under €50 (76.5%).

We were also interested in seeing what initial concerns people had about using a vermicomposter when giving them only an initial introduction into how it works. The word cloud in Figure 33 represents the common phrases of the 26 responses we received, with higher frequency phrases appearing as larger words.Smell was the most common concern displayed coming up 9 times in comments.

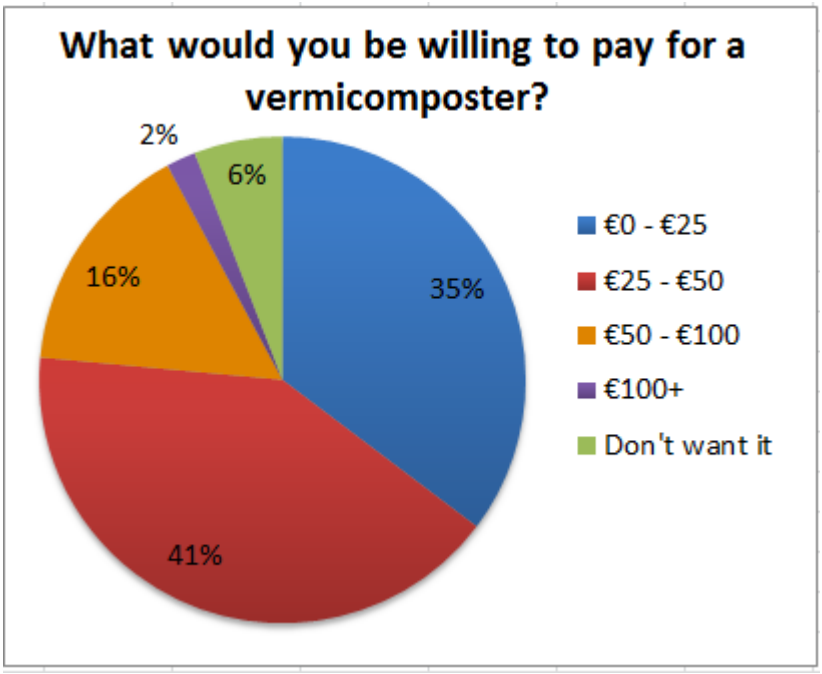


Figure 32: Graph of Possible Price Ranges

Figure 33: Word Cloud of Concerns

To alleviate some of these concerns, we need to have good quality education materials. To gauge what educational materials would be needed, we asked users how they would best learn more about vermicomposting. The top three choices when 50 AFS community members were polled were a website at 86%, a training class at 52%, and a manual at 26%. The training class and manual corresponds to the education Dean Rotsios and Mrs. Tsaparikou received when receiving a vermicomposter. They both felt this was enough education for learning about vermicomposting.

People take into account various design specifications when considering vermicomposters.

In the survey sent out to AFS faculty and students, we asked respondents to rank seven designs. The designs were ranked on a scale of one to five, with a five representing a high inclination for the respondent to use the system, and one representing a low inclination. All of the scores were compiled to determine a weighted average rank of each design. Most notable are the top and bottom ranked designs. The highest ranked design was the white plastic floral vermicomposter, which one respondent called “stylish.” The lowest rated design was a bag version vermicomposter which was described as “fragile.” This survey aimed to assess user preferences, since all designs are functional and plausible. The designs are ranked on the following page with the most preferred design receiving the highest average score:

3.787

3.68

2.92

3.119

2.721

3.079

2.452

Survey respondents were also asked to rank the following design parameters in order of importance: aesthetics, cost, maintenance, size, and smell. For each response, we assigned the first parameter a weight of five, the next a four, and so on. If the parameter was not listed in their rank, it was assigned a weight of zero. We then summed the scores to better understand the overall importance of each parameter. Based on this approach, size is the most important parameter regarding design with a score of 89. Maintenance was ranked the least important parameter with a score of 51. This criterion is important to note because it shows that users will not be deterred from a system if it requires a little work. The results of this ranking are displayed in Figure 34 where a larger circles meant it was ranked more important.

It was important to note that while size was ranked first based on this scale, aesthetics appeared in the number one spot the most. Also, maintenance possibly received its low rank due to the fact that it was not included on 12 respondent lists. Other criteria respondents listed as important included: color, cleaning, safety, and ease of use. Though these parameters did not show up often, they are significant factors that may potentially be considered when designing an ideal vermicomposter for the Thessaloniki region. Updating the poll to include more parameters that came up in this survey would be helpful in further understanding the impact that they could have on a user's design choice.

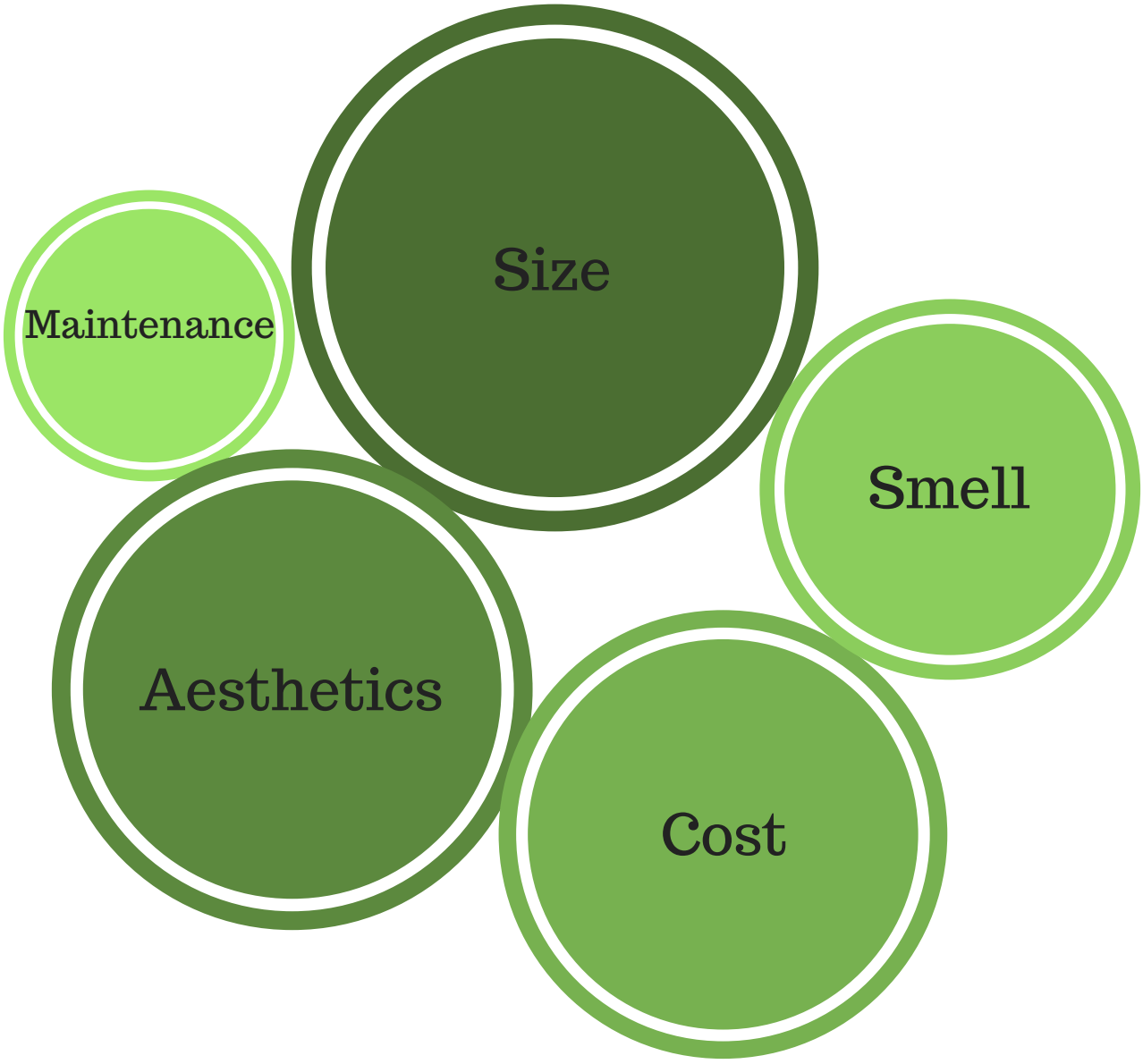


Figure 34: Bubble Chart of Important Parameters

CONCLUSIONS & RECOMMENDATIONS FOR FUTURE WORK

There were several obstacles in regards to advancing our project. Despite the challenges that we faced, we believe that the programs we started can be improved further by other groups in the future. In this section, we lay out steps for our partner and groups that he works with to continue to investigate the feasibility of vermicomposting at individual, institutional, and municipal levels. In doing so, we will be raising questions that still need to be addressed in future research on this topic.

Individual Level

The two case studies on campus showed that the users were pleased with the vermicomposting units, and even expressed that that they will continue using the units after our project. One important finding during our case study regarded the amount of food waste a household produces. Dean Rotsios' family of three did not believe they would produce much food waste, but nearly filled the bin after one week of use. This discovery helped bring significance to our work in the fact that individuals produce more waste than they initially realize. However, with only one week of assessment, we were unable to gauge the user's thoughts over time. To be more thorough, a longer term assessment of users' feelings should be documented. Dr. Vasilikiotis will continue to monitor the interaction between the two residents after our departure and will also provide insight into users' questions.

Since our case studies were only a week in duration, we were unable to assess the participants' use of vermicast. It would be noteworthy to see how the two participants would use the product, considering one of the users actively gardens, while the other does not. Another aspect that would be very important to analyze is what the users did when the system had problems. It is common for new users to make mistakes, which can lead to

issues such as odor or declining worm population. Observing how the user deals with the problems and finds solutions can provide insight into how to design better educational materials.

The two case studies have already provided us with new information to include in the manual and in the training that is conducted before using a vermicomposter. For example, we did not explicitly instruct participants to cut up kitchen scraps. Consequently, they left whole peels and large pieces of fruits and vegetables. This action creates a smaller area for bacteria to degrade and slows down the conversion of food waste to vermicast. We also did not explain that when starting the vermicomposter, it is necessary to not overfeed the system since the worm population needs time to grow. We would recommend future users put in food waste every three days or so to enable the system to start slowly. Through our case studies, we found that users would like to know more about adding yard scraps, so we recommend that a yard trimmings section should be included in the educational materials. For example, grass clippings may be added in moderation, but adding too much to the system can lead to reduced air flow and increased temperatures. Ultimately, the manual and training will continue to be developed as more people use the systems and add their experiences to enhance the materials.

When contacting participants for our case studies, we only reached out to members of the AFS community who lived on campus. Favorably, our survey revealed that 54.7% of off-campus expressed interest in vermicomposting. This expansion would provide a broader range of participants, enabling the collection of more data. The journaling program we implemented proved to be an ineffective data collection method to document user interaction. One of the users did not have the time to journal their thoughts. Consequently, the checklist was used more often since it was quick and straightforward. We recommend looking into other options of documenting user interaction.

We developed the following questions to further investigate different aspects of individual needs of vermicompost users:

Questions for Further Investigation

1. What challenges do users face when having a vermicomposter for an extended time?
2. How do you modify educational materials to fit the range of user needs?
3. How do you increase positive user interaction with vermicomposters?

The first of these questions is important to consider as our project was unable to follow a case study beyond the implementation of the system. Given more time, additional concerns regarding the system may arise based on the background research we conducted. A longer study would help to address these concerns in the manual and also allow for more user interaction to be recorded. The second question works in tandem with the first, as it will help further modify the educational materials that vermicomposting users should have. In addition to the modification, investigating how to present the process of vermicomposting and how to manage a successful bin should be conducted. The development of a website and training materials would be useful as guides, since they were the top two educational material choices on our AFS survey. The third question comes from our unsuccessful methodological attempt at journaling. We wanted to understand users' interactions and interests in the system in a very personal way. An expansion of this study should also pursue this data type to discern people's experiences with using the vermicomposter. Personal perceptions are important when creating programs and incentives. To increase the involvement of participants in the program, we encourage future researchers to actively pursue a user's stance on vermicomposting.

Institutional Level

Working with F-Zone on campus was initially very difficult, since the manager, Ms. Ioannidou, was constantly busy. After multiple attempts to sit down with Ms. Ioannidou, we met with her on the last weekend of our time at AFS. During the time that we worked with her, we were able to set up a bin to collect food waste; however, unless we directly asked for the food waste, the kitchen staff did not provide it to us and often put trash in the bin. We found that Ms. Ioannidou was willing to promote our program to her staff. Since we did not initially communicate our project well to her, she did not encourage her staff to use the bin. Further steps should be taken to work on creating a program and developing ways to encourage the communication between campus food services and institutions.

After in-depth communication with Ms. Ioannidou, we found that she was willing to pursue our vermicomposting project. She explained that she strives to produce very little food waste, but she does not currently have a sustainable waste management system to deal with the kitchen scraps from prepping fruits and vegetables. Ms. Ioannidou believes that the system we set in place to collect vermicompostable waste, a bin outside the kitchen, will be effective. We did not feel that it was our place to impose another method upon her as she was the leading authority in the kitchen and we were uninformed foreigners. Even though there may be easier solutions, she wants her employees to take an extra step in their routine of moving the food waste to a specific bin outside so they can be more aware that their actions have an additional important purpose—environmental sustainability.

Figure 35: AFS Cafeteria

Ultimately, it is Ms. Ioannidou's decision to implement new routines, so it is paramount to have her support in our project. In order to move this project forward, we have informed Dr. Vasilikiotis of this development. Additionally, Ms. Ioannidou stated that if the collection bin isn't receiving proper kitchen scraps, she would take it upon herself to get the workers to cooperate. To keep the process running effectively, Dr. Vasilikiotis' and AFS students will keep in close contact with Ms. Ioannidou about the contents of the collection bin. This step is likely to be more successful if and when AFS partners with F-Zone formally on a food waste reduction initiative. Overseeing the collection of waste would need to be done until the process becomes a habit.

We developed the following questions to further investigate different aspects of institutional needs for vermicomposting initiatives:

Figure 36: Vermicast

Questions for Further Investigation

1. What is the partnership of F-Zone and AFS like, and how would this relationship need to change to support a cooperative program related to managing food waste?
2. What institutional procedures would need to be taken at AFS to adopt a vermicomposting program?
3. What feedback mechanisms would need to be in place to create a successful vermicomposting program?

The first research question explores the current and future relationship between F-Zone and AFS if a vermicomposting program were initiated. It is important to know what types of official meetings between the two parties are conducted as well as other formalities in their relationship. This current state may need to change to support greater cooperation and collaboration around a vermicomposting program. Research should address what other schools with similar programs do, paying special attention to Greek examples where cooperation with outside vendors has occurred, as well as looking at AFS specific vendor relations. The second question addresses what procedures and how much time, given the hierarchical nature of Greek relations, would need to be allocated for AFS to create such a program. The third question addresses various systems of feedback that would need to be in place for the success of an institutional vermicomposting program. The solution to this question would involve an in depth analysis of the jobs required to make the system operate and the overall gains each party would obtain from participating. For example, Ms. Ioannidou may need to be notified of the quality of food waste received at the beginning of such a program. This would require a specific assigned role along with picking up the food waste from the kitchen. Other feedback may be in the form of incentives to know they are on the right track.

Figure 37: Thessaloniki Region

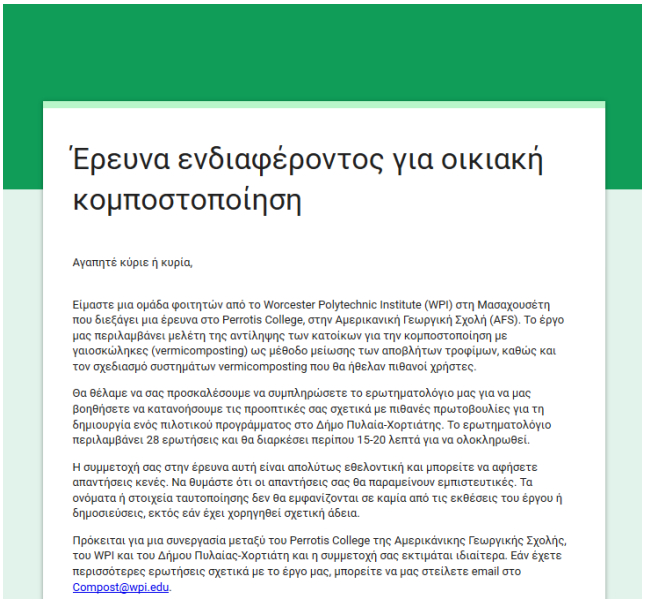
Municipal Level

To introduce our project to the Municipality of Pilea-Hortiatis, our group worked with the management structure of the municipal government. Although municipality officials showed initial interest in our project, we first needed approval from the mayor before we could collect any data, which did not occur until two weeks before we left. This approval allowed our municipality survey, found in Appendix S, to be posted on the municipality's website. We also received a written response on our questionnaire with valuable information referencing the municipality's current statistics regarding municipal solid waste and thoughts about vermicomposting as a program. However, this occurred late in our project due to this hierarchical process and the timing of the Easter Holiday. We ultimately did not have the chance to pursue further work with the municipality.

For future work, analysis of the municipality survey results could yield important findings. Since this survey is available to almost every citizen within the municipality, it would capture a broader population size than our AFS survey. An analysis of the data may shed light on resident perceptions of vermicomposting, current food waste habits, and vermicomposting design parameters. The data might offer insight into citizens' desire for or concerns about a vermicomposting program. This survey data was mentioned in one of our meetings with the municipality as a key component to starting a pilot program, but we did not have the chance to reach that step.

Another thought for the progression of this initiative is how the municipality can create incentives for people to participate in a vermicomposting program. In our background research, we found that strong policies are an effective method to create behavioral change. However, with our limited population at AFS with its bias toward early adoption of environmental sustainability initiatives, we cannot assume the AFS community is representative of an average Greek resident. From our AFS survey, we found "helping the environment" to be the top response of why people will participate in food waste reduction. Therefore, there needs to be further investigation into an average person's motivation to participate in a vermicomposting program that might suggest some incentives to improve participation.

Educating residents is required when implementing a new food waste reduction program like vermicomposting. Through our survey and



Έρευνα ενδιαφέροντος για οικιακή κομποστοποίηση

Αγαπητέ κύριε ή κυρία,

Είμαστε μια ομάδα φοιτητών από το Worcester Polytechnic Institute (WPI) στη Μασαχουσέτη που διεξάγει μια έρευνα στο Perrotis College, στην Αμερικανική Γεωργική Σχολή (AFS). Το έργο μας περιλαμβάνει μελέτη της αντίληψης των κατοίκων για την κομποστοποίηση με γαιοσκώληκες (vermicomposting) ως μέθοδο μείωσης των αποβλήτων τροφίμων, καθώς και τον σχεδιασμό συστημάτων vermicomposting που θα ήθελαν πιθανοί χρήστες.

Θα θέλαμε να σας προσκαλέσουμε να συμπληρώσετε το ερωτηματολόγιο μας για να μας βοηθήσετε να κατανοήσουμε τις προοπτικές σας σχετικά με πιθανές πρωτοβουλίες για τη δημιουργία ενός πιλοτικού προγράμματος στο Δήμο Πυλαία-Χορτιάτης. Το ερωτηματολόγιο περιλαμβάνει 28 ερωτήσεις και θα διαρκέσει περίπου 15-20 λεπτά για να ολοκληρωθεί.

Η συμμετοχή σας στην έρευνα αυτή είναι απολύτως εθελοντική και μπορείτε να αφήσετε απαντήσεις κενές. Να θυμάστε ότι οι απαντήσεις σας θα παραμείνουν εμπιστευτικές. Τα ονόματα ή στοιχεία ταυτοποίησης δεν θα εμφανίζονται σε καμία από τις εκθέσεις του έργου ή δημοσιεύσεις, εκτός εάν έχει χορηγηθεί σχετική άδεια.

Πρόκειται για μια συνεργασία μεταξύ του Perrotis College της Αμερικάνικης Γεωργικής Σχολής, του WPI και του Δήμου Πυλαίας-Χορτιάτη και η συμμετοχή σας εκτιμάται ιδιαίτερα. Εάν έχετε περισσότερες ερωτήσεις σχετικά με το έργο μας, μπορείτε να μας στείλετε email στο Compost@wpi.edu.

Figure 37: Municipality Survey

interactions with our case study participants, we gathered that vermicomposting is an idea not well understood or practiced. The municipality was also concerned about informing residents of vermicomposting. Our survey revealed that people would prefer a website, training class, or a manual (by order of preference) as methods to learn more about vermicomposting. Municipality officials also expressed how the younger generation should be educated in sustainability policies to spread awareness. The municipality questionnaire further elaborated that there is an ongoing effort for this education. More research is needed to figure out proper methods of informing and educating people about vermicomposting. As a starting point, we designed an educational pamphlet about vermicomposting that could be used for one of these events, found in Appendix T.

We developed the following questions to further investigate different aspects of institutional needs for vermicomposting initiatives:

Questions for Further Investigation

1. How might a municipality promote environmental initiatives like vermicomposting to their residents?
2. How can the municipality measure the success or failure of a vermicomposting program?
3. What would it take for other municipalities to participate in a regional food waste reduction vermicomposting effort?

The first question talks about how a municipality would promote a vermicomposting project among its residents to get more than just early users to take on the program. This can include incentives, such as subsidized bins, which have been implemented in other successful programs. Further investigation regarding advertising methods along with marketing of the systems and its benefits would be beneficial to the municipality. Concurrently, further inquiry into concerns residents have with the vermicomposting program and alleviation strategies of these concerns would be beneficial to increase participation rates. The second question would be instrumental in knowing if a lot of improvement is needed to continue a program or if it needs to be stopped and assessed. Since Pilea-Hortiatis has expressed an interest in and will be pursuing a pilot vermicomposting program, it is appropriate to consider how implementation of such a program would be measured. While it may be feasible for Pilea-Hortiatis to have a successful vermicomposting pilot program, it is also important to know when to change the approach so that more encouragement and incentives for promotion can be achieved. During this phase, a program reassessment would

be beneficial along with an evaluation of the methods used for the implementation of the program. Ultimately, the first attempt at a program may not be the most successful, but this doesn't mean that a lot of data and experience cannot be obtained. The third question is something to be investigated when thinking of a regional approach to food waste management. A successful program, or one that gains a lot of attention in Pilea-Hortiatis, would allow for a model to be established that could lead to other municipalities starting their own programs. It is important to note that while a model can be used for other cases, individual assessments of residents' needs should be conducted. To ensure that a proper adoption of Pilea-Hortiatis' program is accomplished, a survey within a neighboring municipality would need to be conducted to understand the specific concerns of those residents. Then, Pilea-Hortiatis' training and implementation program should be utilized, but adapted to meet the new municipality's specific needs to successfully initiate a regional vermicomposting program.

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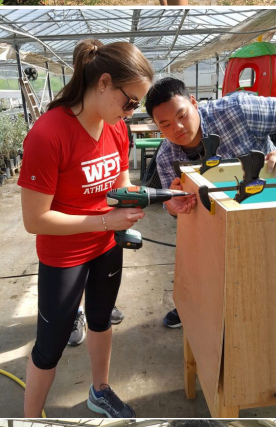
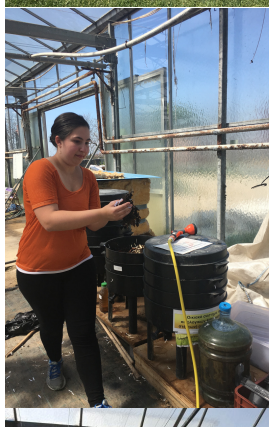
AUTHORSHIP

Section	Primary Author(s)	Primary Editor(s)
Abstract	GC	All
Introduction	GC	All
Waste Management in Greece	SC	All
Vermicomposting and Designs	DV, CW	All
Composting and Vermicomposting Initiatives	GC	All
Methodology	GC, CW	All
Vermicomposting Design	DV, CW	All
Assessing user interaction	DV, SC	All
Campus Food Service	DV	All
Institution requirements	GC	All
Municipality preferences	SC, GC, CW	All
User preferences	SC	All
Household Findings	CW	All
Institutional Findings	GC, SC	All
Municipal Findings	DV	All
Conclusions & Recommendations for Future Work	CW	All
Individual Level	CW, SC, DV	All
Institutional Level	GC, SC	All
Municipal Level	DV, CW, SC	All
References	All	SC
Appendices	All	All

GC - Gina Capobianco; SC - Stephanie Cappelli; DV - Doua Vang; CW - Colby Whitcomb






APPENDIX A

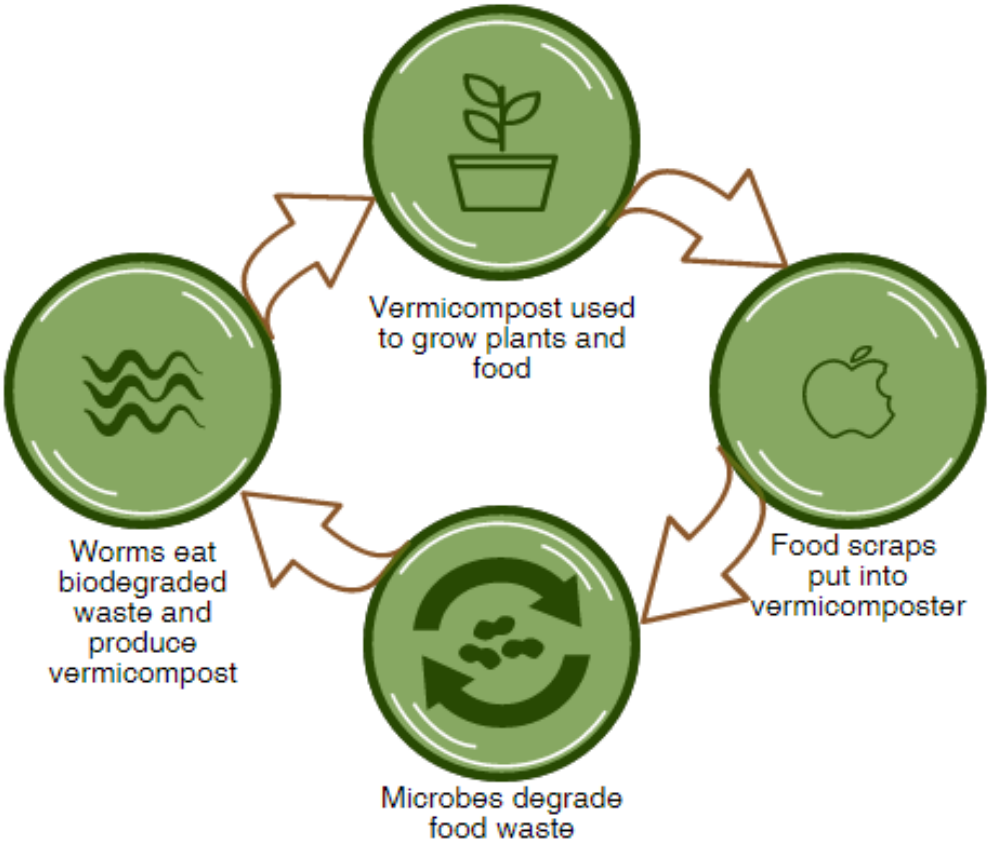
Vermicomposting Manual

Perrotis College and Worcester Polytechnic Institute Collaboration

Gina Capobianco, Stephanie Cappelli, Doua Vang, & Colby Whitcomb
With much appreciated help from Dr. Christos Vasilikiotis

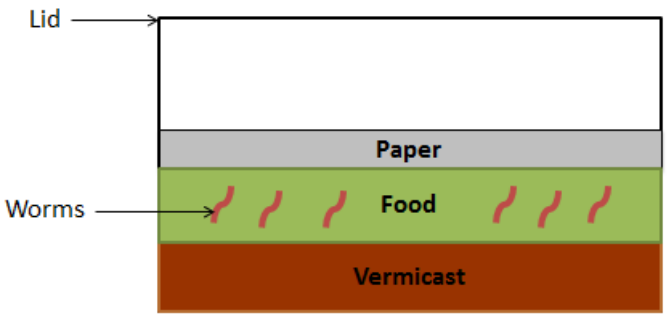
Introduction to Vermicomposting

In your vermicomposting bin, worms transform food waste into a highly nutritious fertilizer for your plants and garden. The bin itself needs water and paper, known as bedding, to ensure an optimal environment for the worms and the food waste that is put in. The ultimate product of vermicomposting is vermicast, which is a soil amendment that can be mixed with soil to form vermicompost. Vermicast is effective at supporting crop health and increasing crop yield. Another benefit of vermicomposting is helping the environment. Food waste in landfills produces methane gas, which is a greenhouse gas that is 21 times as potent as carbon dioxide. By vermicomposting, you are reducing the amount of food waste that will go to landfills and decreasing their overall carbon footprint.



A Description of the Vermicomposter

The design is built to allow for the vermicast that is produced from the system to exit the bottom and food scraps to be constantly added at the top. The worms will move away from the vermicast that they produce at the bottom and will move up as more food is added to the system. The cardboard layer on the bottom is initially used to prevent the contents from spilling into the collection bucket, but as vermicast is produced it will clump together and can be easily removed by using the rake that is provided. Food waste should be added through the top of the vermicomposter. This should be covered with a layer of damp bedding to reduce the amount of flies and light that can get into the digestion of the worms.



This diagram shows the placement of vermicast, food, worms, and bedding (paper) in the vermicomposter.

How to Run the Vermicomposter

Initial Setup

1) To first start the vermicomposter, put a layer of cardboard on the bottom of the bin. The initial vermicast will settle on the cardboard.

2) Next add a layer of approximately half a kilogram of worms to the vermicomposter spread evenly over the cardboard bedding that was established in the first step.

3) Then add about a quarter kilogram of food waste evenly distributed into the vermicomposter

4) This layer is then covered by damp shredded paper and newspaper known as bedding. The bedding should be moist to the touch when you first place it in and will help reduce the smell and keep worms moist.

Steps For Running the Vermicomposter

1) After the initial setup, it is important to wait a week for the worms to get acclimated to the new environment. During this time, worms eat the bedding and the initial food waste.

2) After the initial wait time, food can start being added under the top layer of bedding. To do this, peel back the paper on top and then when the food waste is inserted push the layer back over. The bedding should always be left on top to reduce flies getting to the food waste. When bedding will not cover the layer of new food added, apply additional bedding. Food should be given at a scheduled time. This may be once per week to up to once per day depending on your food waste habits. It can take time to build your worm population up to feeding more regularly, so start out with once per week and work your way up. For more help, look at Troubleshooting and Helpful Tips.

3) As the vermicast builds at the bottom part of the vermicomposter, use the hand rake to scrape it out and collect it in the bucket found below. This step can be done at any point that there is vermicast.

4) One kilogram of worms can digest half a kilogram of food waste per day at an average maturation stage. This ratio can be increased as the population grows and the worms mature. The worms replenish quickly but ultimately can take up to a month to be able to be firmly established and able to decompose materials at the correct rate. It is best to monitor the amount that they are able to consume and slowly alter it to fit your waste production.

5) Continuously monitoring and troubleshooting the vermicomposter for smell, escaping worms, worm population, surrounding organisms, and moisture will ensure that the system is running efficiently.

What food to put in your vermicomposter?

The following chart lists food on the left that you should put in your vermicomposter and on the right foods that should stay out. Ultimately the type of waste that should go into the vermicomposter is freshly cut fruits and vegetables scraps and also any cracked egg shells. Shredded paper and cardboard are also great materials to make the bedding for underneath and above the food scraps that are put into the vermicomposter. While the onions, garlic, and lemons are acceptable materials for vermicomposting, it is not good to place too many in as this will alter the pH to levels that will harm the worms. When putting food into your vermicomposter, you should cut it into smaller pieces.

Troubleshooting

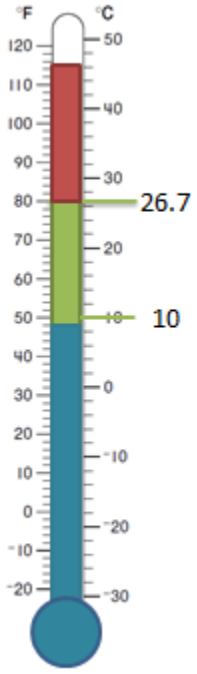
Question	Reason	Solution
Why does the vermicomposter smell?	The vermicomposter may smell bad because there is too much food for the worms to handle. The conditions within the bin can turn anaerobic with too much waste and it will start to stink.	Start feeding your worms slowly at the start. It may take a while for you to learn how much food waste the bin can handle. Over time the worm population will grow and you can add more waste. Typically one kilogram of worms can digest half a kilogram of waste a day. If you are collecting waste after meals, put it in a closed container or freeze it to prevent smells or bugs.
How much water do I need to add to keep the worms healthy?	It is important to water the vermicomposter so that the worms' skin stays moist and proper bacterial growth for digestion can occur. The vermicast will dry out if the system isn't watered enough and it will lose some of the benefits that it typically has as a fertilizer. Flooding the worms can also lead to problems however, as too much water can drown them and cause the system to become anaerobic.	Watering the vermicomposter when you feed the worms is a good practice. This watering can typically be done once a day. The food that is put in should contain a high amount of water but a good rule to follow is that the bedding on top should be damp but not soaked. Damp is when something feels wet but there is no standing water on the paper.
Will rodents or ants get into the vermicomposter?	Rodents and pests should not be able to get into the vermicomposter as it is a closed system except for small aeration holes. If you add grain waste, meat, or dairy waste in the system, animals can try to knock it over to eat these items.	Refrain from putting bones, meat, dairy, and bread waste into the vermicomposter. These items attract rodents and lead to conditions that are not good for the worms. If ants are present, placing the legs of the vermicomposter in water or spreading sticky material on them will deter them from trying to enter.

Troubleshooting continued

Question	Reason	Solution
Will worms escape from the vermicomposter?	The type of worms that are in the system are composting red wiggler worms. This type of worm prefers a dark and cool environment. Since they like a dark environment, they will stay in the middle of the vermicomposter mostly and will escape the system.	If they do manage to fall out, they will dry out and die from lack of food and water. It is best to have a bucket underneath the system and slowly become comfortable with handling the worms. They can safely be picked up and returned to the vermicomposter.
Why are there insects in the vermicomposter?	Fruit flies and other insects can sometimes enter the vermicomposter as eggs on fruit or if the cover is not placed on correctly. They are not harmful to the vermicomposter but can be a nuisance to you and the area around it.	To avoid a lot of flies, either place the waste into the vermicomposter right away or store it somewhere so that flies cannot get to it. Reducing the amount of citrous within the vermicomposter and adding eggshells will make the environment for insects less inviting and will kill off any that get in.

Helpful Tips

This section contains helpful tips to further enhance your vermicomposter and ensure that it is used to its fullest potential.



Temperature Regulation

The temperature of the system is important for the productivity of the worms. Worms will hibernate or die in an environment that is too hot or too cold. Keep the vermicomposter in the shade so the the temperature in the bin does not exceed 26.7℃ which can dry out the worms. To guard against cold temperatures, cover the vermicomposter with insulation or bring it indoors when the temperature falls below 10℃ for a few days. This will ensure that the worms can successfully clump together to stay alive. When the temperature drops close to 10℃, the worms produce little vermicompost even though they can stay alive and compost food waste when the conditions return to normal.

Feeding of the Worms

You do not have to worry about under feeding worms as long as there is paper product bedding within the system. The worm population adjusts well to the amount of food that is in the system. Typically you should feed the worms right away when you are done cooking. This will reduce the amount of insects that could infect it and if you cannot put it in right away it should be stored in a place away from bugs. If you are planning on leaving for two weeks, place more food than usual in the system and cover it with damp paper products. This will allow for the worms to eat during the time that you are away; they will be fine without maintenance.

Worm Population

Worm eggs are white little sacks which typically contain 2-3 worms. Worm eggs take three months to mature fully. When collecting the vermicast, it is important to place any collected worms and worm eggs back into the bin to maintain the population and enable it to digest more food. If some worms aren't separated from the fertilizer and are placed in the garden it will not harm the garden or the vermicomposting system. Worms will actually help the garden and the worm population will replenish naturally to meet the food demand. Eventually the worm population can be fixed by consistently adding the same amount of food waste. At this point the system will be running most efficiently.

Glossary of Terms

Aerobic: environment with oxygen

Anaerobic: environment without oxygen

Bedding: carbon source for worms consisting of paper and/or cardboard. This needs to be fluffed for air and moistened to give the worms a good habitat to live in. It shouldn't be the only source of food but it allows for the worms to live for a brief period of time.

Carbon Footprint: the net amount of greenhouse gas a person or company gives off in a certain time frame based on all actions calculated in tons of carbon dioxide

Greenhouse Gas: gases that, when in the atmosphere, have properties that help warm the Earth. In dangerously large quantities, these gases pose a negative effect to Earth. Common greenhouse gases are carbon dioxide and methane.

Microbes: another term for bacteria.

Vermicast: the worm byproducts that are harvested from the vermicomposter

Vermicompost: made from vermicast and other soils into a compost that can be applied to plants. About a third of vermicompost should be made of vermicast.

Vermicomposter: the total system in which the food waste is broken down, the worms cycle the waste, and the vermicast is produced.

APPENDIX B

American Farm School Residents Interview Schedule

We are a group of students from Worcester Polytechnic Institute in Massachusetts. We are conducting interviews with members of the American Farm School to design a vermicomposting system on campus that fits their needs. We believe this kind of research will ultimately lead to a design that can accommodate the needs of the AFS community and that can be modeled to citizens within Thessaloniki and serve as a way to possibly create a program in a municipal setting. Your participation in this interview is completely voluntary and you may withdraw at any time. This interview will take approximately forty five minutes. Please remember that your answers will remain confidential. No names or identifying information will appear in any of the project reports or publications unless consent is given. This is a cooperative project between the AFS and WPI, and your participation is greatly appreciated. If interested, a copy of our results can be provided at the conclusion of the study.

Questions

1. Do you have a garden/grow plants in your home?
    a. Where? Tell us about it. How much time do you spend tending to it?
2. Do you use any fertilize in your garden?
3. Can you tell us a little about your food waste habits?
    a. Amount of cooked vegetables thrown away? Vegetable scraps?
    b. About how much do you think you throw away in a week?
    c. If you don't know, how many times do you cook at home in a week?
    d. How many people are in your household?
    e. How do you dispose of your food waste?
4. What are your feelings on recycling and environmental sustainability?
5. Have you heard of vermicomposting?
6. What do you think of vermicomposting after seeing the pictures (provided) or based on your past experiences?
7. Do you have any particular concerns about using a vermicomposter in your home?
8. If all your concerns were met, would you use one of these?
    a. If no concerns: Can you see yourself using a vermicomposter?
    b. Why do you say yes/no?
    c. If yes, why would you want to use one?
9. What would you look for in your ideal vermicomposter?
    a. What are the factors that matter the most to you?
    b. Where would you keep your vermicomposter?
10. What would you be willing to pay for one of these systems?

APPENDIX C

Journal Checklist & Record Book

Please check the boxes on the days in which you did these activities.

	19/4	20/4	21/4	22/4	23/4	24/4	25/4	26/4	27/4	28/4	29/4
Fed the System											
Used Vermicast											
Looked inside the system											
Smelled offensive odor											
Noticed Worm Eggs											
Noticed Worms Outside System											
Added Water											
Noticed insects inside system											

Please also keep a journal throughout this process to express your ideas and experiences. When starting a new journal entry, please put the date. It would be appreciated to document anything you found “picture-worthy” with the vermicomposter with a picture and caption. It would also be appreciated if you documented what sorts of food you put into the vermicomposter and if the directions provided were helpful or confusing when starting this process. You can email us anytime at compost@wpi.edu if you have any problems or concerns while using it.

Please use this sheet to document your food waste habits. Note the variety and quantity when available. An example is shown in the first row:

	Vegetable	Fruit	Other
----	2 cucumber peels, 3 bell pepper cores, 2 tomato cores	1 banana peel, ½ apple	2 eggshells, 3 Tbsp coffee (w/ filter)
20/4			
21/4			
22/4			
23/4			
24/4			
25/4			
26/4			
27/4			
28/4			

APPENDIX D

Participant Exit Interview

Could we use your information to further develop material and plans for future vermicomposting programs?

Questions

1. How would you describe your experience with vermicomposting?
    a. With journaling?
2. What do you think would make the educational material more effective?
    a. What was the first place you looked at for help?
3. What did you like about the design? Dislike?
    a. What would you change?
4. Who in your household participated in vermicomposting?
    a. What was your family's perspective of the vermicomposter?
5. Did you move the bin from when we first installed?
    a. Why did(n't) you move the bin?
6. What was your biggest challenge during this process?
7. What were your initial concerns about having a vermicomposter? (can remind from first interview)
    a. Were your initial concerns addressed and resolved?
    b. Why or why not?
8. Would you want to continue pursuing vermicomposting?
    a. Why or why not?

APPENDIX E

Food Chart for Cafeteria

Ναί

όχι

APPENDIX F

Cafeteria Interview Schedule

We are a group of students from Worcester Polytechnic Institute in Massachusetts, United States of America. We hope to develop a way to involve the American Farm School campus in collaboration with kitchen staff to support vermicomposting. We believe this kind of research will ultimately lead to a design that can accommodate the needs of the AFS community and that can be modeled to citizens within Thessaloniki and serve as a way to possibly create a program in a municipal setting.
Your participation is completely voluntary and you may withdraw at any time. Please remember that your answers will remain confidential. No names or identifying information will appear in any of the project reports or publications unless consent is given.
This is a cooperative project between the AFS and WPI, and your participation is greatly appreciated. If interested, a copy of our results can be provided at the conclusion of the study.

Questions

1. Please describe your roles and responsibilities.
2. Does your company currently have a sustainability program?
    a. If no, is the company interested in one?
    b. If yes, can you describe the program?
3. How do you dispose of your food waste?
    a. Is your food prep waste included in that?
4. Do you know about how much food waste would be produced in a day?
5. Would reducing your food waste reduce costs? (associated with waste removal)
6. Do you have any desire to participate in this program/ would it provide the company with any benefits?
7. Please describe your current kitchen process. (separate food? Different lines for prep?)
8. Do you think the employees who cook will be willing to work with a slightly different system?
    a. How flexible is the kitchen towards changing their process?
9. What kind of training do your employees go through?
    a. What would the process be like for introducing new training?
10. The first attempt was a bag and the bin was outside of the kitchen, do you think there is a better strategy? What is easiest for you?
11. Has there ever been a waste audit conducted in your kitchen? Do you think this would be beneficial if the project moved forward?
12. What do you think would encourage your employees to stick to this program?
13. Would you like to see this project continue with AFS students?

APPENDIX G

AFS Faculty & Student Survey

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Dear Sir or Madam,

We are a group of students from Worcester Polytechnic Institute (WPI) in Massachusetts conducting research at Perrotis College, at the American Farm School (AFS). Our project involves gauging people's perception of vermicomposting as a food waste reduction method as well as determining designs that potential users would want.

We would like to invite you to take our survey to help us understand your perspectives about possible vermicomposting initiatives on the AFS Campus. The survey consists of 28 questions and will take about 15-20 minutes to complete.

Your participation in this survey is completely voluntary and you may leave answers blank throughout. Please remember that your answers will remain confidential. No names or identifying information will appear in any of the project reports or publications unless consent is given.

This is a cooperative project between Perrotis College and WPI, and your participation is greatly appreciated. If you have more questions about our project, you can email us at Compost@wpi.edu.

1. What is your age?
    a. Less than 18
    b. 18-29
    c. 30-42
    d. 43-53
    e. 54-65
    f. 65+

2. What is your gender?
    a. Male
    b. Female

3. Position within the American Farm School
    a. Faculty
    b. Staff
    c. Student
    d. Other: _____

4. What is your highest level of education?
    a. Elementary School
    b. Middle School
    c. High School
    d. Bachelors
    e. Masters
    f. Doctorate

5. What type of home do you live in?
    a. Dormitory
    b. House
    c. Apartment Complex
    d. Maisonette
    e. Other: _____

6. What municipality do you live in?
    a. Pylea-Hortiatis
    b. Thermi
    c. Thessaloniki
    d. Other: _____

7. Do you have a garden?
    a. Yes
    b. No

8. If yes, where is your garden located?
    a. Balcony
    b. Windowsill
    c. Yard
    d. Other: _____

9. How do you currently fertilize your garden?
    a. Compost blend
    b. Artificial fertilizer
    c. Do not use fertilizer
    d. Does not apply
    e. Other _____

10. How important is it for you to fertilize your garden?
    a. Not important at all
    b. Somewhat important
    c. Important
    d. Very Important
    e. No Opinion

11. How much time do you spend maintaining your garden/plants?
    a. Less than 1 hour per week
    b. 1-2 hours per week
    c. 3-4 hours per week
    d. 5-6 hours per week
    e. More than 6 hours per week
    f. Does not apply

12. How many days per week do you prepare meals at home?
    a. 0-1 days
    b. 2-3 days
    c. 4-5 days
    d. 6-7 days

13. How many people are in your household?
    a. 1-2
    b. 3-4
    c. 5-6
    d. 7+

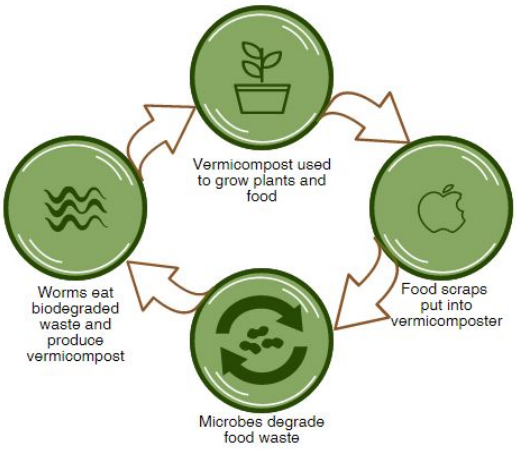
14. How do you dispose of your food waste (e.g. raw vegetables, fruits, eggshells)?
    a. Trash Can
    b. Composting
    c. Vermicomposting
    d. Other: _____

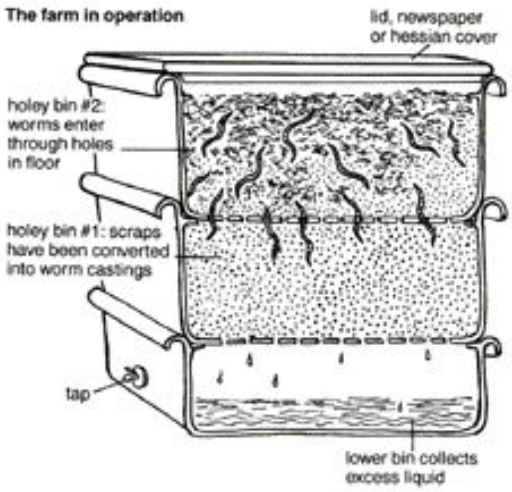
15. How do you practice environmental sustainability (check all that apply)?
    a. Recycle plastic, paper, or metal
    b. Use low flow water faucets
    c. Use LED lights in place of incandescent
    d. Recycle organic waste
    e. I do not practice it
    f. I do not know what it is
    g. Other _____

16. What would motivate you to practice food waste reduction (check all that apply)?
    a. Save money
    b. Help the environment
    c. Create high quality soil amendment
    d. Learn more about composting
    e. Like to experiment
    f. Nothing
    g. I don't know what it is
    h. Other_____

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't Know
17. AFS has successful recycling initiatives.						
18. Recycling is important.						
19. Recycling is a common practice in Greece.						
20. Recycling does/would take a lot of time out of my day.						
21. I am willing to participate in a new food waste reduction program.						

Our proposed project aims to reduce organic household waste that is added to the waste stream. To accomplish this, we are designing a vermicomposting system where worms break down the food scraps that would be put in. The leftover product is a great fertilizer and soil amendment that can be used on plants. The below schematic shows how the process works:





We provided a picture for each design so you can rate them based on aesthetic appeal of each bin. We ask that you rate each picture using the scale below and at the end answer overall questions on the possible designs.

Please use this scale to rate how likely you are to use each system based on its aesthetic appeal.

Very Unlikely	Unlikely	Unsure	Likely	Very Likely
1	2	3	4	5

Please comment on why you chose that rating and what characteristics influenced your decision?

Design **Dimensions (L x W x H)**	**Rating and Comments**
 2 m x 1 m x 1.5 m	Rate: 1 2 3 4 5 Comments:
 0.74m tall, 0.5m diameter	Rate: 1 2 3 4 5 Comments:
 1.5 m x 0.5 m x 0.5 m	Rate: 1 2 3 4 5 Comments:

1.1 m tall, 0.6 m diameter

Rate: 1 2 3 4 5

Comments:

 0.45 m x 0.45 m x 1.0 m	Rate: 1 2 3 4 5 Comments:
 0.4 m x 0.2 m x 0.2 m	Rate: 1 2 3 4 5 Comments:
 0.5 m x 0.5 m x 1.5 m	Rate: 1 2 3 4 5 Comments:

22. What design do you find most attractive and why?

23. Where would you place the vermicomposter?

24. What concerns would you have about using one?

25. After learning about vermicomposting and seeing some designs, how interested would you be to start vermicomposting?

a. Very uninterested
b. Uninterested
c. Neutral
d. Interested
e. Very interested

26. What factors are the most important to you in an ideal vermicompost bin? Rank them 1-6, with 1 as most important.

__Aesthetics
__Cost
__Maintenance
__Simplicity
__Size
__Other _____

27. What would you be willing to pay for one of these systems?

a. €0 - €25
b. €25 - €50
c. €50 - €100
d. €100+
e. Don't want it

28. What educational materials would you use to learn more about vermicomposting? (check all that apply)

a. Website
b. Pamphlet
c. Training class
d. Newsletter
e. Manual
f. Online forum
g. Other _____

Additional comments:

APPENDIX H

Municipality Interview Schedule

May we please ask if you are willing to allow us to use your name in our final report?
May we record this meeting?

We will discuss our project and the pieces that we will be able to provide them at the end for either them or another team to continue in the future.

1. What is the current situation with waste within this municipality?
    a. Is there currently a problem that needs to be addressed?
    b. Current consequences of waste?
2. What does the town currently do with waste and how much does it cost to remove the waste?
    a. What data do you collect on waste?
3. How does the municipality currently educate the citizens about waste sustainability?
4. Is there currently a recycling program within your municipality that could incorporate vermicomposting as an option to further reduce organic waste?
5. What benefits would vermicomposting offer to the municipality?
    a. Money, reputation, tourism
6. What are some concerns you would have about initiating a vermicompost program?
    a. Why do you have these concerns?
7. Based on your experience in this field, do you think it's possible to have a program like this at the municipality level?
    a. If not, do you know of any grassroots organizations that could help in this endeavor?
    b. How do you envision the program going?
    c. Are you more interested in: everyone has a vermicomposter, a program to drop off waste, or having a company do everything?
8. What would be the necessary steps in order to start a vermicomposting program?
    a. From the ground up?
    b. Best method?
    c. Would it be beneficial to conduct a waste audit?

APPENDIX I

Municipality Proposal

Developing Vermicomposting to Reduce Organic Waste

To: Mayor Kaitezidis, Municipality of Pilea-Hortiatis
From: Gina Capobianco, Stephanie Cappelli, Doua Vang, & Colby Whitcomb
Date: 31/3/17

We are students from Worcester Polytechnic Institute in the United States. We are currently working on a project with Dr. Christos Vasilikiotis, at Perrotis College within the American Farm School in Thessaloniki until May 5th.

Pilea-Hortiatis is a vast municipality that is a model location for vermicomposting. The population of 70,000, along with the varying degree of urban and suburban settings will allow us to survey a breadth of people to make our study more meaningful. The past work of the town in environmentally friendly programs such as composting makes us believe that the municipality will be great to work with and allow for a higher degree of success moving forward. We believe that by working with Pilea-Hortiatis we will be able to make a long lasting and impactful program.

Objective:
Our project deals with researching the use of vermicomposting systems in order to reduce organic waste, while taking into account users needs to maximize the potential for continued use. Vermicomposting is the process of producing fertilizer from the decomposition of organic waste with the addition of worms. Currently, we are gathering information on the best method in which vermicomposting can be implemented at the municipality level. We would like to explore ideas such as: creating an education program, household systems, communal systems, and how to best benefit the overall community. We are asking the municipality for support on the following goals. We would like to post a survey on the municipality website in order to gauge interests and perceptions about vermicomposting. We also heard that there was a composting pilot program and we would like to meet and interview the person who led this program as well as possibly getting in contact with the participants to understand their experience. In the future for the implementation phase, we would like support in providing and distributing vermicomposting bins to participants. We hope to start an initiative that will have a long lasting positive effect on the community.

Goals:

1. Analyze interests and perceptions of local stakeholders for the project
    a. Identify target users for a vermicomposting system and pilot program
        i. Interact with municipalities for interest
            1. Contacts for participants of previous composting initiative
            2. Promotion of survey for resident interest
        ii. Talk to universities for interest
            1. Plan on conducting studies at Perrotis College, at the American Farm School

2. Construct a vermicomposting prototype using human centered design
    a. Generate prototypes for field test and as models for potential users
    b. Implement case studies and feedback mechanisms for design iterations

3. Create an implementation and disbursement plan for vermicomposting units
    a. Assess the factors needed to implement a successful vermicomposting system.

Deliverables:

1. Recommendations on findings for vermicomposting system designs
2. Educational or training materials to supplement the recommendations
3. Recommendations for municipality vermicomposting program

APPENDIX J

How to Build Our Vermicomposter

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How to Build Our Vermicomposter

This is a collaborative project between Worcester Polytechnic Institute and Perrotis College at the American Farm School

Part 1: Gathering Materials

Materials Needed

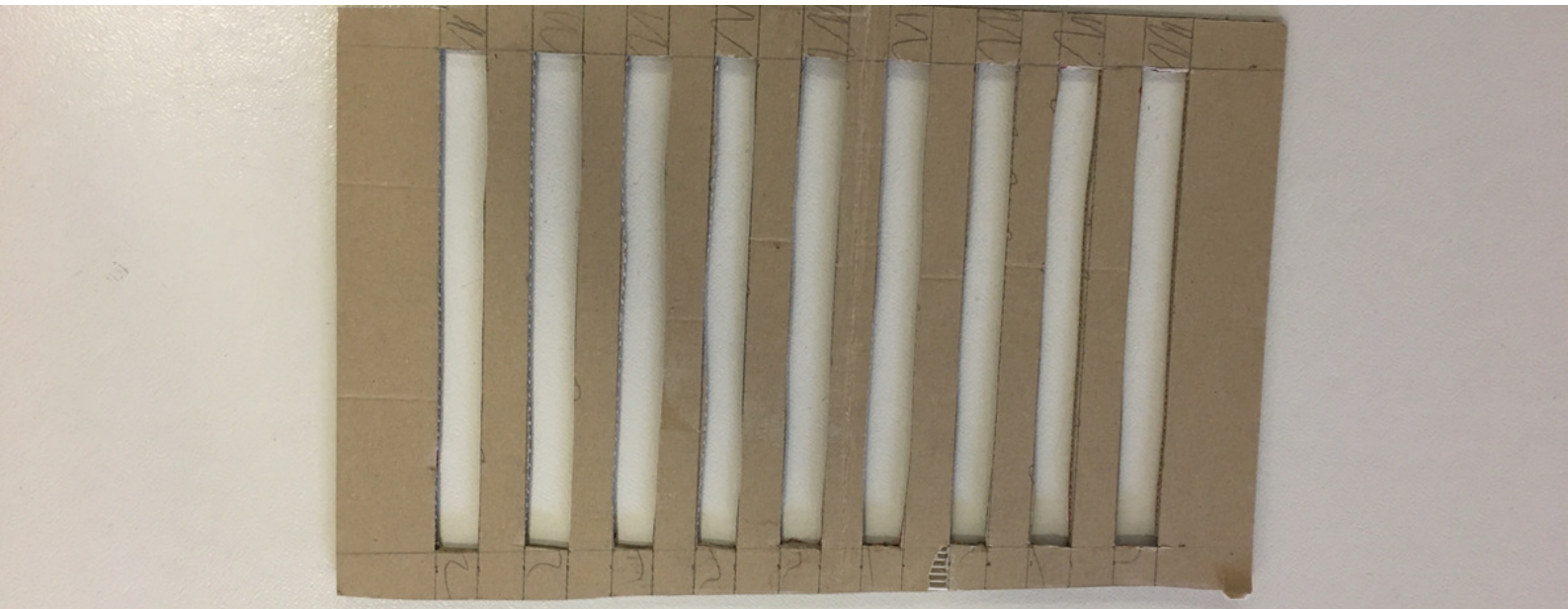
Plastic Bin
Garden hand rake
Dremel
Knife
Wood pallet (pieces of wood)
Drill
Hot glue gun
Screen
Saw
Hammer & nails

Total Cost: €13.50

Total Time: 3 hours

Part 2: Preparing the Bin

Create a template with 2 cm wide slits for the rake to eventually scrape out the vermicast.



Mark the position of the slits on the bottom of the vermicomposter.

Cut the slits using the Dremel, being careful not to crack the bucket.

Leave some space around the bottom edge of the bin, about 2-3 cm.

Drill four holes on each of the top long sides of the bin.

Use the hot glue gun to glue on strips of screen on the inside of bin to cover any holes so that airflow can enter but not insects.

Part 3: Making the Stand

Make a base using a section of the pallet. Cut 4 pieces of wood to be about 1 m long.

Cut a square out of the pallet to be used for the base.

Use the blocks that the pallet stands on as an anchor point for the v-shaped legs of the vermicomposter.

Nail the legs together so that a small amount would be at the top for the bin to sit on.

Place the bin on top of the stand to finish your vermicomposter. Please see our manual to learn how to start vermicomposting!

APPENDIX K

Dean Rotsios' Interview

IInterview with Dean Rotsios
4/11/17
Transcription:

Doua (D): Do you have a garden or do you grow plants in your home?
Dr. Rotsios (R): No. I have a garden, a backyard garden, but I don't have the time to.
Christos(C): But do you have landscape plants?
R: Yes, yes.
D: Do you tend to that or use fertilizers?
R: We don't use any fertilizers, and I don't have the time to. I love gardening, it's my dream. We have a farm 30 kilometers from here but unfortunately the time constraints do not allow me to go. I bought six flowers yesterday, after a two month fight with my wife that I don't pay any attention to my house, so I have six flowers.
Whitcomb (W): And you live here on campus?
R: Yes that is why I volunteered. My house is near the high school. The white house by where the president lives. 200 meters down the road.
D: These next questions will go a little more in depth into your habits with food waste. So if you could just tell us overall about your food waste habits, more predominantly when you're cooking. Would you throw away your raw vegetables that you don't use?
R: Yes, yes. With my wife, we try to follow a healthy lifestyle, although we don't have time. So that's why I'm very interested, yes. We buy vegetables from the open markets. Not pre-cooked, not pre-cut, not pre-washed. We try to do everything by ourselves. As a result, we have waste, although it's a 3-membered family. The two of us and our son. But relative for the number of people in the household, we have a lot of vegetable waste, because we again, like to do all of these things by ourselves.
D: And would you say, you cook on a regular basis?
R: We cook on a very … very regular basis. My ...so my wife cooks once every Sunday. Meals for the family for a few days. Yes, we spend a lot of effort into this, because she works too. My wife is a lawyer at Aristotle University and she has difficult time to I mean you know her work schedule, but we cook on Saturday and Sunday for the whole week. Tupperware ready to go.
"while showing us the tupperware" Yes so this is what we consume every .. so at beginning of the week we have 12 of these. So this is spaghetti and fresh vegetables. So that's how we, we don't cook every day, but we eat the food that we prepare on Saturday and Sunday.
D: and
R: A lot of fruits as well…yeah
D: so for the scraps, when you do
R: We throw them away

D: just in the
R: Well if I have the time and patience because I have a farm, farm brother who is a farmer. I keep those for the poultry, for the chicken he has, but most of the time we throw them away.
D: ok, so I know you talked a lot about you want to be environmentally friendly and you try your best
R: I think one of the good things that we got from the states is that this environmental awareness that we saw in this country with exception of this huge tax, which is completely stupid. But apart from that, this is I think this is philosophy over time to give to our students... to our families to our students as well. The school that you see has done huge steps toward this direction. I mean there are still cities and schools in Greece that will not recycle for example. Things that are obvious to us, for many years because and Christos Vasilikiotis had the chance to spend time in the states. It's not obvious to other schools, so yes I consider myself to the extent of the environment in which I live, to do efforts and to pass this sentence (sentiment) to our students as well.
D: I know we talk a little about vermicomposting, but have you ever heard of that
R: From experiments that Dr. Vasilikiotis has done in the past. I saw the poster when we went to the Perrotis College. From time to time we get… we get papers from the office, is that the same project? Christos- yeah
R: Yeah
C: shredded paper
R: So it's you know, a very interesting, very exciting. Yeah very exciting project.
D: and now we're just gonna show you some pictures of some bins that we found through the internet, we have a picture of Professor Vasilikiotis in the greenhouse and we just want you to kinda look at .. look at it and just .. we'll ask some questions in a bit
R: Can I see them or do I need my glasses, oh yeah I can ok. So all this is interior?
D: interior meaning?
R: For inside or outside house?
D: It can be either
C: Balcony, not in house
R: OK, OK,OK. So what do you want me to do with this?(In regards to our design pictures.)
D: You can just look at them and ask us any questions if you have any.
R: So all of these are doing the same thing? Same function?
D: Yes same function
W: So for the most part you don't have to collect the waste by hand, you can scrape it out with something on the bottom. And you can collect it in a container underneath
R: So it is not only vegetables, its food and everything organic. LIke olive oil, cooking oil, everything?
C: No actually, anything with oil you want to avoid. They developed a nice poster. So if you want to participate.
R: Of course that is obvious.
C: So you can have it on the bin and it can be very visual
R: So you can have a clear idea of what is going in.
Showed him the picture on the screen.
C: So it is in color
R: Excellent, good, good.
C: You can see like no cheese or bread or sweets.
W: So it would probably be great for the way that you cook on like Saturday and Sunday as you have all of our fresh vegetables cut up then and you can put them in then
R: Yes, I can put them right in. We won't have much as we are only three but..

C: The quantity doesn't matter too much as it is more important that it is steady state. The population of the worms develops according to the amount of food you put in. It will reach an equilibrium
D: After looking at these designs, what is your initial thoughts about putting one of these in your house? I mean garden or wherever.
R: So my affect, as a person who lives in a countryhouse? Or in an apartment now? Because eventually you want to move to an application that is apartments?
C: It can be both small houses or apartments.
R: I don't have any preferences, whatever is more convenient I would say. They are all the same to me. So yeah this one perhaps. (Points to the commercial bin one.)
C: So yeah that is the one that we have, the black one
D: There's going to be worms and there's going to be food scraps and there's going to be, you know, the byproducts and all that. Do you have any concerns about smell, or what are your initial concerns?
R: Again, if you are talking to me as a person who wants to help you or are you talking to me like you found me in the street? Greeks have an issue with cleanliness. They are very very much to have a very clean and safe environment, indoor environment, for their families and their children. I like the States when, you know, people care a lot about the(ir) surroundings. Greeks pay a lot of attention to the private property and house. They don't care about the public space and this is why you see it's a mess outside. They throw the garbage all over the place, they don't care. OK. but if you go into their houses it's amazing. The average Greek lives into a sterile environment. They are very much, yeah. So some people might have some objectives about the smell. Which I do not have because again, I'm coming from a different background, to help. I live on campus, which is, you know, countryside. But some, if it's too smelly, the average household might have some reservations about this. Misconception because they'd think that's dirt, that's lots of, I don't know, of pollutions of microbes. But, yeah, you might have a problem if you want to go to large scale. But I don't have an issue.

D: OK. And, I guess, this does take some level of maintenance because, you know, you do kind of need to check on it and see it's not smelling and there's not something that are in it that shouldn't. Is that, like, of concern to you? The level of maintenance?
R: So what you mean level of maintenance? Is that something you have to deal with on a daily basis or on a weekly or what?
D: It depends on the design honestly and it kinda depends on your time. You can do it weekly or if you have a lot of time you can do it daily.
R: HHHmmmmmmm. It requires a lot of time or what? I would think …. (muffled with many voices)
C: For example if you only cook once a week then (Rotsios answers phone call) Then it would be if you only cook once a week it would just be adding them and making sure things are OK. It doesn't take any time. And the only thing for example if you use this kind (points to black commercial bins) you might need to once every few weeks to empty the liquid and pour it out. So if you are careful about what you put in and do it right away, maintenance is minimal. And then once, once you start using it for a long time (CUTS OFF)
R: (He was OK with this level of maintenance at this point though)

The rest are summarized in our notes that we took some of, but didn't know that the recording cut off. The interview only had a few questions left. This is summarized below.

D: What would make your ideal vermicomposter?
R: Low maintenance would be a major factor for them
Needs to know it is safe and not a source of pollution and diseases
Notes that Greek people highly value cleanliness inside their houses
D: What would you be willing to pay for a vermicomposter? Noted the black commercial one is 120 Euro but can build own for much cheaper out of scrap wood.
R: 120 Euro is the top price he would pay for one
What you would pay for the waste in Greece is capped so it would not change anything by having a vermicomposter. Fixed Tax for waste pickup for residents, so no matter how little or much they throw, it costs the same. For people who live on the AFS campus, it's free.
25% of a starting salary is 120 Euro so it would be very expensive to get that black vermicomposter mentioned, therefore need substantial benefits
Need to find the benefit
G: Not buying fertilizer, composter can pay for itself by not buying fertilizer.
D: Increasing quality fertilizer
S: People that like environmental would cut down on greenhouse gases
R: Young people are better with knowing this
Starts with the younger people because it will effect them but it won't effect the older generations are they will be gone soon
D: Why did you volunteer to participate?
R: To help you guys.
C: Do you see any benefits to you or your family
R: Not really.
- But he would like to send a message to other families that there can be a cultural changes and get a different mindset that things can start changing
- Setting an example
- (For the AFS campus → not just professors, tradesman, milkers?, electricians)

Starting and running a vermicomposter and see how it goes from there

Rotsios suggested we reach out to PAP Corp, which we then explained we have been trying, but it has been challenging.

Garbage collection is a fixed price so vermicomposting doesn't change their money. Can give them a green appearance, publicized it (Christos' ideas for sustainability angle for cafeteria).

Rotsios thinks there isn't any way to incentivize a company besides their bottom line. AFS is a major brand that everyone wants to be associated with

How to provide concrete benefits for people → Flat fee for all trash pick ups in city, no fee for campus residents. Therefore, must try for some other incentive for people (like we talked about above) Getting the city to subsidize the program because it would save them money.

APPENDIX L

Dean Rotsios' Exit Interview

Interview with Dean Rotsios
4/27/17
Transcription:

Rotsios (R): I looked at your (indiscernible) and was very excited about your project. I didn't see too much activity. The only thing that I did experience that apparently our waste, and this is something you have to write, when we first met, because it has an impact and it enhances your project. When we first met, I told you, you know, don't worry, I will help you, however, we don't have too much waste in the family--Don't expect too many things. Now, surprisingly, of course this is very positive for your project, I came to realize that there are quantities. So even a three member family like mine who is not a traditional family where everybody will sit around a table and eat all together happy and then OK I will see you tonight and then eat dinner all together, there is waste. So there is potential for something like that even for families that at the beginning they might say, 'You know what, I don't think there is too much I can help you with because we don't have any waste', or 'we don't have substantial waste'. OK. So I think this a positive aspect…

Rotsios answers phone call

Doua (D): We'd like to ask if, we see on here you fed the system (points on tracking sheet), almost every day…
R: Everyday, Yes
D: ...Can you tell us a little more about what you fed the system?
R: I, as I told you before, we have a son who's 17 years old, so every day my son eats a lot of fruits. So it was mostly fruits. Yes, and some vegetables from our salads. Yes, and coffee. So, yes, at least 3 or 4 or 5 fruits a day, the peel of the fruits. And on weekends of course it is more because that is when we do most of the cooking for the week. Yes.
D: I don't know if you got the chance to look at the manual at all or if you…

R: Tell me what you want me to do about the manual and I will do it. Because I will be able, having a lot of time in the airport and flight today. So I can do this, if you want I can answer. Ask me and I'll give you the answers. (Flipping through manual)
D: Oh no it's fine, we just wanted to ask, if throughout having this did you ever look at the manual for help or anything?
R: No. The only thing I did was I took very seriously with the feeding and the water you told me to be very careful and moisture.
Stephanie (S): So the training experience really helped you.
R: Yes it did. Yes it did because, yes. Now I know exactly, yes of course.
D: Now if you did have a, if you did notice an odor or something wrong would the manual be the first place you would look, or would you prefer, a website or something else?
R: I would prefer the webs---- the manual.
D: The manual?
R: I like manuals, yes. My generation would like this, yes yes, I would go to the manual. Yes. Of course mine is not close to the house, I mean I smelled it once but it doesn't really bother us. But yes I think a manual is very important, very important.
S: And it said that you noticed insects. (Pointing at checklist tracking sheet). Do you know what kind of insects?
R: Some ants.
S: Some ants?
R: Yes, some small ants, that, quite a few of them yes. And there is some liquid that comes out of… I opened the ….
D: the tap?
R: The tap there, yes, and then I closed it.
D: So for the black design, did you find anything you particularly liked or disliked about it? Like how, like the tap, or maybe it was too big…?
R: It was very convenient. And what I like it was very easy to carry around. This size, for households our size, three people, it's very easy, and that's, I found that very convenient. The lady who help us with the cleaning of the house came this morning and move that so she could do her walk and clean her, you know whatever you call that. Entrance. That was very convenient.
D: Anything you particularly didn't like about it?
R: No I cannot help. It's almost full. Yes, I don't know if you have the chance to go there?
D: We can go check after this.
R: Yeah we'll go.
Gina (G): Did anyone else in your family, use or look at the system? Or just was it just you?
R: Yes yes, no no. All of us. I mean, just when you eat your food in the afternoon. Yes all of us. Open the lid and we put the--yes all of us. Yes.
D: Do you know how they felt about the system? Do you know if they resisted against using it or they thought it shouldn't have been in the household or were they all kind of comfortable with it?
R: They're comfortable, they're comfortable. The weather is still nice. It's still close. It doesn't require a huge, you don't get out of your way, that's what I'm saying. That's what, the simplicity of this thing makes it attractive I believe. Because we are all very busy I told you. My wife too. And we work many hours but it's not something, you know, you have to spend hours and get out of your way.

D: So, from the initial place, where we placed it under that tree, did you ever, did you move it to a different place now?
R: No. It's, from the tree I put it on the pavement, we have some stones there. I put it there because it's more convenient for all of us to open it. Remember, there was some branches. And then I moved it back because our cleaning lady wanted to clean that. So not really, I did not really move it, just 2 meters to clean and then back. But it was very, very convenient. Not heavy at all. No problems.
D: Could you describe the biggest challenge you had during this process? Like maybe sometimes you were confused about what to put in?
R: No no no no no, this thing is very good (points to food guide sheet). No, no confusion. I mean there are specific items in the house that we put in it. And after awhile you get used to it. You know exactly. It's not like, you know, we experiment with new cooking every afternoon and we don't know what goes there. After awhile, you know, it's mostly the same fruits, the same vegetables, the same type of food we use.
D: Was cleanliness ever an issue? I know that was one of the concerns.
R: No.
D: Another concern you brought up in the beginning was maintenance level and if you had time. Was that, was maintaining that system ever taking too much time?
R: No so if I didn't have anything, there's no need to maintain yet.
S: Was having pictures of all the foods helpful in the beginning? (about food guide sheet)
R: These pictures? (pointing to food guide sheet)
S: Yeah.
R: Of course, it was very helpful. This is very helpful.
D: And lastly would you want to continue vermicomposting?
R: I think I will. Yeah. I think I will, yeah. Again it's something that's part of the life now and doesn't require an no excessive amount of time, of energy, of thinking. It's there. Instead of the garbage bin this is, you know, 2 meters away. So it's not a big deal.
S: So you didn't say you had any real use for the vermicompost that would come out of it so what would you…?
R: I don't know if there was some out of it. Was it?
Colby (C): I don't think there was any.
S: I don't think there was any but eventually…
R: No
S: ...in a month or two.
R: In a month or two?
S: yeah
R: OK. I put it in my garden. Yes. Yes, no I will find a use, but it's not like it's my hobby that I like in the afternoons to go and play with my flowers and my garden. That's what I said. It's not my hobby. I don't have this as a hobby, but uses I'll be fine because, you know, we have some flowers, we have things, yes.

End
Recording cuts off

APPENDIX M

Dean Rotsios' Checklist

Please check the boxes on the days in which you did these activities.

	19/4	20/4	21/4	22/4	23/4	24/4	25/4	26/4	27/4	28/4	29/4
Fed the System	X	X	X	X	X	X	X	X			
Used Vermicast											
Looked inside the system	X	X	X	X	X	X	X	X			
Smelled offensive odor											
Noticed Worm Eggs											
Noticed Worms Outside System											
Added Water						X					
Noticed insects inside system						X					

APPENDIX N

Mrs. Maria Tsaparikou Interview

Interview with Mrs. Maria Tsaparikou
4/12/17
Transcription:

Christos(C): I'll do like a quick translation or something because [Greek]
[Christos and Maria conversing in Greek]
C: She's asking about, first if the worm will escape and that's one thing is they don't like to get out.
[Explaining this to Maria in Greek]
Maria(M): Ok
C: [Greek] … rats and stuff and that's an important thing about not putting any bread, pasta, [explaining this in Greek]
M: Ok
Doua(D): And so the first question we have for you is, do you have a, just walking around we just want to ask, do you have a garden or grow plants around or in your house?
M: Yes
D: And is this outside or do you have some inside you house?
M: It is around the house.
D: We saw a lot of pots, is it just the pots? Or is there like a garden as well?
C: [Explaining in Greek]
M: Yes, yes over here is the garden [pointing to outside].
[Christos and Maria conversing in Greek]
C: There is a vegetable patch also.
D: And how much time do you spend on these plants and garden?
M: One time or one hour per day in the summer, spring and summer days.
D: So you work on it every day?
M: Mhmm, I like.
C: Yeah it's good.
D: Do you currently use any fertilizers for any of these plants?
[Christos and Maria conversing in Greek]
M: Compost from the school, from the campus.
D: Compost from the school?
M: Yeah compost yeah
D: And now we want to ask you a little about your food waste habits like how you cook and everything and what you do with the raw vegetables that you don't' that you cut off and don't end up using to cook. Where do you place those?
[Christos and Maria conversing in Greek]

C: Ok, so same thing as like Dr. Rotsios said, either garbage or some people have a chicken, she gives it to them. Rotsios told us that he gives to a friend who has chickens also. So yes it's mainly [Greek].. yeah in the garbage and then sometimes people with friends with chickens might give some because chickens love food waste so.
D: Would you say you cook regularly, cook on a regular basis throughout the week?
C: [Explaining in Greek]
M: Everyday. Two times.
D: Two times everyday?
M: Yes.
C: Wow
D: So would you say you throw a lot of that food waste away? Or do you think, for your household, do you not buy a lot of produce and you don't use a lot of vegetables and all that in your cooking?
[Christos and Maria conversing in Greek]
C: Yeah it's all fresh.
M: All fresh.
D: Ok.
C: [Greek]
M: Not from my garden. I buy some of this.
C: Yeah but you don't buy ready made.
M: No no.
C: You use fresh veggies and cook with fresh. So you have a lot of waste?
[Christos and Maria conversing in Greek]
D: How many people are in this household, that you cook for?
M: I have one son in your age and [Son's name] few years later.
C: Younger.
M: Younger, my husband and me.
D: We wanted to get your feelings on recycling and other environmental sustainable practices. Do you do any of those in this household?
[Christos and Maria conversing in Greek]
M: Yes, I recycle the glass, the paper, aluminum.
C: You put it in the front here [pointing to the front yard].
M: Yes.
C: Yeah, there are the four bins.
M: [Greek]
C: Yeah so recycle everything.
D: Ok, have you heard of vermicomposting before? Or more on traditional compost?
[Christos and Maria conversing in Greek]
M: Yes, yes many years before.
C: Yeah it was one of the staff people here, [Name of this person], who actually started a big vermicomposting project with cow manure.
[Christos and Maria conversing in Greek]
C: Earthworms, earthworms
C: [Greek]

C: He was doing a big project so she knew vermicomposting from that but it wasn't for food waste, it was cow manure. It was also another way of using vermicomposting.
D: And now we are going to show you some pictures of some vermicomposting bins.
M: (Goes to get glasses) Christos chats with us.
D: So these are just examples that we found online. You can look through them and see. We are just going to ask some questions afterward, after you see some of them and touch the screen and scroll to the bottom
C: [Greek]
D: Is there any particular one that you would want more in your house?
C: [Greek]
M: This (Wooden one) and this (Flower one).
D: The flower one and the wooden box
C: [Greek]
C: She says the round one (Commercial Bin) is for like a balcony but doesn't like it in the garden. She likes the wooden one and the one with all of the flowers
C: [Greek]
D: So after looking at some of these pictures, what are your initial thoughts about these bins, do you think you could take one into your house and be fine with that? Or do you think something else?
G: Not into your house but like the garden
C: [Greek]
C: She is asking if the wooden ones will rot after being in the rain and exposed. But I think that it will last a long time. But eventually it will. (Greek to Maria)
D: I know you talked about some concerns like the vermin or worms escaping but is there any other concerns that you have about vermicomposting?
C: [Greek]
C: Greek explaining concerns to Maria
M: [Greek]
C: [Greek]
M: The cost and the size, Greek?, (doorbell rings) sorry
D: Now we're asking if cost wasn't an issue, if we told you that your concerns were met, would you actually use a system on your own?
C: [Greek]
M: Greek, Why not? Yes of course. This, or this, this is very good idea (pointing at different designs) (again pointing at the wooden ones, but saying the flower one was very good idea) this
D: And we wanted to ask why would you use one? Is it to continue your motivation for recycling or are you interested in the fertilizer that comes out of this system?
C: [Greek]
M: Both of these. Greek. Yes. Greek.
C: Fertilizer
M: Fertilizer, yes, and for the recycling
D: And now we want to ask more about the uhh, if you were to create kind of like your own, if you were to tell us what you want, what are the most important aspects that you want us to keep in mind if we were to give you your perfect one?
C: [Greek]

M: Greek...fertilizing... Greek
C: You're talking about the design, right?
D: Yes, if it were to give her her idealistic
C: [Greek]
M: [Greek]
C: [Greek]
M: It would be of wood, wood [Greek]
C: Wooden
M: Wooden and tall, but who cares. Not too big or too narrow.
D: Is there a reason why she said wood? Is it for aesthetics or..?
C: Why you want the wood? [Greek]
M: Yes
C: Yes, aesthetics to blend
M: [Greek]
C: [Greek]
Gina(G): More natural
C: Yes, more natural. Around the house it would look very natural. So, for aesthetics.
D: Where do you see you would place this composter? Would you place it somewhere outside in the garden?
M: No, the side, beside the house, near the kitchen (Note: the garden area was in front of the house, but the kitchen area was in the back of the house on the first floor)
C: That makes sense.
D: I guess now we wanna uh, this is the last question, how much would you be willing to pay for one of these systems if you were to buy one of these systems? For example, umm. The black one
C: [Greek]
M: Greek. I don't know. I don't know the prices. [Greek]
C: Give her some costs and she can decide. She doesn't know the costs.
D: For example, this black one, you can buy it from a company and they'd send it to you. It's for 120 euro, but if you were to make something like this (wooden sheddy one) you could get scrap wood and could make it yourself. But, umm, or you can get some really cheap ones like this (flower one). These are just tubs so you kinda make the holes and … uuhhh… you can do it for very cheap. You can make it out of wood, for better wood, (Christos') this one is in the greenhouse is for 100…
C: 100 yeah
D: ...100 euros.
C: Greek
M: Yes, why not [Greek]
C: She'd be willing to give 30 to 40 euros to get started and see how she likes it. She wouldn't give more to get started.
D: That's all the questions we have prepared. (Asks team) Do you guys have any other questions?
G: I don't think so
S: Do you have any questions for us about the program?
M: [Greek]
C: [Greek]

M: How many… How is the during of the program? Greek. The duration.
C: [Greek]. I'm saying you're leaving May 5 but we can continue that project and we can start if she's willing to have it longer and you can get some feedback by the time, before you leave. But then I can follow up and then see how it goes. I think that makes more sense then people get two weeks and continue waiting, so they can enjoy it.
M: Only 20 days
C: [Greek]
M: OK
G: Would you allow us to give you one of the bins we have in the greenhouse? Probably next week, after Easter. We can set up a time and show you how to use it. Is that something you're interested in?
C: [Greek]
Stephanie shows picture of our design from her phone
G: We made this one for 14 euros. We used scrap wood and bought a bin.
C: [Greek]
M: Yes, it's ok. I don't like the color so much, but yes.
Discussion about our majors and Easter plans.
M: *Referring to the plant system:* I like this one. It's good for lettuce, and small onions.
Referring to the black commercial system: This one is good for balconies.
C: [Greek]
M: [Greek]
C: They are throwing away all the drawers that are made of solid wood. Those can make excellent material. So yeah. So she likes starting but she wants to make a bigger one, which is great. We can start the process so you guys can get feedback how she likes the whole process. How much she throws away. How the whole thing works. And then after you leave I can help her design a bigger box, a wooden one, and we can send you some feedback.
G: Yeah, that would be great.
C: [Greek]
M: [Greek]
C: She doesn't want to throw away anything, even clothes.

Cuts off.

Notes from conversations while packing up and walking out:

- Maria is the only one of her family to garden
- Maria was interested in the earthworm species used and how they multiply, which Christos explained
- She wanted to study agronomy but ended up studying financing

APPENDIX O

Mrs. Maria Tsaparikou's Exit Interview

Interview with Maria and Petros Tsaparikou
4/29/17
Transcription

Previous discussion: Questions on grass clippings, olive tree leaves, hard boiled egg. She uses the hand rake to push back the paper and put in food. Husband says maybe the holes and netting need fixing because of bugs. Some of the netting is loose on the sides and maybe the holes on netting is too large. So, need construction improvements.
Observation of bin: needed more water and ants and flies inside (many).

Doua (D): And so, first question we have for you is: How would you describe your experience with the bin. Has it been good? Bad? What are some of the good things and some of the bad things?
Maria (M): I find it is a good thing. Because I put all of the rubbish from the kitchen. There was a lot, as you will see, there was a lot in the basket. Every day, I put the rubbish every day from the cooking. Before the cooking.
D: Would you say it's been easy? It's not too much work?
M: No, no, it's not difficult. Because for me, it is near the kitchen. No, I have no problem.
D: How do you think you've been doing with the journaling? Is it something that takes a lot of time? Do you think there is there an easier way for you to do it?
Petros (P): Actually, if you separate the waste in the source, instead of putting everything in a common basket, then it easy to move what is to go in the basket, direct there. It would be more difficult if you continue to select all waste food in a common basket, and then to select again those that will go to the project.
D: How do you guys do it right now? Do you guys just, after, when you guys cut, do you just bring it outside and put it in there, or do you guys put it in a bag in the house and then bring it out?
P: We keep them in a bag. (Greek). Direct.
M: (Greek) Direct. When I prepare the meal, direct I put the rubbish here. Direct.
D: Um, so has is your experience-
M: An idea, if I can, my mother in her village, she keeps a cup in the kitchen, yes a basket, and puts all of the rubbish from the chickens. She puts the rubbish, the leaves, Greek. And after, see, it's better to have in the kitchen, some small basket to collect all of these materials, all of these leaves. But I have no problem, because the kitchen is beside, very very close to the basket. But I have no problem. It's good.
D: Have you had any problems with the journaling? Or writing stuff down? Or the check list?
M: I check only the draft paper, I don't write this. If you want write I have no problem.
P: Greek
M: Yes, it's easy.

D: I don't know if you got the chance to read the manual, the big piece of paper with the bin in the front picture. The one I gave you.
P: Greek
M: *Looking for manual in pile of papers* Greek. Yes, it is very good.
D: Do you think there is anything missing? How can we make it better?
M: It's good.
D: Its' good?
M: It's good because we speak with you before, so I have no problem with this.
D: So the first demonstration was very helpful?
M: Yes, yes. (Greek?)
P: *Colby walks in and goes to get a chair*
D: So was the manual the first place you looked when you had a question?
P: [Greek]
M: No, no. I have not had any questions. I have only questions from the leaves of the tree [she asked us before we started recording about putting olive tree leaves in the vermicomposter] on the alive [olive] trees and this. I have not other rubbish.
P&M: [Greek]
P: She has only one question if the olive leaves could be on, in the basket or not.
M: This is the only question.
P: Maybe it was not written in the manual.
D: It was, uuhh, I think Professor did like an experiment on if you could do it, but we have to talk to him about what he found.
M: Yes, OK.
D: But, we'll get back to you. We'll email you again.
M: OK
P: So you continue to improve the manual and…
D: Yes.
P: And develop it…
D: Yes
P:... A question could be the leaves of olives because…
D:...Because we are not from here so we don't know what you usually cook or…
P: Something, yes, something that is ongoing and continuously improved. Another question of the eggs as she told you [about hard boiled eggs] and the hard surface of the eggs if you could put them inside or not and you didn't know, I mean these kind of questions that could, could, add on the, on the, manual and improve.
M: And the other, other thought is that this basket is, is the result of one week cooking for me. And it's in the half. In the half as you see, half of the basket. If I cook again the second week, it will be full.
D: Yep
M: I will finish and after how many days can I put, (Greek). In a week it will be full, if I cook as in the previous year [misspoke], previous week, it will be full. Maybe it's small from a, this basket is small from a four person family. Maybe.
D: Yep, that's one of the things we were looking at…
M: Maybe, yeah.
D: ...some people, cause

M: If I cook every day, maybe it's full in two, two and a half weeks it's full.
P: But I think from the other side it is digested.
M: Composting, how many days he will...? (With Petros also speaking in the background about the same thing)
P:...using?
D: That's why we added more worms. More worms mean they can eat the food faster.
M: Yes, worms are benef…(Greek)
C: At the beginning it takes longer for it to start, but like after a few weeks it will get to the point where it can do that in like a week. [talking about building up the vermicomposter to a point where it can take her food waste load]
D: So, if, maybe in a few months from now maybe if you throw in one kilogram of food and you have one kilogram of worms it'll be gone next day. So, once it gets to that level, it'll be really fast.
M: Yes. For example in the beginning you put a little rubbish and a little, and a few worms and after you put a lot of worms because the amount is bigger.
P: There is always a balance between quantity of food and worms?
D: Yeah, it'll balance itself out. If you stop feeding it, a lot of worms will die then, but if you feed a lot, there will be a lot more worms because they will be able to survive.
P: another question from my side, if it was summer we used to eat the melons. No watermelons, watermelons have a big slices of the outside part that we throw away, so if we put three four of these slices we cut watermelon, it will be full. Is it proposed to do this or to avoid? I mean is it watermelon something that helps the project?
C: No, watermelons can be added. One solution to that too is you can cut it up more and its smaller and fits.
G: Smaller and it fits and that way it will compost quicker if it's a smaller piece.
M: [Greek]
D: Next, we have questions about the bin. Is there anything you like about it? I know you already mentioned it's too small.
P: About what? The bin?
D: The bin.
M: The bin.
D: What are some things you like about it and some things you like to be changed?
M: If I will buy this and if in this cottage, I would prefer to have a wooden bin. As you see in the previous meeting.
D: Anything you dislike about the one over there? [referring to the bin]
M: No, it's good. It's good.
D: You just think it would be nicer to have a bigger one?
M: Yes, four-person family, I think it's more because I cook every day. These days my children out of the house, so I have no problem, but if I cook every day, it will be complete.
D: Were you the only one who put food into the system or did your son or did you [referring to husband]?
P: She's the only one.
D: She's the only one?
M: Yes.
D: Ok. Did you move the bin from when we first put it there? Did you ever move it?
M: No, I didn't. I leave in the same place.

D: Do you think you would move it or do you think you would just leave it there?
M: Maybe he will, another questions is maybe a problem with the wind. The problem to throw the wind. Maybe the wind threw the basket, bin, down maybe. Maybe I will change the place from the wind
D: Ok. What was the hardest part about using that bin? Was it knowing what to put in there? Or having a lot of questions and not knowing the answer?
M&P: [Greek]
M: No, I have no problem. No.
D: So, I know when we first started, the first interview you mentioned some concerns being it might get smelly, there might be a lot of bugs, or some mouse getting into it. Did you see any of those problems?
M: No. Only insects. Small insects.
D: Is that a problem for you? Is that something that you really dont like?
M: This time not, there isn't a lot of insects, after maybe in the summer maybe
P: We have high temperatures in the summer. And it creates the smells. This and we collect more insects. And maybe mice. MIce yes.
D: And lastly, we want to ask, would you want to continue with the bin and vermicomposting.
P: Greek to Maria explaining.
M: No problem.
D: So you would keep doing it.
M: Yes. It will be an experience for the summer. It will be a good experience. We want to see what would be the summer.
P: The full evaluation for the project will be done (when).
D: We will be gone by next week. So Professor Vasilikiotis will be checking up with you. And I know you wanted a wooden one, so I think that he will be in talks with the workshop to build you a wooden one. One that you would like. And I think if you have any questions he will answer them for you.
C: You could always reach out to us too.
P: What is the final target? Create a compost solid for the plants?
D: Yep
P: This is the target of ecological compost? And how kilograms of compost solid do you expect to have from this basket? And what time to make more practical evaluation?
M: It depends on the food that we put in.
D: Yeah it depends on the food that you put in.
M: Maybe the watermelon is difficult from
D: Because every time the worms have a new generation, new worms are born, they are different from the old ones, they could be better, or could be slower. And if you feed the worms a certain thing they could get used to it, so if you feed them stuff that they can eat quickly, you will get stuff very quickly. But if you give them stuff that breaks down very slow, it might be slow. But I don't know about the ratio about the compost. But you will get enough. You don't need to put too much on the plants to make them really good.
P: You don't have any experience from other times? This is the first time that you create this experiment, so whatever will come out will be will also for you be something new?
Gina (G): Yeah something for us to learn.
P: You make the questions.
D: Yeah when we go home we will make one too.
D: That is all for our interviews, do you have any further questions?
M: No, I want to say that you are a good group. Good students. Congratulations. Bravo.

APPENDIX P

Mrs. Maria Tsaparikou's Journaling Notes

	19/4	20/4	21/4	22/4	23/4	24/4	25/4	26/4	27/4	28/4	29/4
Fed the System	X	X		X	X	X	X	X	X		
Used Vermicast											
Looked inside the system	X	X	X	X	X	X	X	X	X	X	X
Smelled offensive odor											
Noticed Worm Eggs											
Noticed Worms Outside System											
Added Water						X					
Noticed insects inside system						X	X	X	X	X	X

	Vegetable	Fruit	Other
----	2 cucumber peels, 3 bell pepper cores, 2 tomato cores	1 banana peel, ½ apple	2 eggshells, 3 Tbsp coffee (w/ filter)
20/4	Beetroot, pepper cores	1 apple peel	1 eggshell
21/4	Pumpkin cabbage, spinach	1 apple peel	
22/4	1 potatoes, eggplant	1 apple peel	1 eggshell
23/4	1 potatoes, pumpkins	1 apple peel	
24/4	1 Cabbage, tomatoes, 1 Cucumber Peel	1 apple peel	1 eggshell
25/4	Tomatoes, pumpkin	1 apple peel	
26/4	Cucumber Peels	1 apple peel	1 eggshell
27/4	Red Pepper Cores	1 apple peel	
28/4	Tomatoes, spinach, cabage	1 apple peel	

APPENDIX Q

Sylvia's Interview

Interview Notes: Cafeteria Manager: Sylvia Ioannidou
Saturday, April 29, 2017

Did not consent for recording

1. Please describe your role and responsibilities.
A: In charge of food cafeteria at AFS. Responsible for taking reservations, set up, making menus, send them to the kitchen, make orders, then have the events. Responsible for food here; must taste everything for quality and quantity. Depends on how many students they have, have to be accurate so they don't waste food or miss food. Been working 25 years in this area [kitchen industry], she manages it. Cannot manage 100% [accuracy] because it is a buffet. 80-90% Sylvia and her team manage it. She has a great team with cooks and cleaning staff. Have to be good, clean, and professional. Besides food and meals during the day, they have breakfast, lunch, snack, and dinner for high school. Kindergarten gets breakfast and lunch. Elementary gets lunch. About 400 people getting meals a day. Hard because not everyone likes everything, so it is a lot of people to please, it's a great responsibility. Cooking is very personal to everyone. She gets reports from the students, and her reports are good. Majority of the people are satisfied. Their system is good.

2. Does your company currently have a sustainability program?
A: Blue cans are for recycling: paper, plastic, and glass. Green cans: regular trash. Different vans come and pick up the garbage and recycling. They try not to have food waste, so they are very strict with their orders. Try to cook just as much as they have to cook, especially since expenses are high. They do not cook huge quantities just to throw away. Make orders by grams. They try for extreme accuracy and rarely waste food that was cooked, people can eat it before they go home. They understand which meals students prefer, to have accurate orders. Example, order more souvlaki because kids take 2 portions where they only take 1 portion of lentil soup. Reuse leftovers like sauce (which makes larger quantities than needed). Have meatballs one day, and with extra sauce they add some fresh veggies and pasta for the next meal. Lunch is the same food for Kindergarten to high school. They have gotten good at calculating how much students eat. Example, kindergarten and elementary school kids count as one person when calculating portions. There is not much food waste here, they try and keep that down. The team is professional and no what they are doing.

3. How do you dispose of your food waste?
A: Put extra food waste in the regular trash can (banana peels, orange rind, etc.). Would participate in food waste sustainability (already participating).

4. Do you know how much food waste would be produced in a day?
A: Doesn't know exactly how much, but they don't use bad leaves, or peels, etc. Seemed to cook with lots of fresh vegetables.

5. How flexible is the kitchen towards changing their process?
A: Everything new is difficult. Anything extra has some complaints. When they prep it is easy to put in the trash can right next to them. It is an extra movement for them to go outside to put it in our bin. However, if she says they are going to do it, they'll do it after some time.

6. Would reducing your food waste reduce costs (associated with waste removal)?
A: The school pays for the waste removal.

7. Do you have any desire to participate in this program?
A: I think I am participating.

8. Would it provide the company with any benefits?
A: My company, no. The scraps would go to benefit the American Farm School, not us. American Farm School and F-Zone are different. We are partners. We do not use their gardens. She's still willing to participate.

9. Would this be good advertisement for environmental efforts?
A: Yes, would like to advertise program [[for environmental program on food waste reduction]. They [PAP Corp] have lots of hotels, Green Key [certified], I don't know if you know. We clean the seas and the beaches. All the trash goes to a biological center that makes it into water, and use it to plant the trees in their hotels. [Maybe Waste Water Treatment Plant?] They are very environmental. In hotels can only have electricity when the card is in the room. Someone leaves and takes the key and cannot have electricity. It is good for conserving energy.

10. Explain kitchen process:
A: One man sells them vegetables, has a contract. Get the orders 3 times a week. Give him the final order every Sunday. Monday he starts bringing things. Monday, Tuesday, and Friday. That way they get fresh fruits and vegetables and won't waste any by getting bad in the fridge by the end of the week or squashed in transport by too many (tomato to sauce example). The chef is responsible for cooking, and takes whatever he needs to make the meal. He knows how many potatoes and veggies he needs. Separate spot for veggies and meat. It has to be separate, separate knives, cutting boards. Everything is color coordinated. Green is for veggies, yellow is for kitchen [chicken]. Even separate sinks for the meat. Eggs have a separate fridge; they are not with the vegetables.
Doua: are chicken bones and veggies scraps in the same trash?
Sylvia: They are separate. There are 3 different trash cans, one for chicken, one for veggies, one for the other. They are by foot, so you don't have to touch the trash. [everyone's wearing gloves]
Doua: Is there a person who takes the trash out?
Sylvia: Yes, the women who are not cooking, who clean dishes in the kitchen. They take it on the carts out to the back.

Sylvia: She wants it to be outside. She wants it to be an extra step in the routine. She doesn't want it to be easy for them. If they do something easy, they will not understand they are doing something special. She wants them to learn, be more educated in some way. Practice is more important than theory.

11. What kind of training do your employees go through?
A: They have to go through education every year for the health and security [safety] training. They get a certificate. Even if he cooks, cleans, or takes the trash out they all have to go through education. Me and the chef go through extra education to keep training the staff all year, to make sure everyone is doing things correctly (right knives). Checked a lot by authorities. School is much higher standards [for kitchens], because we are feeding the kids [very strict]. If the food is not good, we will have problems with authorities. Because I am responsible, and I don't like to be in jail. I want to do my work correctly. Everyday I have to check my employees. That is why I am more educated. I understand when things are not going the right way. That's why I choose chefs that are well educated. Working in Paris, in Europe, so they bring their experiences. Nothing is stable. Every year something else is added. So you have to learn it and make sure the employees know it. For example, the vegetables have to be in water and vinegar many hours, so they are very clean. Then we wash them again, and then we cut them. It needs to happen every day. If it doesn't happen, then I will find out. So the employees are training every year, and get a certificate. So when the authority comes, they check everything. When they are showed the papers, they understand that they have been trained.

12. Would you allow a waste audit in your kitchen?
A: Yes, would like to have a waste audit. Thinks it would be good advertisement after we explained it to her.

13. What would encourage employees to participate in this program?
A: Unemployment! But they have to do it if they are told. We are very happy to help with your project, and with the American Farm School we like the projects. We are partners with the American Farm School. Environmental issues are with our company so in ourselves, so she is very happy to help it. If they understand how much they throw away, they can see it as money being thrown away. They can train themselves. They can be more aware and careful with what they are throwing away, since they are taking it out of one bin into another and seeing it. Maybe they can use it for something else. The vegetables are expensive, maybe they can understand they have to be more strict, and careful with their work.

14. Would you like to see this project continue with AFS students?
A: Yes, I would like this project to continue. I would like to help you.

APPENDIX R

Municipality Interview Notes

Pilea-Hortiatis 3/27/2017

To start the meeting we explained our project to them and Christos explained Vermicomposting to them in Greek.

Composting Program
They have a small scale program and it didn't work well and they aren't sure why. Composting is not under any department in the municipality so no one is directly responsible for it. We are talking to the Parks and Recreation Department of the city. Other departments that could help us are landscape and recycling, and cleaning and garbage department.

Municipality Proposal and How They Think it Could Work
Tessa will send an order for the worms too. Focus on advantages in proposal: our simplicity, harvesting capabilities, can use recycled materials, etc. No particle wood, must be real wood for vermicomposters. Are there pallets available? They think it is possible. Questions arose on whether old or new pallets should be given out for quality purposes.

Write about our research, our plan, and some questions. Start something new, start with children. Children force new things in Greece. She went into a story of her younger brother not adapting to recycling, but she gave recycling bags to her nephews and they had a competition of who could fill it fast enough. Then she said if you want a blue bin for recycling you must call the municipality to get it, otherwise you don't call and you don't get it.

Thinks there will be a lot of desire for it because it saves money and the benefits are there. Tessa is 'warm' to the idea and they think the mayor and others will be open since it's a process that happens by itself.

The questions will help make them excited and we can collect a lot of data.
The end result would be to help subsidize the bins for people and have training for people that want to participate in the program. The municipality believes that they can find a lot of materials that they can use that would be cheap, 100 euro is not good. We will give options of materials and dimensions for how to build them.

Pick a day to present our final project with the results and our proposal with the mayor. Last week April probably.

They have old voting booths that could be used for vermicomposters. Woman we were talking to had 6 at her house. Modify them to use them. Municipality has stuff that could be converted to vermicomposters. Find solutions in the garbage. Reuse, many people in Greece make money from that, even picking through recycling bins.

More of what the Municipality is thinking about for Future Projects
They would also like designs for something for the municipalities wastes. We could take grass clippings and stuff for public vermicomposters in the park. These would be constructed in wood. The town can buy wood to make bigger boxes. Suggested making between 2 and 4 bigger boxes for outside use that are simple for the people in the municipality to build. Every week grass is cut for about 20 acres of lawns. It is kind of a big problem that they need to cut the grass but then it is just left there. Also, less frequent cutting of 100 acres of lawns of about 5 to 7 times a year. They have 7 soccer fields with natural grass and they just leave it on its own to decompose. The product of the compost is not as good. How to improve the conditions of the fields because it is poor quality soil and they don't have the knowledge base to deal with the soil condition now.

Another problem that they have is tree trimming and don't have a wood chipper. But it would make a big difference. Huge volume but not as much weight and costs a lot to move to the landfill. Need a license for the bigger tree wood chipper and also a place that could be quieter. They have a lot of people that put out there tree and yard pieces. This is very expensive currently.

The also said that it would be a good idea to talk to schools to promote vermicomposting. School for adults would be a great place to talk to. Second Chance School would be a good place to start for doing our questionnaire. We can send in English for now and then we can translate it later. We will look at the website and see what they have currently.

Compilation of Notes from Meeting
First we explained our project.
In the city, we have a very small scale compost bins. Not a large scale currently. Didn't work well until now. Composting is not under one municipality department, so nobody is really responsible. It can be for both the one we talked to, landscape and recycling, and cleaning and garbage department.
Environment and parks people. The cleaning and recycling part does vermicomposting. No one is responsible for it.

Christos explained the vermicomposter to the people in Greek
A good start would be to look into the compost systems that they gave to them. Find out from the people who didn't like it and now see why and if they are able to address the problems. Arrange a meeting with the professor that started the last program.
List of people that can do it. The system is for the kitchen scraps is what we need to push. Can combine with garden if they have one.

One idea is to access the people that have already done it.
Then promote it on their website with information on vermicomposter.
Work on a push forth the questionnaire.
Then see how to proceed from there

Or work with schools and talk to the children or kids to get responses. Present on vermicomposters.

Make a workshop to show people how it works
Tessa will help link out the questionnaire for everyone.
A paper to sign from both the AFS and the municipality. Will have to get the ok from the mayor. Get permission from Tessa and then from the mayor. Proposal and step by step for the mayor to see.

We are this from this and will provide this by doing this and stuff. No longer than a page.

He will be happy that they aren't working with a corporation.

The questions will help make them excited and we can continue asking questions.
The end result would be to help subsidize the bins for people and have training for people doing stuff. They believe that people can find a lot of materials that they can use that would be cheap, 100 euro is not good. Should give options of materials and dimensions for how to build it.

Choose three schools and have them come and present. Can get a lot of worm species in grapes/composting materials. Company sells them. Get a center one and then give them out to people. Multiply very fast. NO imported worms, bad idea. Bad but ours are European. Sometimes when it rains they come into houses and they aren't social. Our worms won't escape boxes, aren't social.

Learn Greek. For tomorrow Tessa will let us know the the people that we could talk to. Find out statistics wise how many people we should talk to. This is a very diverse town and we could get a lot of people to do stuff. Huge municipality.

Make now what we are what we want. How many people. Look up models for how many people should be in our survey.

A professor from the Aristotle University of Thessaloniki pushed organic waste reduction.

We didn't record it because it will be a transcript when they answer the questions.

School for adults would be a great place to talk to. Second Chance School would be a good place to start for doing our questionnaire. We can send in English for now and then we can translate it later. We will look at the website and see what they have currently.

Add a question about volume and how much yard waste and food waste do they have. Do they get the scraps every week or day, time frame question? Very seasonal too.

Instead of meeting with Tessa, prepare a presentation and overview of our proposal, send it to Tessa to modify and then she will present it or maybe a meeting with us. Prepare the thing for the municipality. This is what we have so far for a questionnaire and then they can modify it and we will work on it.

APPENDIX S

Municipality Questionnaire

1. What is the current situation with waste within this municipality?

Regarding Municipal Solid Waste (MSW), it is estimated that in Municipality of Pilea-Hortiatis almost 30.732 tones are produced. Almost 93% out of these tones are driven to a specific sanitary landfill, after prior treatment (selection) where through an engineered method –spreading the waste in thin layers, compacting it to the smallest practical volume and covering it with compacted soil– waste management is taking place in a manner that protects the environment. Another 6.6% of MSW is “exploited” though recycling with the use of special storage containers (bleu waste collection containers) that helped to promote the recycling effort while 0.4% of MSW regards portable electrical devices that are disposed to specific waste separation and recovery centers.
In 2014, the median per capita generation of MSW was 0.44 tones/person/year while the composition of MSW in 2014 is very similar to other developed countries: 40% were organic waste (mostly kitchen ones); 27% paper; 13% plastics; 3% glass; 3% leaves and grass; and 14% other.
It worth to mention that in Municipality of Pilea-Hortiatis, compared to 2011, a substantial decrease in MSW is occurred (5.4%), with a parallel decrease of both solid waste disposed in green containers and residues disposed in blue ones (for recycling) by fault. At the same, an equivalent increase (5.9%) of recycled solid waste is showed, indicating an optimistic perspective regarding solid waste management.

a. Is there currently a problem that needs to be addressed?

According to both European and the Greek legislation, municipal waste must be recovered in order to save raw materials and energy. The applied practice until today at municipal level, as described above, includes transportation of solid waste collected through green containers to a specific sanitary landfill and transportation of solid waste through blue containers (recycling) to a Material Recovery Facility (MRF).
However, the National Waste Management Plan, approved by the Hellenic Ministry of Environment & Energy and Hellenic Ministry of Interior on July 2015, in correlation with Council Directive 2008/98/EC, determines the strategy, political objectives and measures for waste management at national level that must be accomplished until 2020.
Specifically, this Plan has set 3 specific goals at municipality level (generally, not only at Municipality of Pilea-Hortiatis):
* Preparation for reuse and recycling, through separate collection of recyclable – organic waste up to 50% of MSW.
* At least separate collection of glass, paper, metal and plastic, to ensure a minimum of recycling 65% of MSW total weight of by the stage of pre-sorting until 2020.
* Separate collection of organic waste (minimum target of 40% of MSW total weight).
For Municipality of Pilea-Hortiatis, these national goals illustrate the need for the development of an integrated waste management plan, which will incorporate the national and European institutional developments regarding MSW management, as well as the specialization of national and Central Macedonia regional planning objectives at municipal level.

b. Current consequences of waste?

Even though Municipality of Pliea-Hortiatis does not face serious problems or consequences regarding solid waste management, this topic represents today one of the most urgent environmental problem for several countries worldwide, especially on account of the widespread pollution of soil and aquatic systems. Moreover, municipal waste can be the cause of wild fires in forested areas, a source of spreading infectious pathogens to underground waters and pollutants of agricultural soil and farm products by heavy metals and hazardous chemicals.

MSW reflects excessive consumerism and technological culture of the human societies and effective and environmentally acceptable waste management strategies depend on local waste characteristics, which vary with cultural and socioeconomic variables.

2. What does the town currently do with waste and how much does it cost to remove the waste?

The applied practice until today at municipal level, as described above, includes transportation of solid waste collected through green containers to a specific sanitary landfill and transportation of solid waste through blue containers (recycling) to a Material Recovery Facility (MRF).

However, in Municipality of Pliea-Hortiatis a series of 7 activities regarding separate collection of MSW is already implemented today in cooperation with alternative management systems and individuals or social organizations. More specifically:

1. Recycling of packaging materials. Municipality of Pliea-Hortiatis has concluded a cooperation agreement with the Greek Development Company-Recycling SA for Municipality's packaging waste management (paper, plastic, glass, metal).
2. Separate glass collection. Municipality of Pliea-Hortiatis in cooperation with the Greek Development Company-Recycling SA has developed a program for glass collection by placing 50 special containers, mostly nearby restaurants and catering places.
3. Recycling of electric - electronic equipment. The collection of electrical and electronic equipment waste (lamps, lighting, devices) is taking place in cooperation with the company Recycling Devices SA. Moreover, Municipality services collect electrical and electronic devices in correspondence to citizens' claims.
4. Recycling of waste batteries. A program is implemented by the Municipality regarding collection of waste batteries within specific points of Municipality as well as in cooperation with enterprises that have expressed their interest with the support of the non-profit organization AFIS SA.
5. Collection of worn tires. The collection of worn tires used by Municipality's vehicles s taking place in selected areas in cooperation with the company ECO-ELASTICA SA.
6. Collection of Waste lubricating oils. A project regarding the collection of waste lubricating oils though the cooperation of Municipality's Directorate of Environment and Recycling with A.L.E. company.
7. Collection of waste batteries and accumulators. Municipality of Pliea-Hortiatis is participating in a program regarding recycling of waste batteries and accumulators in cooperation with the Company Alternative Management System for Batteries (SYDESYS SA).

Regarding the MSW management cost, it amounts to almost 4,4 million euros, including cost of collection, cost of transportation (to sanitary landfill and to material recovery facility) and distribution cost to Regional Organization of MSW management. Total cost of MSW management per ton amounts to 135.21 euros while total cost of MSW management per citizen amounts to 62.79 euros.

a. What data do you collect on waste?

The data that Municipality's Directorate of Environment and Recycling collects, are:

* volume of solid waste disposed in green containers transferred to sanitary landfill (per day);
* volume of residues disposed in blue containers (for recycling) by fault and transferred to sanitary landfill (per day);
* volume of solid waste disposed in blue containers (for recycling) and transferred to material recovery facility (per day);
* volume of electrical and electronic equipment waste (for recycling) and transferred to material recovery facility (per day);
* average number of garbage vehicles' routes and kilometers (per day) for both green and blue containers;
* expenditure per transportation.

3. How does the municipality currently educate the citizens about waste sustainability?

Municipality of Pilea-Hortiatis places environment on the basis of each Municipality's policy. As municipality, it has been recognized as one of the first sustainable energy communities in Greece, constantly undertaking environmental initiatives in collaboration with schools and voluntary organizations and agencies involved in recycling programs and urban environmental improvement actions. For example, at 2010, Municipality's staff in collaboration the Department of Agricultural Economy of Aristotle University of Thessaloniki successfully implemented a pilot composting program. Residents who expressed interest in participating in the program attended informative workshops held at the Town Hall and then received a compost bin with useful and practical instructions regarding management process of household waste.

These awareness-raising efforts have continued since then, particularly in cooperation with the schools located in the municipality. In addition, according to Municipality's Waste Management Plan for 2016-2020, prepared during December 2015, more school activities on environmental and recycling issues (environmental competitions with awards/prizes, presentations and environmental education courses, etc) in cooperation with teachers are foreseen, as well as local events organization, sending reminder letters with information on the actions undertaken, planned events, replacement of equipment, etc, awareness-raising campaign through social media (Facebook, Twitter, etc) or even the development of mobile info-kiosks, for the continuous updating of citizens and record of problems and users' complaints.

4. Is there currently a recycling program within your municipality that could incorporate vermicomposting as an option to further reduce organic waste?

Regarding composting program, after the pilot one mentioned above, Municipality of Pilea-Hortiatis extended its efforts to all regional units. Citizens who are interested in obtaining a free compost bin and participate in the home composting program can contact Municipality's corresponding department and state their full contact details. Then, they get in contact with employees who inform them about program's details; the exact date and place of the informative workshops; and the availability of special bins. The citizens of the Municipality will have to sign a declaration of acceptance upon receipt of the compost bin, which must maintain in good condition. The necessary conditions for participation in the program include the existence of a free land space in the garden or fore garden and residence within the administrative boundaries of the Municipality of Pilea-Hortiatis.

Moreover, according to Municipality's Waste Management Plan for 2016-2020, the immediate free distribution of 1,000 home composting bins to citizens is foreseen, which corresponds to 4% of municipal households (total 24,014 households). Additionally, in future further actions are included, such as:

* free distribution of additional household composting bins and possibly neighborhood ones;
* development of monitor plan regarding the operation of home composting bins through random inspections by the Municipality;
* implementation of households' guidance system, for those that already have or are going to "adapt" a home composting bin; and
* development of a new bill category related to municipal cleaning fee, including discount on municipal taxes for residents who have and operate composting bins.

According to the above, a vermicomposting program could be incorporated as an option in the existed Municipality's recycling program.

5. What benefits would vermicomposting offer to the municipality?

a. Money, reputation, tourism

Within Municipality's Waste Management Plan for 2016-2020, a citizens' survey took place through Municipality's website, in order to achieve broad involvement of local communities regarding waste management. Regarding composting, 56.3% of respondents believe that composting means "I produce my own good quality fertilizer". 62.5% of respondents would like very much to compost at home, while overwhelmingly 94.1% would like very much to participate in a contributory plan of the municipality and would like to stand out and throw the waste composted in bins (brown).

All participants (100%) believe that everyone should separate waste and 93.9% believe that a relevant program would contribute to solve the problems related to waste in municipality level as well as they believe that Municipality should invest in management waste because such investment will bring economic benefits and jobs, while upgrading the quality of the environment.

6. What are some concerns you would have about initiating a vermicompost program?
There are no concerns.
a. Why do you have these concerns? -

7. Based on your experience in this field, do you think it's possible to have a program like this at the municipality level?
Yes, it is possible to have a program like this at municipality level.
a. If not, do you know of any grassroots organizations that could help in this endeavor? -
b. How do you envision the program going?
It would be rather helpful to start this program by informing local community for the benefits of a vermicompost program, even through demonstration on how a vermicomposter is working. According to local community needs, maybe the operation of call center which could support residents (e.g. answers to common questions; solutions to indicative operational problems) would be helpful. Having in mind that a vermicomposter per property would be more convenient at the beginning of such a program, the Municipality's Directorate of Environment and Recycling would
be responsible for collecting container's content, especially compost that citizens are not willing to use and "exploit" it for public settlements as playgrounds and schoolyards.
c. Are you more interested in: everyone has a vermicomposter, a program to drop off waste, or having a company do everything?
A combination of single vermicomposter per property and a drop off waste point per neighborhood would be a more convenient alternative, at least during the beginning of a similar program.

8. What would be the necessary steps in order to start a vermicomposting program?
a. From the ground up?
As it was described above, a vermicomposting program should start from the ground up, however citizens who already participate in the pilot composting program that Municipality implements, should work closely with your team and maybe even stand as 'ambassadors" of this effort.
b. Best method?
A combination of single vermicomposter per property and a drop off waste point per neighborhood would be a more convenient alternative, at least during the beginning of a similar program.
c. Would it be beneficial to conduct a waste audit?
At least at the beginning of such a program, it would be necessary to conduct a waste audit, since according to data collected by Municipality's Directorate of Environment and Recycling, even though there is a decrease, still solid waste improper for recycling can be found in blue containers (for recycling) by fault.

APPENDIX T

Municipality Vermicomposting Interest Survey

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Dear Sir or Madam,

We are a group of students from Worcester Polytechnic Institute (WPI) in Massachusetts conducting research at Perrotis College, at the American Farm School (AFS). Our project involves gauging people's perception of vermicomposting as a food waste reduction method as well as determining designs that potential users would want.

We would like to invite you to take our survey to help us understand your perspectives about possible vermicomposting initiatives in Pilea-Hortiatis. The survey consists of 28 questions and will take about 15-20 minutes to complete.

Your participation in this survey is completely voluntary and you may leave answers blank throughout. Please remember that your answers will remain confidential. No names or identifying information will appear in any of the project reports or publications unless consent is given.

This is a cooperative project between Perrotis College, WPI, and Pilea-Hortiatis, and your participation is greatly appreciated. If you have more questions about our project, you can email us at Compost@wpi.edu.

1. What is your age?
    a. Less than 18
    b. 18-29
    c. 30-42
    d. 43-53
    e. 54-65
    f. 65+

2. What is your gender?
    a. Male
    b. Female

3. What is your highest level of education?
    a. Elementary School
    b. Middle School
    c. High School
    d. Bachelors
    e. Masters
    f. Doctorate

4. What type of home do you live in?
    a. Dormitory
    b. House
    c. Apartment Complex
    d. Maisonette
    e. Other: _____

5. Do you have a garden?
    a. Yes
    b. No

6. If yes, where is your garden located?
    a. Balcony
    b. Windowsill
    c. Yard
    d. Other: _____

7. How do you currently fertilize your garden?
    a. Compost blend
    b. Artificial fertilizer
    c. Do not use fertilizer
    d. Does not apply
    e. Other _____

8. How important is it for you to fertilize your garden?
    a. Not important at all
    b. Somewhat important
    c. Important
    d. Very Important
    e. No Opinion

9. How much time do you spend maintaining your garden/plants?
    a. Less than 1 hour per week
    b. 1-2 hours per week
    c. 3-4 hours per week
    d. 5-6 hours per week
    e. More than 6 hours per week
    f. Does not apply

10. How many days per week do you prepare meals at home?
    a. 0-1 days
    b. 2-3 days
    c. 4-5 days
    d. 6-7 days

11. How many people are in your household?
    a. 1-2
    b. 3-4
    c. 5-6
    d. 7+

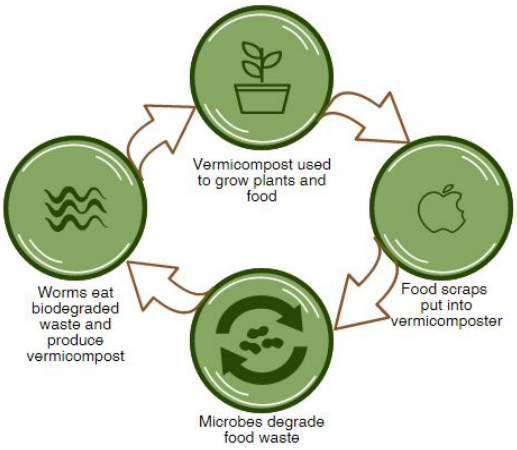
12. How do you dispose of your food waste (e.g. raw vegetables, fruits, eggshells)?
    a. Trash Can
    b. Composting
    c. Vermicomposting
    d. Other: _____

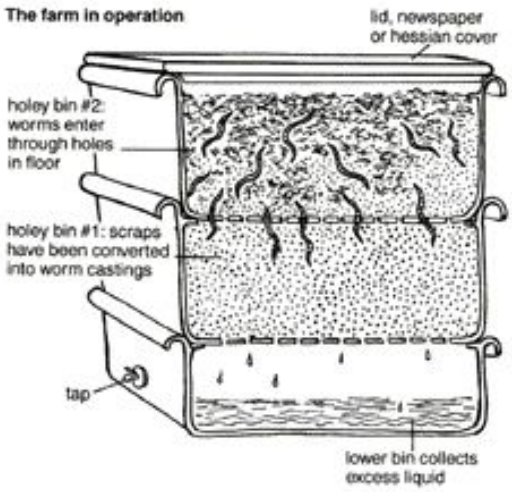
13. How do you practice environmental sustainability (check all that apply)?
    a. Recycle plastic, paper, or metal
    b. Use low flow water faucets
    c. Use LED lights in place of incandescent
    d. Recycle organic waste
    e. I do not practice it
    f. I do not know what it is
    g. Other _____

14. What would motivate you to practice food waste reduction (check all that apply)?
    a. Save money
    b. Help the environment
    c. Create high quality soil amendment
    d. Learn more about composting
    e. Like to experiment
    f. Nothing
    g. I don't know what it is
    h. Other_____

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't Know
15. Pilea-Hortiatis has successful recycling initiatives.						
16. Recycling is important.						
17. Recycling is a common practice in Greece.						
18. Recycling does/would take a lot of time out of my day.						
19. I am willing to participate in a new food waste reduction program.						

Our proposed project aims to reduce organic household waste that is added to the waste stream. To accomplish this, we are designing a vermicomposting system where worms break down the food scraps that would be put in. The leftover product is a great fertilizer and soil amendment that can be used on plants. The below schematic shows how the process works:





We provided a picture for each design so you can rate them based on aesthetic appeal of each bin. We ask that you rate each picture using the scale below and at the end answer overall questions on the possible designs.

Please use this scale to rate how likely you are to use each system based on its aesthetic appeal.

Very Unlikely	Unlikely	Unsure	Likely	Very Likely
1	2	3	4	5

Please comment on why you chose that rating and what characteristics influenced your decision?

Design **Dimensions (L x W x H)**	**Rating and Comments**
 2 m x 1 m x 1.5 m	Rate: 1 2 3 4 5 Comments:
 0.74m tall, 0.5m diameter	Rate: 1 2 3 4 5 Comments:
 1.5 m x 0.5 m x 0.5 m	Rate: 1 2 3 4 5 Comments:

1.1 m tall, 0.6 m diameter

Rate: 1 2 3 4 5

Comments:

 0.45 m x 0.45 m x 1.0 m	Rate: 1 2 3 4 5 Comments:
 0.4 m x 0.2 m x 0.2 m	Rate: 1 2 3 4 5 Comments:
 0.5 m x 0.5 m x 1.5 m	Rate: 1 2 3 4 5 Comments:

22. What design do you find most attractive and why?

23. Where would you place the vermicomposter?

24. What concerns would you have about using one?

25. After learning about vermicomposting and seeing some designs, how interested would you be to start vermicomposting?

a. Very uninterested
b. Uninterested
c. Neutral
d. Interested
e. Very interested

26. What factors are the most important to you in an ideal vermicompost bin? Rank them 1-6, with 1 as most important.

__Aesthetics
__Cost
__Maintenance
__Simplicity
__Size
__Other _____

27. What would you be willing to pay for one of these systems?

a. €0 - €25
b. €25 - €50
c. €50 - €100
d. €100+
e. Don't want it

28. What educational materials would you use to learn more about vermicomposting? (check all that apply)

a. Website
b. Pamphlet
c. Training class
d. Newsletter
e. Manual
f. Online forum
g. Other _____

Additional comments:

APPENDIX U

Vermicomposting Pamphlet

This page was intentionally left blank, see the next page for Appendix U.

MANAGE YOUR FOOD WASTE EFFECTIVELY

A cooperative project between Worcester Polytechnic Institute and Perrotis College at the American Farm School

VERMI COMPOSTING

"So there is potential for something like that even for families... I think this is a positive aspect."

Dean Rotsios

What is vermicomposting?

Vermicomposting is the process of using worms to turn food waste into nutrient-rich fertilizer. It requires very little maintenance, and can be tailored to any budget.

How do I start vermicomposting?

1. Buy or build a vermicomposting bin
2. Add a layer of cardboard, and wet newspaper called "bedding."
3. Add worms
4. Add a small amount of food scraps
5. Add more bedding

Why should I vermicompost?

- Do your part to reduce organic waste going to landfills
- Produce your own high-quality fertilizer with little extra work
- Customize the system to your own preferences
- Use excess worms as bait supply for fishing

How do I maintain my vermicomposter?

1. Worms typically eat their weight in food per day. (Ex: 1 kg of food for every 1 kg of worms)
2. Inside of bin should remain damp. Add water when necessary.
3. Keep a layer of bedding on top of the layer of food.