Monmouth College Proposal for a Composting System

A study conducted by the University of Arizona Garbage Project found that each day an American throws away 1.3 pounds of food, which results in about 475 pounds per year per person.[1] The amount of food wasted is a serious issue, not only in our own country, but many others. With the amount of food waste produced in the United States alone another country could be fed comfortably. Food waste not only includes post-consumer food, which is the leftover food from a person's meal, but also wastes from the production of food in factories, cafeterias, and kitchens. A surprising discovery, reported by the *New York Times Online*, indicated that 96.4 billion pounds of the 356 billion pounds of edible food was not eaten. That is, about 250 billion pounds of food was wasted before consumers even had the chance to get their hands on it. Also reported by the *New York Times Online*, "all but about 2 percent of that food waste ends up in landfills."[2] The country not only has a problem with wasting food, but because of this problem, landfills are being filled up with materials that can be otherwise utilized.

The current practices for the production of food are not sustainable, meaning they do not promote the health or well being of the land on which crops are being produced. The ever increasing demand for more food has pushed farmers and agriculturalists into an agricultural revolution in which many farming practices are becoming increasingly industrialized. With this movement towards industrialization, farms are seeing an increase in the application of chemical pesticides and herbicides, but most importantly, an increase in the amount of commercial fertilizer applied.

Commercial fertilizer has become increasingly popular over the past decades in industrial agriculture. The reason for this is because crops, and all life in general, is reliant upon nitrogen, yet the usable nitrogen on earth is limited. In order to overcome this limitation, efforts were made to fix nitrogen, converting it to a usable product. Since then, agriculture has seen a drastic increase in the amount of synthetic fertilizers used which has also lead to increasing environmental risks. The fertilizers used to help promote growth in agriculture also pollute the water when runoff occurs. This incident has already shown a detrimental effect in the dead zone of the Gulf of Mexico. The dead zone is a result of nitrogen and phosphorus contained in synthetic fertilizers blocking the absorption of oxygen in the Gulf of Mexico, making aquatic life impossible.[3] Though these fertilizers boost agricultural yields, they severely affect other life forms.

An alternative to the use of synthetic fertilizers is the use of organic compost and manure to provide the soil with the nutrients it needs to promote crop growth. Compost consists of any organic matter, from yard trimmings to food waste, and avoids adding to already ovesized landfills. The use of compost has a multitude of applications, such as suppressing plant diseases and pests, reducing the need for chemical/synthetic fertilizers, promoting a higher yield of agricultural crops, and remediating soils.[4] Reducing the need for chemical fertilizers will in turn reduce the amount of nutrient runoff and environmental pollution. This is a major building block to more sustainable agriculture practices.

The senior integrated studies class at Monmouth College is interested in designing and implementing a composting system to use on campus in order to teach a more integrated, healthy, and ethical means of agriculture. It comes as no surprise that a large portion of the food purchased and prepared is wasted. In this way, the food will not be sent to landfills where they will no longer serve a significant purpose, but instead will be converted into usable nutrients for our educational garden. These nutrients will provide the garden with natural growth stimulants, thus resulting in a better crop. Pre- and post-consumer food waste will be collected from the cafeteria at specified times and composted in bins built by the students. Compost will be decomposed not only by microorganisms already present, but also red worms to aid in a fast turnover rate. This compost will be managed by the students working in the garden and applied as needed. The application of compost will be implemented by students where they will be able to learn and see for themselves how important natural nutrients are to production.

The Science of Organic Composting

There are five primary valuables that must be regulated when composting that will be further investigated in following sections. The five variables include the following:[5]

1. Feedstock and nutrient balance
2. Particle size
3. Moisture content
4. Oxygen flow
5. Temperature

Feedstock and Nutrient Balance

It is important to have the right balance of green organic materials and brown organic materials in composting, as the green materials provide nitrogen and the brown materials provide carbon to the compost pile. These two elements are critical to the nutrition of microbes present in the compost, so having the right balance between the two will result in a more controlled and effective compost.[6] The two types of materials also help the control the moisture content of the compost pile, which will be discussed in a later section.

Particle Size

Materials used in compost piles can come in all shapes and sizes, and the size of particles can greatly affect the rate in which wastes are converted to compost. The smaller the particle size, the more surface area microbes have to feed. Smaller particles will also distribute materials more evenly throughout the pile, thus resulting in a more consistent pile. It is important though, that particles are not too small as they will prevent the flow of air through the material. This in turn will result in an anaerobic living environment for the microbes, decreasing their activity. An ideal particle size is between two and three inches but may be variable.

Moisture Content

A compost pile should have the moisture level of a wrung out sponge, which allows for a thin film of water to coat all, if not most, particles in the compost. This water content also aids in the transportation of microorganisms in the pile. If the compost pile has less water than this, the amount of time it takes the microorganisms to break down the organic material is much greater, more water in the compost pile will result in a much slower decomposition rate, as the compost is weighed down and does not allow for adequate air flow. Inadequate air flow results in an anaerobic growing environment for the microorganisms, and as a result of this sodden compost pile, odor problems can arise. Also, if using a vermicompost system, worms will drown in an excess of water. During rainy seasons, it may be necessary to cover the compost pile with a tarp or lid if using bins, but during dry seasons it would be best to water the compost occasionally.

Oxygen Flow

Proper oxygen and air flow through the compost pile will create a more aerobic environment for microorganism to live in, thus resulting in a faster decomposition rate of organic materials. Aerating or turning the pile can help to ensure proper air flow is being provided to the pile. It is also suggested incorporating wood chips, newspaper, or straw (mulch, which will be discussed later) into the compost pile as they are bulky, dry materials. Care must be taken when adding these materials because they may allow for too much air flow, that may result in a dry compost. If the compost gets too dry water should be added. Having the right balance between air flow and water are critical to the rate in which organic material is broken down by microorganisms.

Temperature

Microorganisms require a certain temperature range, typically 140-160°F, for optimal activity. At these temperatures, the rate of decomposition is very high and pathogens and weed seeds are typically destroyed. If this temperature increase is not seen, the previous four variables should be controlled and an increase will occur. Though this is the optimal temperature range for microorganisms to thrive, it is not entirely necessary for a fast rate of composting. If all variables are optimized, compost piles can thrive at temperatures well below the typical range.

It is also important to remember that if the temperature of the compost falls well below the optimal temperature range for microorganisms, the decomposition may significantly decrease or stop completely. This is not usually a problem in the winter, as the compost will begin again when the temperature begin to rise, but other actions can be taken to continue composting throughout winter months. Composting bins can be constructed or moved indoors if feasible, where the temperature is likely to stay constant, allowing the compost temperature to rise. Also, vermicomposting can be utilized, where red worms can actively participate in the decomposition of organic materials at temperatures optimal between 55°F and 77°F.[7] This temperature is easier to maintain in winter months and will be utilized in our composting system.

Microorganisms

Microorganisms use organic material to produce heat, carbon dioxide, water, and humus and are particularly important in nutrient cycling. Since plants are not able to convert organic nitrogen to inorganic forms such as nitrates (NO_3^-) and ammonium (NH_4^+), the microorganisms convert these molecules through a process called mineralization. Plants are then able to take up the nutrients released by the microorganisms. Soils that have been exposed to agricultural pesticides, such as methyl bromide, may have reduced populations of microorganisms. Through composting, natural nutrients are provided to the soil, synthetic fertilizer use decreases, and microorganisms are reintroduced into the soil. There are three main types of microorganisms found in compost, including actinomycetes, fungi, and bacteria.

Actinomycetes

Actinomycetes are tolerant of lower moisture conditions than other bacteria and are responsible for the release of geosmin, a chemical associated with the typical musty, earthy smell of compost.

Fungi

Fungal hyphae, larger than actinomycetes, decompose chemically and mechanically and provide aeration and drainage for the compost. Fungi also aid in breaking down dead plant matter.

Bacteria

Bacteria contributes to the stabilization of aggregates through the excretion of organic compounds that bind adjacent organic matter and soil particles together.

Worms in composting[8]

Microorganisms soften the food for the worms to digest, and small parts of food, as well as grinding material such as topsoil, limestone, or topsoil, enter through the gizzard into the intestine. The ground food is mixed with enzymes to break down the food, and what is not absorbed is released through worm casting (defecation). The general anatomy of the worm is seen in Figure 1 which helps to visualize the process of worm defecation and turning food scraps into compost. Worms may die if water is low since their bodies are made up of 75%-90% water, but too much water can drown them, so water levels are very important to consider in a vermicomposting system. Too much salt, high temperatures, and acidic foods may also cause death.

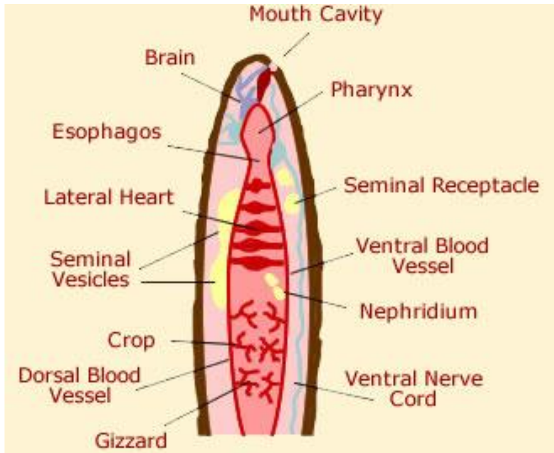

Figure 1: Once food scraps are softened by microorganisms, the scraps are taken in through the mouth cavity and travel through the crop and gizzards to be released through defecation.

Worms are vital to composting because they turn food scraps into the organic material known as humus and add nutrients to the soil. When using worms, it is most appropriate to stick with fruits, vegetables, and paper products. If meat is used during composting, the break down will take a longer period of time and may attract pests that will take away from the compost's function. The most beneficial worms to use for composting are red worms, scientifically known as *Eisenia foetida* and *Lumbricus rubellus.* Worms that should be avoided include the common ground worm, *Lumbricus terrestri,* since they primarily dig deeper into a soil environment and can't optimize break down in a shallow composting bin. Red worms function best between 55 and 77°F and in a neutral pH of seven, but are known to survive in environments with a pH of 4.2 to 8.0. Using lime and calcium carbonate may provide a stable pH for the worms while composting, but hydrating lime should never be used because it will kill the worms, which, in turn, will decrease the compost's productivity.

Once the compost bin is ready to be harvested it is important to remove the worms before applying the compost to the garden, as they can damage crops when they run out of food to eat. In order to remove the worms, two methods can be used. The contents of the compost can be dumped on a table or plastic tarp. The worms will avoid light and travel to the bottom part of the compost, and after a few minutes the top layer may be removed. This process can continue until a majority of the worms end up in a small pile on the tarp and the remaining worms can be added to the next compost bin or used to start a new bin. Another method to prepare for harvesting is to refrain from adding new food to the bin for a week or two. This creates a cycle that will allow the worms to harvest the next batch of scraps more effectively, as they were being deprived of food and nutrients. Then the finished compost can be pushed into the next bin, removing any large pieces of food or newspaper that has not been decomposed. Fresh bedding and food scraps should be added into the now empty bin, and worms will migrate toward the new food you have provided them with. This cycle can be repeated, as the worms will naturally move to the bin with fresh food.

Dealing with population control is also an issue when composting with worms. If populations are large, eliminating the source of food will slow the rate of reproduction. In the situation where more worms are needed, adding more food will increase worm population. A ratio of 2:1 pounds of worms to pounds of compost should be used to produce compost efficiently.

What to Compost

The following lists were taken from the United States Environmental Protection Agency Website[4], suggesting what should and should not be included in compost piles.

What to Compost - The IN List

- Animal manure
- Cardboard rolls
- Clean paper
- Coffee grounds and filters
- Cotton rags
- Dryer and vacuum cleaner lint
- Eggshells
- Fireplace ashes
- Fruits and vegetables
- Grass clippings
- Hair and fur
- Hay and straw
- Houseplants
- Leaves
- Nut shells
- Sawdust
- Shredded newspaper
- Tea bags
- Wood chips
- Wool rags
- Yard trimmings

What Not to Compost - The OUT List
Leave Out/Reason Why

- Black walnut tree leaves or twigs
  - Releases substances that might be harmful to plants
- Coal or charcoal ash
  - Might contain substances harmful to plants
- Dairy products (e.g., butter, egg yolks, milk, sour cream, yogurt)
  - Create odor problems and attract pests such as rodents and flies
- Diseased or insect-ridden plants
  - Diseases or insects might survive and be transferred back to other plants
- Fats, grease, lard, or oils
  - Create odor problems and attract pests such as rodents and flies
- Meat or fish bones and scraps
  - Create odor problems and attract pests such as rodents and flies
- Pet wastes (e.g., dog or cat feces, soiled cat litter)
  - Might contain parasites, bacteria, germs, pathogens, and viruses harmful to humans
- Yard trimmings treated with chemical pesticides
  - Might kill beneficial composting organisms

Animal manure has been used throughout history to fertilize gardens and farms, as it contains many natural nutrients and aids in the cycling of nutrients through plants. Though the EPA states animal manure is permissible in compost piles, we do not suggest this addition in our compost pile. As stated before, the temperature of the pile must reach very high temperatures in order to destroy pathogens that may be present in the manure. In using a vermicomposting system, the compost pile does not need to, and likely will not, reach those temperatures. To avoid the possibility of disease and infection transmission, animal manure will be left out in the beginning. The use of manure can be implemented after initial composting procedures have been explored and properly utilized, and should be worked into composting in the next two to three years. We have the possibility of obtaining animal manure from local animal owners, such as Joe and Karen Angotti's horse stable or nearby animal farms.

It is important to make sure items on the out list of composting are not incorporated into our compost pile to avoid possible problems such as odor, pests, and diseases. Also, as described in the microorganisms section, microorganisms and worms do not like greasy materials, as the oils coat their digestive systems and significantly decrease the productivity and decomposition rate.

There are many ways to add waste to a compost pile, and we have considered two for our purposes. The first is a layering method in which wet and dry materials are layered in alternate sections, as shown in Figure 2.[9] This will help to keep the moisture level of the compost even and consistent without the need to use additional water. Layers should be no more than 3-4 inches thick so that microorganisms and worms have easy access to both types of food. Also, the compost layers should always end with a brown layer on top to filter odors before they leave the compost.

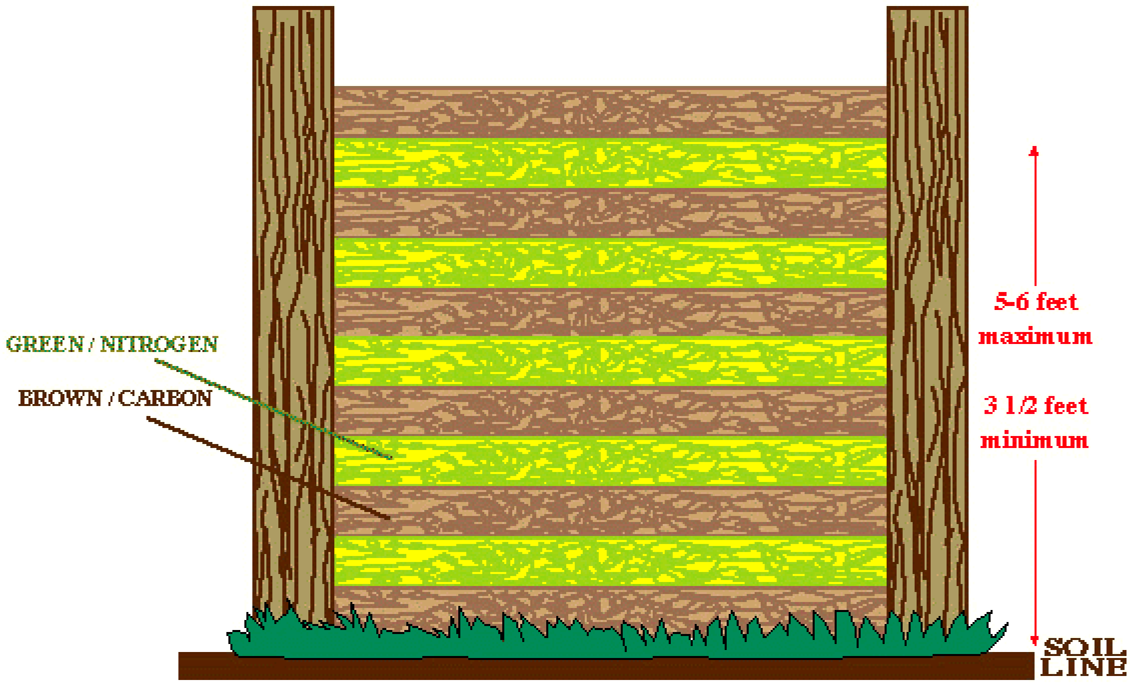

Figure 2: Cross sectional view of layers in a compost bin, alternating brown and green materials.

Though this a great way to add waste to a compost pile, it is not feasible in our situation where all food scraps will be added to the same collection containers before being transported to the site of composting. We will use the mix-it method, where all organic waste to be added will be mixed prior to addition to the compost pile. This has many advantages in our situation, first and foremost being that different types of waste do not need to be further separated. It is also advantageous because it prevents the green layer, which is comprised primarily of wet material, from forming compacted layers that restrict the flow of water and oxygen through the pile. This will in turn decrease the probability of excessive odors. New materials should be added when the compost pile is turned, so this will occur three times a week to coincide with our collection days.

The compost must be turned at least once a month (if not being turned when new material is being added) to allow the proper amount of oxygen flow into the bedding and worm survival.

The addition of oxygen will increase the amount of time the food items will turn into compost, however turning the compost too often will hinder the microorganisms' functioning. Watering the compost should be regular, not too dry and not too wet. By creating a properly water balanced compost, the compost will not produce foul odors.

When is Compost Ready to Use?[10]

It is possible to predict the amount of time it will take for organic material to be turned into usable compost (we have illustrated this in the bin construction section), but there are many factors that may affect this. The size of the particles when they are added to the bins will have a great affect, along with moisture and oxygen levels. Compost that will be used as mulch (discussed below) can be applied after the least amount of time while compost being applied to plants growing in containers takes the longest. Signs that will helps us determine when our compost is ready to use include: the pile has shrunk to about half of its original size, the individual materials are no longer easily distinguishable, the pile no longer generates a large amount of heat, and the material has a dark, earthy appearance and odor.

Mulch allows gardens to grow richer, more nutritious products with a very minimal amount of damage to the crop. Compost and mulch can also be used for erosion control, soil moisture retention, and nutrient content.[10] Using mulch in our garden, along with compost, will provide the garden with a significant amount of protection and natural nutrients that the soil alone would not be able to provide. Mulch comes in many different forms, such as ground-up yard trimmings (grass and small plants) or wood chips from tree trimmings. Mulch can be applied directly to the ground and is not, by any means, tilled in. Using mulch with compost can also aid in the suppression of weeds, and our hope is to avoid the use of chemical pesticides, so mulch will help protect the crops from weed infestation. It will also help retain moisture, thus resulting in less outside input.

Application of Compost to Our Garden

Compost will be applied to the garden as it is needed, primarily at the beginning of the growing season just after seeds have been planted and again about half-way through the growing season. If multiple crops are to be grown throughout the growing season in the same beds, compost and mulch can be added after the planting of new seeds/plants. Compost one inch thick will be applied to all raised beds, resulting in about 960 gallons of compost that will be needed for each bed (5x30ft). Though this seems like a very large amount of compost, we are confident it can be generated in a sufficient amount of time. We found in our own experience (described below) that 420 gallons of food waste can be collected in each 3 hour meal period (lunch and dinner). This number may vary slightly from day to day, but this will be more than enough waste for our needs.

Our Experience in Collecting Food Waste

Bruce Cvancara, director of food services at Monmouth College, graciously allowed five students to try their hand at collecting food waste in the cafeteria. The ambitions of the group were to experience how difficult or easy it would be to separate the food waste and how much waste could be collected in one dining period. The students were split into two groups: one group was to collect pre-consumer food waste and one group was to collect post-consumer food waste.

Pre-Consumer Food Waste

Two students worked on the meal preparation line where they were able to collect food scraps that would be unused in preparing meals for the students. It was found that 40 gallons of pre-consumer waste could be collected for use in composting in one hour. Much of this waste consisted of vegetable and fruit scraps from salad bar preparation, especially lettuce. This accounts for much of the wet material needed in the compost pile. This waste was relatively easy to collect because usable scraps were simply thrown into a separate bin/bucket. Food scraps that were not usable in the compost pile were thrown into the garbage. It was concluded that collecting pre-consumer food waste is not difficult and could easily be implemented.

Post-Consumer Waste

The collection of post-consumer food waste, the waste from students, was done by three students in the dishroom of the cafeteria. This proved to be a more difficult task, as many usable food scraps were often contaminated by unusable food items such as cheese, meat, or condiments. The most abundant product in post-consumer collection was napkins, and these are available to use as the dry material in the compost to allow for adequate air flow and the prevention of odor. These students collected 30 gallons of post-consumer waste in one hour. A major hindrance to the collection of post-consumer waste is the rate in which food comes into the dishroom. We found that it may be difficult to separate food quick enough to keep up with the influx of dishes.

In speaking with Bruce Cvancara, he ensured us that it would not be a problem to find people that will aid in the separation of food, as workers will be able to do so while performing their regularly assigned jobs. It may create more work, but, according to Bruce, it should not be more difficult. It is not a matter of who is going to separate food in this case, but rather educating those already in food service positions to do so. It will take extra training time and effort, but he assures us this will not be a problem and can easily be incorporated in the everyday routine. Food waste will be collected three times a week and taken to the composting site where it will be added to the bins and applied as needed.

Choosing a composting method

There are many different composting methods to consider when composting organic materials. One way many people find efficient and easy is to place the organic waste into a bin or drum with drilled holes to achieve air circulation. However, this technique is best for small systems, such as household composting. We decided on a technique that takes full advantage of the amount of waste and space we have available. We chose a three-chambered bin, and with this method we will be able to compost and maintain a considerable amount of waste.

How the Bin Operates[11]

The bin has three chambers, and the basis behind a three-chambered compost is to emulate an assembly line, as shown in Figure 3 below. The waste starts off in the first container, where it will stay for three to six weeks. While in this bin, the waste is allowed to heat up and decomposition begins. After this 3-6 week period, the waste from the first bin is moved to the second bin where it will stay anywhere from four to eight weeks. At this time, the first bin can be filled again with new waste products to be turned into compost. Though the compost is nearly complete by the end of the eight weeks in the second bin, an additional couple of weeks is needed to cure the compost, or allow the complete decomposition of all materials. The compost will be moved to the third bin for this process, and by the end of the complete sixteen week period, the third composting bin contains ready to use compost that can be applied to gardens, farms, and plants. The time frame for the turnover of waste to compost can vary depending on the type and amounts of waste that are added to the bins. A three chambered bin allows for the continuous transformation of organic waste into usable compost.

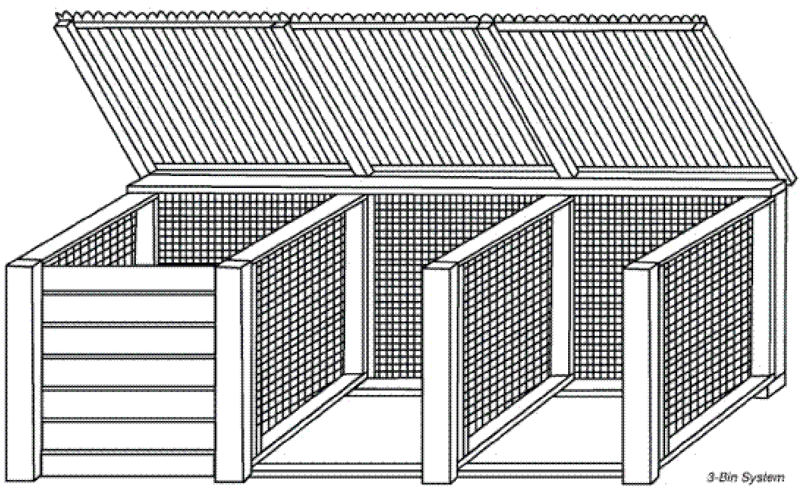

Figure 3: Three chambered bin system in which fresh organic waste is added to the first bin, compost in the intermediate stages of decomposition is held in the middle, and ready to use compost is in the third.

Construction of the bins

Each bin will be four cubic feet in order to maintain the oxygen flow through the system while having a large enough space to create the amount of compost that will be needed to cover the garden. The bins will be constructed of wood and chicken wire, and this is where the greatest costs of the project will arise. In order to minimize costs and maximize output, we recommend a sturdy wood that will not rot or decay in the changing weather. With this in mind, the best wood to construct the bins out of is redwood or cedar, both of which can be expensive to purchase but will last longer than other woods. It is also important to construct the bins out of wood that has not been pressure or chemically treated, as this can contaminate the compost. The bins (as shown in Figure 3) will only have one side that is completely covered in wood, along with the bottom, while the other three sides of the bins will be primarily constructed from chicken wire. The chicken wire will allow adequate air flow through the compost bins in comparison to bins made completely out of wood with drilled holes throughout. This constant air flow will keep the pile at its optimal temperature, reduce odors, and ensure harmful bacteria do not inhabit the compost.

The front of the bins, made of wood, will have the ability to slide up and down off the structure to allow for easier removal of compost being applied to the garden. The top of the bins will be made from chicken wire to allow rainfall into the pile as a natural source of water. It will have hinges so the lid can easily be lifted out of the way. This is to make easier the addition of new organic material to the first bin, turning of all of the bins, and the transfer of compost from one bin to another. The bottom of the bins will be made entirely out of wood for two reasons; so compost does not fall through the bottom, especially in the final stages of decomposition when compost has a soil like consistency and so the worms do not fall through the bins onto the ground where they will be able to get into the garden much easier.

Compost Odor

Though there are many benefits and advantages of composting for our own garden and the entire Monmouth community, some neighbors many voice their opinion against compost due to the possible odors that may come from it. However, smell will not be an issue for two reasons. First, we do not intend on having a large amount of compost in the beginning. We will only be using three bins and will only be collecting organic waste three times a week. Compost odors primarily come from large compost facilities, not smaller scale operations like the Monmouth College garden will have.[12] Second, odor can easily be controlled by practicing proper composting techniques. Compost compaction, low temperature, too little oxygen, too much moisture, and improper carbon to nitrogen ratio are causes of compost odor, and all of these can be easily eliminated by practicing good techniques, described below.

Too much moisture in compost (in excess of 60%), is a major cause of foul odors. *Agriculture Resources Compost Handbook* states, “When materials become saturated, air is squeezed out, and the contents become packed. If there is no space for oxygen, the pile becomes anaerobic and will produce odors”.[13] One way to prevent moisture build up is to have proper ventilation, as we will have in using chicken wire for the sides of the bins.

Another cause of odor is compost compaction, which is caused by stomping and pushing down the raw materials. When this happens, the porosity of the mixture is reduced, which decreases air circulation and enables anaerobic processes to flourish.[13] There are simple ways to reduce compaction and the odor it causes by never stomping on the pile, turning the pile often, adding bulking materials such as mulch, and scattering the new material around the entire surface as opposed to one spot. Compost compaction can also be caused by low temperature, but as long as the temperature stays constant in the winter months, compaction should not occur and neither should odors. As stated before, this can be achieved by moving the compost bin indoors in the winter.

Another cause of compost odor is too little oxygen caused either by compaction of materials or overwatering. Composting is an aerobic process occurring in the presence of oxygen. Again, *Agriculture Resources Compost Handbook* states, “If the oxygen content decreases, anaerobic conditions will develop. Then anaerobic decomposition occurs which is sometimes called fermentation”. [13] Fermentation produces hydrogen sulfide which gives off a rotten egg smell, but it is easy to prevent by allowing the compost to get sufficient oxygen.

Another factor in compost odor is improper carbon to nitrogen ratio. The ideal carbon to nitrogen ratio is 30:1. “Microorganisms that live in the compost need carbon sources for energy and nitrogen sources for population growth. The ideal carbon to nitrogen ratio for compost is 30:1. If there is too little nitrogen the decomposing process slows. If there is too much nitrogen, ammonia gas will develop producing odors”. [13]

Insects

Fruit flies can be a nuisance around compost bins, but as with odor problems, insects should not be an issue if proper composting techniques are practiced. Fruit flies are common insects that are found flying around compost bins and garbage cans. Fruit flies are not harmful or dangerous, and when they are seen flying around compost it “indicates that the ratio of food scraps to high carbon material is too high”. [14] To solve this problem, add brown leaves, shredded paper, or cardboard. Also, it is best have food scraps high in carbon buried or covered. This will help reduce the number of fruit flies around compost bins.

Another insect that can be found around compost piles are fungus gnats. Fungus gnats are attracted to moisture and fungus. If fungus gnats become a problem, the best solution is to eliminate areas with obvious fungus growth and reduce the moisture content of the compost by adding dry materials.

Community and Education Outreach

We foresee the compost section of the Monmouth College garden serving the community in the next couple of years. One way to expand composting to the community is to have workshops available to members of the community. These workshops would provide information about what and how to compost and help residents set up their own compost piles or bins at home. Having a compost bin or pile at home would help the community save money on waste collection fees and enrich their own gardens and plants. Backyard composting also reduces:

1. Waste that goes into landfill
2. The amount of space need for landfills
3. Air and water pollution
4. The needs for fertilizers and pesticides

Another involvement opportunity for the community is to donate the extra compost material to the Monmouth City Garden. Families of the local community could also bring in excess organic waste from their own homes in exchange for soil or vegetables from the garden. Finally, the college could bag and sell the excess soil. These ideas could be explored and further expanded upon as the garden grows and would be more likely to occur as the garden is expanded into a mini farm. Additional opportunities for community and educational outreach will be discussed in the next proposal section.

Budget Breakdown

The following is a list the represents the estimated costs to construct and maintain the composting bins.

- Worms-**$50**
    - The average cost is $50 for 500 worms. We are anticipating the reproduction of the worms to happen quite quickly due to their nature, so we are only expecting to need this amount.
- Pitchfork/shovel to turn the compost-**$40**
- Wheelbarrow to transport the compost from the bins to the garden-**$50**
- Construction materials for the bins-**$300**
    - This includes wood, chicken wire, bolts, nails, and screws.
- Labor-**$0**
    - The labor for turning the compost and applying it to the garden is incorporated into the labor associated with the garden itself and is therefore covered in the garden proposal.
- Total Cost-**$450**

Timeline

The following table shows a proposed timeline for all activities involving the use of compost.

Composting Timeline					
	1-3 Months	3-6 Months	6-9 Months	9-12 Months	12+ Months
Construction of Bins	x				
Food Service Training	x				
Collection of Food Waste		x			
Application of Compost		x			
Expansion of Compost					x
Composters' Education	x				
Community Involvement				x	
School Age Education			X		

Table 1: Timeline for composting procedures as proposed by all aspects of an educational and experimental garden.

The construction of the bins can begin immediately, as there is not much planning or training involved in this aspect. The training of those working in food service could also begin immediately, as they will need to be educated on what can go into the compost and how their jobs may be affected. The food service is important to the success of the compost, and all should know of the great impact they will be having not only on the school but the whole community. We expect the initial stages of food collection will occur around month 3, after the bins have been properly constructed and training has taken place. The application of compost can also occur in the 3-6 month time period, as it can be applied before initial planting takes place to enrich the soil. Educational opportunities for those interested in composting can also take place immediately and will be beneficial for all involved. Community involvement in our compost will likely need to wait until we have established a strong system and are comfortable with our practices. This then will lead into the expansion of our compost. As the garden grows, we will need to expand our compost to satisfy the needs of a larger plot of land. This leaves room for opportunities to build more composting bins or experiment with new composting techniques. School age education will be described in the next section but should not be implemented until, again, we have established a strong system.

Conclusion

We have explored the possibility of establishing a composting system in which food waste from the Monmouth College food service would be collected and stored in bins near the garden. The decomposition process, aided by red worms, is expected to take about 3-4 months, though this could vary depending on a number of circumstances. Upon completion of decomposition, the new compost can be applied to the garden and/or plants on campus to enrich the soil and provide plants and crops with natural, recycled nutrients. It is our hope that the campus community, along with the community around us, will be open to this opportunity and appreciate the benefits of using natural products over synthetically made chemical products. It is also our hope to educate those around us of a more healthy and ethical way of food production.

[1] Miller, Chaz. "Food Waste." *Waste Age Magazine | For professionals in the waste management, recycling, landfill, garbage professions*. 1 Oct. 2005. Web. 30 Nov. 2009. <http://wasteage.com/mag/waste_food_waste_3/index.html>.

[2] Martin, Andrew. "The New York Times Log In." *The New York Times - Breaking News, World News & Multimedia*. 18 May 2008. Web. 10 Nov. 2009. <http://www.nytimes.com/2008/05/18/weekinreview/18martin.html?pagewanted=1&_r=1>.

[3] "What Causes the Dead Zone." *Science Museum of Minnesota - Minnesota's Favorite Museum*. Web. 30 Nov. 2009. <http://www.smm.org/deadzone/causes/top.html>.

[4] "Basic Information | Composting | US EPA." *U.S. Environmental Protection Agency*. 7 Oct. 2008. Web. 14 Nov. 2009. <http://www.epa.gov/waste/conserve/rrr/composting/basic.htm>.

[5] "Science/Technology | Composting | US EPA." *U.S. Environmental Protection Agency*. 7 Oct. 2008. Web. 14 Nov. 2009. <http://www.epa.gov/waste/conserve/rrr/composting/science.htm>.

[6] "Composting Demonstration Sites." *VegWeb.com - Vegan Recipes and Cooking Tips*. 2009. Web. 10 Nov. 2009. <http://vegweb.com/composting/how-to.shtml>.

[7] "Vermicomposting." *New York Worms-Your Live Feeder Superstore*. 2007. Web. 20 Nov. 2009. <http://www.nyworms.com/vermicomposting.htm>.

[8] *Red Worm Composting*. 2009. Web. 1 Dec. 2009. <http://www.redwormcomposting.com/>.

[9] "Online Composting Center - Build a Pile." *Florida's Online Composting Center*. Web. 14 Nov. 2009. <http://www.compostinfo.com/tutorial/BuildPile.htm>.

[10] "Vineyards Benefit From Compost and Mulch." *California Integrated Waste Management Board*. Apr. 2002. Web. 1 Dec. 2009. <http://www.ciwmb.ca.gov/publications/organics/44399005.pdf>.

[11] "Procedure for Managing the Three-Bin Composting System." University of California Cooperative Extension. Web. 14 Nov. 2009. <http://ceplacer.ucdavis.edu/files/350.PDF>.

[12] According to compost-bin.org "compost odors in small scale compost piles, heaps, or bin are easy to eliminate with weekly maintenance, but for large scale facilities as more advanced method is required."

[13] "Causes of Compost Odors and Their Elimination." *Agriculture & Natural Resources Compost Handbook*. The Alabama Cooperative Extension Service: Auburn University. Web. 1 December 2009. <http://www.p2pays.org/ref/06/05446.pdf>.

[14] "How to Control Fruit Flies & Fungus Gnats | Waste & Recycling | MassDEP." *Mass.Gov*. Massachusetts Department of Environmental Protection. Web. 1 Dec. 2009. <http://www.mass.gov/dep/recycle/reduce/flies.htm>.