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Project

Integration of Solid Waste Management Tools into Specific Settings of European and Asian Communities

Activity 4

Planning of a management scheme for sanitary waste in the campus of Miriam College, Philippines

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1. Introduction

Used sanitary feminine napkins are usually considered as residual waste, that is, waste that is not compostable or recyclable and, therefore, goes to dumpsites and landfills. However, used feminine napkins can be composted because its main components are wood pulp and non-woven cotton, which are compostable materials.

As an all-girls school, Miriam College, is faced with an everyday generation of used feminine napkins from mainly its Middle School, High School and College units. Based on a survey of students and staffs, an average number of days of one's menstrual period is 5 days, an average of 3-4 napkins are used per day, and an average of 2 napkins are disposed of per day within Miriam College. With a student population of about 3,800 females in the High School and College levels, it is estimated that an average of 38,000 napkins are disposed of in the campus every month.

Miriam College's participation in this project is the formulation of a management scheme for feminine napkin wastes in the campus. A main component is to conduct an experiment on selected methods for composting the napkins. Activators and different compost vehicles will be used to determine the most effective means of composting feminine napkins. The study will form the basis for other schools and other communities to make their own management plans for used feminine napkins and similar materials.

2. Addressing Wastes from Used Feminine Napkins

In 2001, the Ecological Solid Waste Management Act of 2000 or R.A. 9003 was passed into law. This has provided the basis for a more systematic implementation of solid waste management in the Philippines. As mentioned in the Act's Handbook dated July 2003, "the first priority of the ecological solid waste management (SWM) system shall be volume reduction at the source. All LGUs (Local Government Units) are required to actively promote among its constituencies the reduction and minimization of wastes generated at source." This paradigm is a shift from the old paradigm of garbage disposal in which raw materials are processed, used, and thrown in dumpsites. The new paradigm emphasizes processing activities: a) segregation, re-use, recycling, and composting; b) other SWM activities such as collection and transport; c) establishment of materials recovery facility (MRF); and d) disposal. Composting is a processing activity to reduce the amount of waste in dumpsites or landfills. According to a JICA study (2001), 42% of Metro Manila's wastes are kitchen wastes. Reducing the amount of compostable wastes that go to our dumpsites and returning it to our soils are the major reasons for composting.

An accepted definition of composting is that it is a controlled aerobic process carried out by successive microbial populations combining both mesophilic and thermophilic activities, leading to the production of carbon dioxide, water, minerals, and stabilized organic matter (Pereira-Nera, 1987). In the Philippines, composting experiments have mainly dealt with agricultural waste and its by-products. Several groups and individuals are trying to promote organic farming through composting. The government, for example, is promoting Rapid Composting Technology using compost fungus activator (CFA) Trichoderma harzianum (Tricho). It is said to be effective in decomposing lignocelluloses like straw, corn stalks, sugarcane bagasse, grasses and weeds. CFA Tricho is supposed to increase the population of microbial cellulose decomposers, provided there is adequate moisture content, enough nitrogenous materials, and good aeration. The increase in microbial population raises the temperature in the compost heat, which, in turn, hastens the decomposition process. According to Dr. Virginia Cuevas, the main proponent for CFA using Trichoderma, the composting period is shortened to just four weeks (Cuevas, 1997).

Feminine napkins and diapers are considered residual wastes in some literature. This is primarily because there is no system available to compost such materials. In the Philippines, there has been an effort by a Barangay Captain to compost baby diapers. The captain, Mr. Bert Guevarra, is a compost practitioner and has experimented on many materials. He has successfully promoted segregation and composting in his barangay. In an interview, his experiment with diapers showed that the plastic component could only be removed during the shredding process and after the composting process. The Zero Waste Recycling Movement also promotes the composting of napkins and diapers although they have not conducted studies on it. Building on their experiences, this experiment will focus on used feminine sanitary napkins.

This study will also build upon the observations of Ms. Ma. Teresa Oliva of the Environmental Studies Institute, Miriam College, who conducted a similar experiment in 2002. She observed that decomposition took place in all the experimental plots using regular soil, *Trichoderma harzianum*, and Happy Soil™. The latter is a powder formulation consisting of Lactobacillus microorganisms, cocopeat and bentonite clay powder. It has two strains of Lactobacillus and four strains of Bacillus originally feeding on Sacharomyces yeast. It has been in use in South Korea for more than ten years and is now being locally produced in the Philippines.

Another activator available in the Philippines is EM or Effective Microorganism, which consists of mixed cultures of beneficial and naturally occurring microorganisms that can be applied as inoculants to increase the microbial diversity of soils and plants. EM contains selected species of microorganisms including predominant populations of lactic acid bacteria and yeasts and smaller numbers of photosynthetic bacteria, actinomycetes and other types of organisms. It was developed by Professor Teruo Higa, University of the Ryukyus, Okinawa, Japan. In the Philippines, toxicity tests were conducted on chicken and tomato plants and showed no adverse effects of EM on both. Rice can also be used as a compost activator. Fransisco Rizal Lopez developed a method of using cooked rice which is mixed with raw brown sugar and aged and in the process a fine white microorganism is grown. This is can easily be made at the household level of which the raw materials are affordable and available.

Windrows, static aerated pile, pits, and in-vessel composting are methods practiced depending on the scale and nature of the organic materials. In windrows composting, organic materials are placed in long rows called windrows and these windrows are occasionally turned for aeration of microorganisms. This is usually applied to large-scale composting and is not commonly used in the Philippines. More common to the Philippine setting, especially in agricultural areas, is the static aerated pile method. In this method, layers of compost materials are made and pipes used to supply oxygen into the pile. Hallow bamboo poles are also used instead of pipes.

The compost pit is another method where a hole depth of 2 – 3 feet is usually made. With the compost pit, a lesser amount of organic materials are exposed to air, and the walls and bottom of the pit provide insulation against heat and moisture loss.

In-vessel composting refers to a group of methods, which confine the composting materials within a building, container, or vessel (FAO, 2003). Examples of in-vessel systems are containers such as bins, pots, sacks, and rotating drums. These systems provide better control of aeration, temperature and the moisture in the organic materials being composted, resulting to faster decomposition. Pots are used for places with limited spaces. The rotating drum is an in-vessel method that uses a horizontal drum to mix and aerate the organic materials. Its other main function is to rapidly start the composting process. This comes from the process of rotation which provides oxygen to the microorganisms and which expose more elements of the organic materials. Some users of rotating drums, especially for large-scale composting, use the drum primarily for mixing to immediately start the composting process, after which it is transferred to sacks or aerated static piles.

3. Determining the Rate of Feminine Napkin Generation in the Campus

An initial survey was conducted to estimate the number of feminine napkin wastes generated in the campus. A random sample of about 240 students is selected to answer the following questions:

a. What is the average number of days of your period?
b. How many napkins do you use a day on average?
c. How many sanitary napkins do you dispose of within Miriam College on average?

Figure 1 shows the response to the first question. The data indicate that the average number of menstrual days is 5 days. Figure 2 shows the response to the second question. The data indicate that the average number of napkins used per day is about 3.8. Finally, figure 3 presents the response to the third question. The data indicate that the average number of napkins disposed of in the campus is 2. If each female student disposes, on average, 2 napkins per day in the campus, during an average menstrual period of 5 days, then 3,800 students would be expected to generate about 38, 000 napkins in the campus per month. This is indeed a very substantial amount and requires an effective waste management program if the school can achieve to reduce the amount of solid wastes that it finally discharges to the landfills.

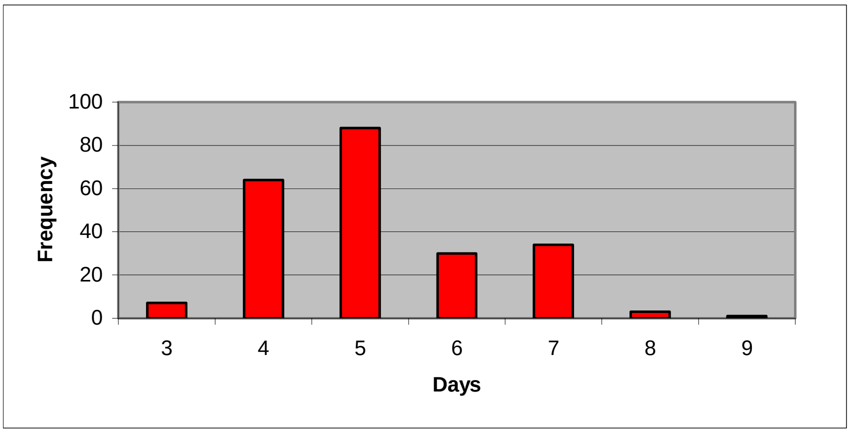


Figure 1. Average number of menstrual days.

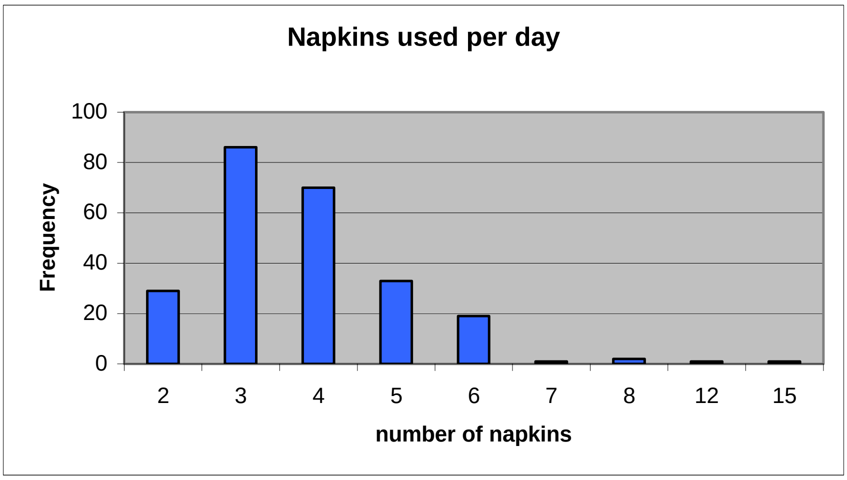


Figure 2. Average number of napkins used per day.

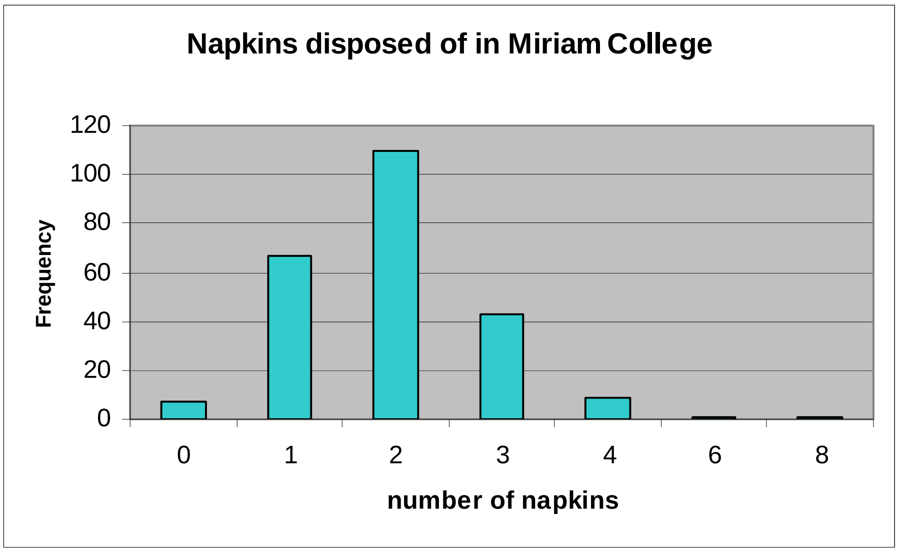


Figure 3. Average number of napkins disposed of in the campus.

Collection of used sanitary napkins indicates that the rate of generation is actually much lower. There are only about 2,000 napkins collected per month, which is much less than the estimate. In our estimate, we assumed that the students come to the campus five days a week. However, inspection of the schedule of classes of students shows otherwise. Some students even stay for half a day and leave the campus soon after their classes. This means that during their monthly period, the students are not present in the campus everyday and, therefore, do not generate the expected amount of used napkins per day.

4. Information Campaign

To encourage the participation of students in the proper segregation of their used sanitary napkins, an information campaign was conducted among all the units of the school—from the Child Study Center, with its adult teachers and staff, to the College Unit. Presentations to students and faculty and staff of all the Units included the following: the ISTEAC project, plans for the experiment, and the importance of segregation and composting. The details of project are presented during meetings, such as the President's Council meeting, Dean's Assembly, faculty meetings, and staff meetings. Posters about segregation and composting are placed in each ladies room, while signages are pasted on the walls of each cubicle in the ladies room. Articles were also written for the school's monthly newsletter. This is an electronic newsletter distributed to all electronic users of Miriam College. We observe that majority of the students do segregate properly by wrapping their used sanitary napkin in a paper instead of plastic and placing their used sanitary napkin in the biodegradable bin.

To facilitate collection of used napkins, an extra bin solely for the sanitary napkins is placed inside each cubicle of each toilet in the High School and College buildings. A folder with used paper placed inside each cubicle for the purposes of wrapping the used sanitary napkin. The folder will also contain information and guidance: "*Let's compost our sanitary napkins so that we help reduce the waste that goes to our dumpsites and landfills . . . Wrap your used sanitary napkin in the paper provided and throw in the green trash bin . . . Thank you for being an earth saver*." An assigned janitress will collect the used sanitary napkins in a yellow trash bag every 3 PM and bring the bag to the compost area.

5. Operational Framework

5.1 The Research Locale

The experiment will be conducted on the compost area of Miriam College located at the back of the Environmental Studies Institute building. A temporary shed will be constructed to house the experimental area. This will protect the area from outside elements such as rain. The experiment area has 12 compost pits, 12 rotating drums, and 12 sacks, which will serve as the compost vehicles.

5.2 Sample

The experiment will use feminine napkin wastes generated by the Middle School, High School and College Units. The classes start in mid-June and the experiment would begin a week after. There are 144 cubicles in the toilets of the High School and College Units. Waste bins will be placed in each cubicle specifically for containing the used sanitary napkins and liners. A sign on what, why, and how to segregate is placed on each door of the cubicle and papers are provided for wrapping the sanitary napkins. A janitress will collect the used sanitary napkins everyday.

5.3 Method

Shredding

Particle size of composting materials is one determinant of the speed of decomposition. Shredding the feminine napkins will hasten the decomposition period because of the expected bacterial invasion on a greater surface area. Decomposition of shredded napkins will be compared with non-shredded napkins..

Activators

Two activators will be used for this experiment: Trichoderma harzianum and Effective Mircoorganism. *Trichoderma harzianum*, also known as Compost Fungus Activator (CFA), is a single-celled fungus that hastens the decomposition of organic materials. It is particularly effective in decomposing lignocelluloses like straw, corn stalks, sugarcane bagasse, grasses and weeds. In the Philippines, it is widely distributed and promoted for use in agricultural areas. *Effective Microorganism* consists of mixed cultures of beneficial and naturally occurring microorganisms that can be applied as inoculants to increase the microbial diversity of soils and plants. EM contains selected species of microorganisms including predominant populations of lactic acid bacteria and yeasts and smaller numbers of photosynthetic bacteria, *actinomycetes*, and other types of organisms.

Composting vessels

Three composting vehicles will be used in the experiment. These include the compost pits, rotating drums, and sacks. The compost pit measures about 1 square meter and 0.6 meter in depth. With the compost pit, a lesser amount of organic materials are exposed to air, and the walls and bottom of the pit provide insulation against heat and moisture loss. Miriam College has been using compost pits for its yard wastes and some kitchen wastes. The set-up is composed of 12 pits.

Rotating drums and sacks are examples of in-vessel composting, which confine the composting materials within a container, or vessel (FAO, 2003). Other examples of in-vessel systems are containers such as bins, pots, sacks, and rotating drums. These systems provide better control of aeration, temperature and the moisture in the organic materials being composted, all of which result in faster decomposition. The rotating drum uses a horizontal drum to mix and aerate the organic materials. Its other main function is to rapidly start the composting process. This comes from the process of rotation which provides oxygen to the microorganisms and which exposes more elements of the organic materials. Some users of rotating drums, especially for large-scale composting, employ the drum primarily for mixing and to immediately start the composting process, after which contents are transferred to sacks or aerated static piles. Because of the small-scale nature of the experiment, the organic materials will be left inside the rotating drums until the composting process is over.

5.4 Procedure

Stages

The experiment involves two stages. Stage 1 is the time for application of activators to the napkins. Stage 2 involves the observation of the decomposition process. The whole experiment takes about 10 weeks. For the first week, activators are applied to the unshredded napkins and the shredded napkins. A control group is maintained where no activators are applied. During weeks 2 to 10, the following parameters will be monitored: carbon and nitrogen content, pH, and temperature.

Weighing

Each day during the first week—days 1 to 6—at 3 PM, the assigned janitress will collect all the feminine napkins from all the units involved. The napkins will be brought to the experimental area and weighed. The napkins are then placed in each of the compost vehicles, namely, 6 compost pits, 6 rotating drums, and 6 sacks. One portion of the napkins is shredded while another portion remains unshredded. The shredded napkins are placed in each of the three compost pits, 3 rotating drums and 3 sacks. The same procedure is repeated for the unshredded napkins. Dried leaves and the waste tissue paper collected are added to the feminine napkins.

Application of activator

For the shredded case, no activators will be applied on one of each composting vessel. The next set of vessels will be applied with trichoderma harzanium, while the last set will be applied with effective microorganism. After the application of each activator, the napkins, tissue paper and dried leaves are then partly covered with soil. The same procedure is repeated for the unshredded napkins (*see figures 4 and 5*).

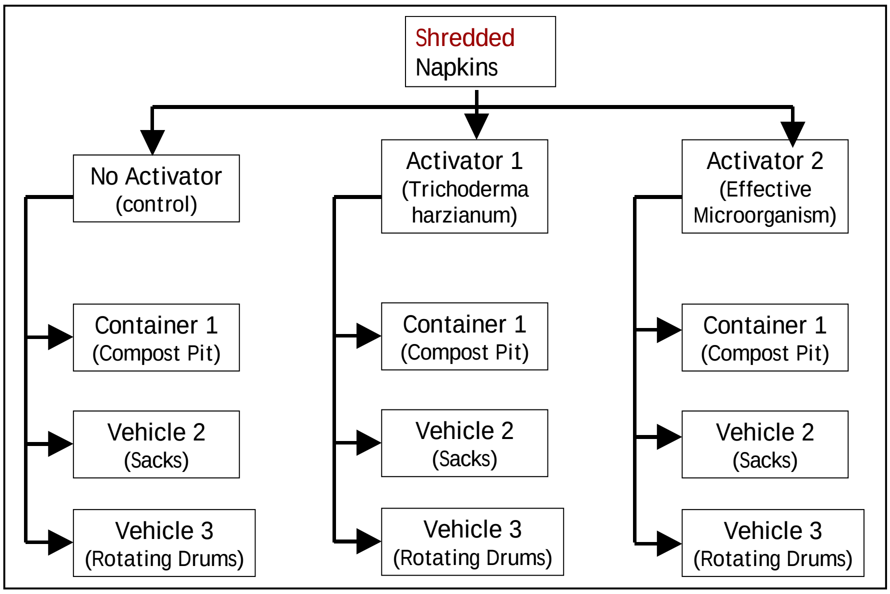


Figure 4. Experimental set-up for the composting of feminine napkins – shredded group.

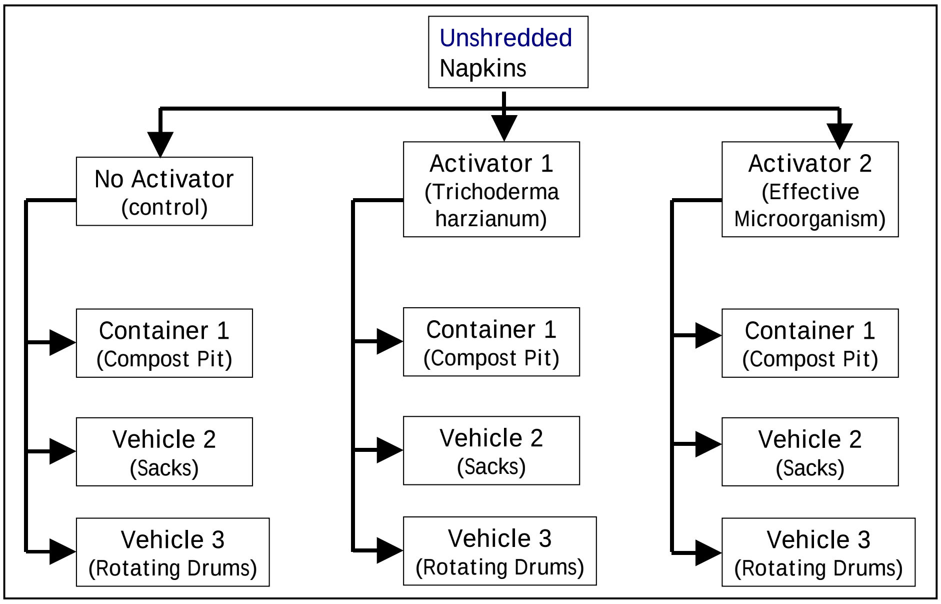


Figure 5. Experimental set-up for the composting of feminine napkins – unshredded group.

5.5 Monitoring the Composting Process

The following major parameters are monitored to be able to analyze the factors that may induce or prevent decomposition of feminine napkins.

<u>Temperature</u>

Biologically produced heat generated in a composting pile comes from the activity of microorganisms when they break down the organic materials. Soil temperature, using a soil thermometer, will be taken from the first day (baseline data) on all the 25 samples. This will be monitored each day until temperatures decline and are stable. This is an indication of the end of the composting process. There is a temperature pattern in the composting process, which can determine if the decomposition process is finished. According to Polprasert (1989), these are:

1. Latent phase – when microorganisms acclimatize and colonize the new environment in the compost pile.
2. Growth phase – rise of biologically produced temperature to mesophilic level.
3. Thermophilic phase – temperature rises to the highest level. This is when pathogenic destruction is most effective. Thermophilic temperature range is from 50 – 65 degrees Centigrade.
4. Maturation phase – when the temperature decreases to mesophilic, and, consequently ambient levels. Mesophilic temperature is from 25 – 45 degrees Centigrade.

If temperature levels go beyond 65 degrees Centigrade, the rate of bioxidation will be reduced. If this happens, the temperature may be controlled by aeration or moisture content. However, as an experiment, if such conditions occur, they will merely be noted for comparison with other variables.

<u>Aeration</u>

Thorough mixing assists in quick and complete decomposition. The frequency of turning, however, depends on temperature, moisture content, and type of raw materials. A huge volume of organic or compostable materials would require a pipe to assist in the aeration of the pile. This experiment will have to look at the volume of napkins to be used so as to determine the frequency of mixing or the necessity of an aeration pipe. It will have to take into consideration that if the pile or amount of raw materials napkins is too low, there may be a rapid loss of heat so that the optimum temperature of 60 degrees Centigrade for the destruction of pathogenic microorganisms is not attained. Also, a small volume may lead to an excessive loss of moisture, which would slow decomposition. An important aspect of rotation, as well as mixing, is that the raw materials at the perimeter are turned inwards so that it will receive high temperatures.

Nutrient balance

Another parameter that determines the rate of decomposition is the presence of carbon (C) and nitrogen (N). The microorganisms use the carbon as a source of energy and nitrogen for cell structure and growth. If there is excessive C, microorganisms will have growth limitations due to the lack of N. They will have to go through many life cycles, oxidizing the excessive C until a final C/N ratio of about 10/1 is reached in the composted materials. This means that more time is required to decompose. The optimum ratio in soil organic matter is 10 carbons to 1 nitrogen (10:1).

Moisture

Moisture is a significant parameter because it is essential for cell growth. Although some studies say that ideal moisture content can range from 50% to 70%, this would actually depend on the type of raw materials. Considering that feminine napkins are mainly wood pulp and cotton, there is little structural strength when wet. Therefore, less moisture may be better. The ideal moisture content will be analyzed in this experiment. This should be maintained during active bacterial growth and reactions. Excessive moisture will result in leaching of pathogens and nutrients, and can also block the passage of air. Too little moisture, on the other hand (less than 40%) limits microbial growth and activity.

Soil pH

Soil pH is an important parameter because it affects the biological activity of soil organisms. Soil bacteria prefer pH neutral soils while fungi prefer weakly acid soils. During the initial stages of decomposition, organic acids are formed, making conditions acidic and favorable for fungi and breakdown of lignin and cellulose. The optimum pH for most organisms is 6.5 to 7.5. However, pH in aerobic composting usually starts at neutral and rarely experiences extreme drop or rise. Figure 6 shows the scale for soil acidity.

Type of soil	***Active pH***
Strongly acid	4.9
Acid	5.0 – 5.9
Weakly acid	6.0 – 6.9
Neutral	7.0
Weakly alkaline	7.1 – 8.0
Alkaline	8.1 – 9.4
Strongly alkaline	9.4

Figure 6. Scale of soil acidity.

5. Preliminary Results

The discussion here presents the preliminary results obtained from the first experiment conducted from mid July to mid September. The experimental set-up, especially the compost pits, was flooded during two consecutive typhoons that brought heavy downpour. This caused the overflow of water in the pits containing different activators. The data from the compost pits have to be invalidated. The data presented here are those from the rotating drums and sacks. It would be noted that the temperature readings from all these cases vary between 25 degrees to 34 degrees Celsius, which are far from the expected temperature of 50 degrees to 60 degrees Celsius. This indicates an incomplete decomposition.

The results presented here show the pH and moisture contents of samples taken from each of the rotating drums and sacks in the shredded and unshredded groups. The vessels comprise the control set-up and the ones applied with Trichoderma and Effective Microorganism. Figure 7 shows the moisture content of the unshredded group: control, EM, and trichoderma.

For the rotating drum, moisture content in the control, EM, and Trichoderma cases show an initial increase and eventually decrease in the fourth and fifth week. Similar pattern is seen for the moistures content in the three cases using sack as the composting vehicle.

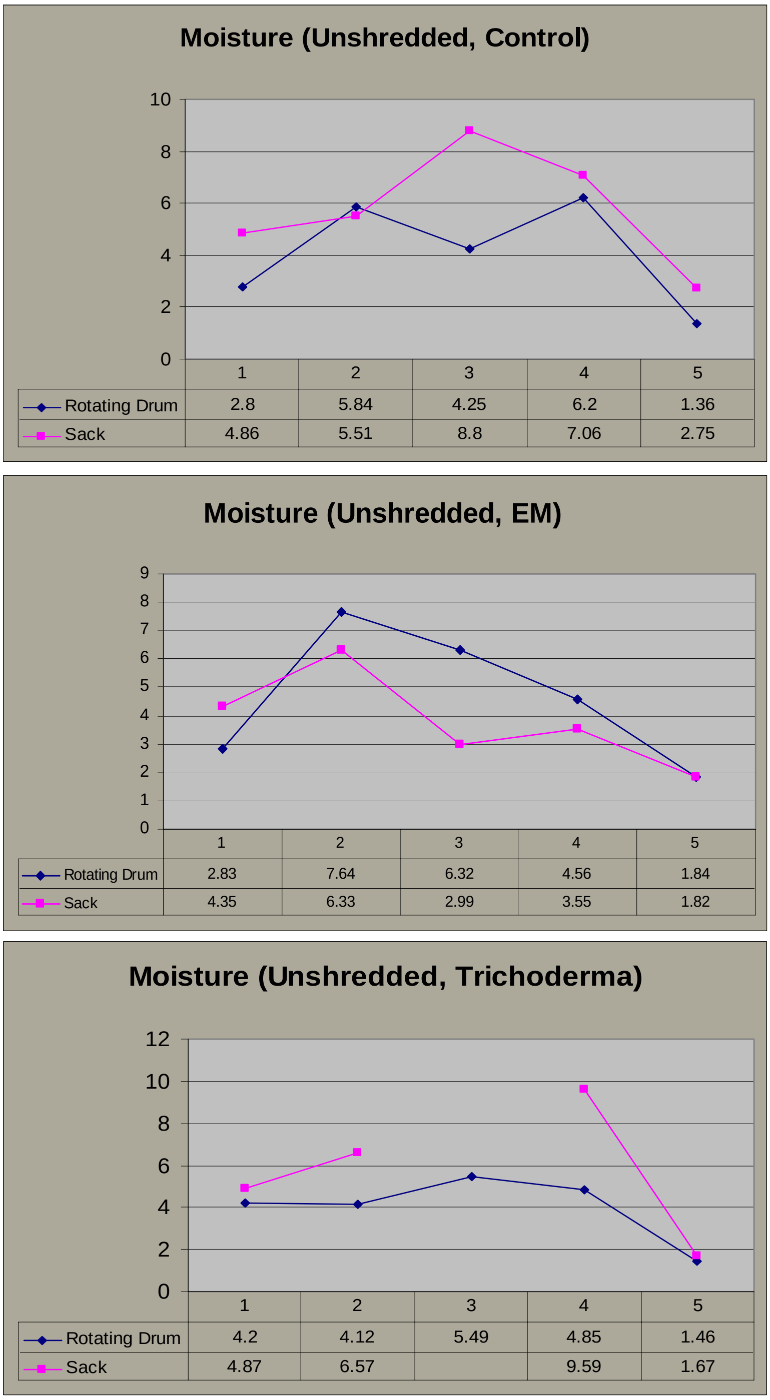


Figure 7. Moisture content of the unshredded group.

Figure 8 shows the moisture content of the shredded group: control, EM, and trichoderma. It will be observed the moisture content in the three cases in both the rotating drum and sack deceases over the three-week period that data were gathered.

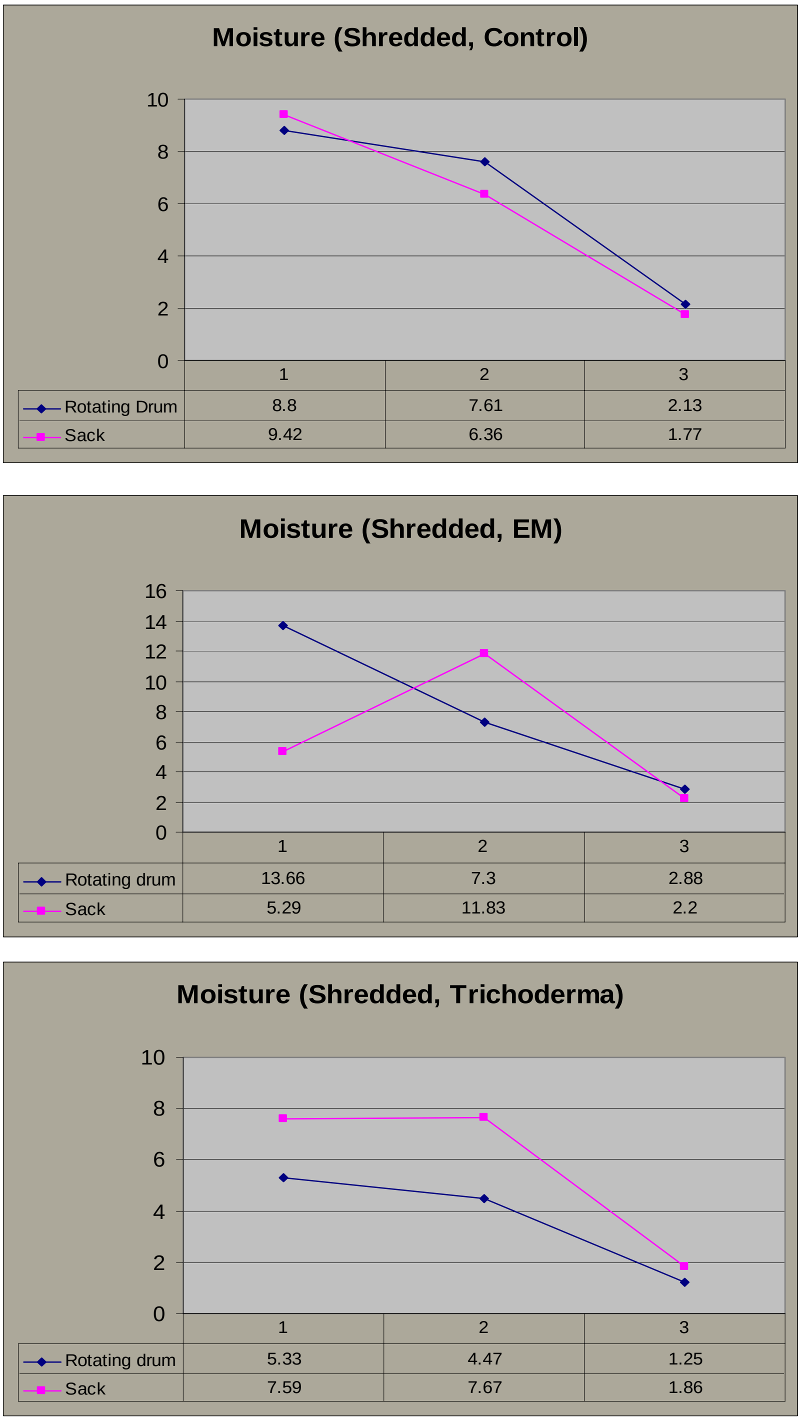
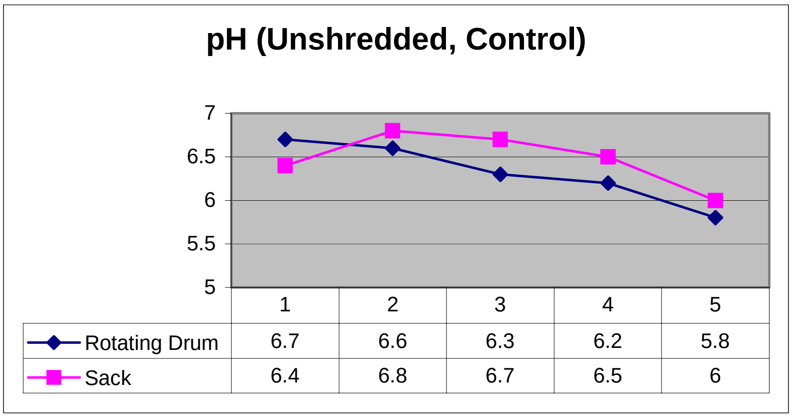
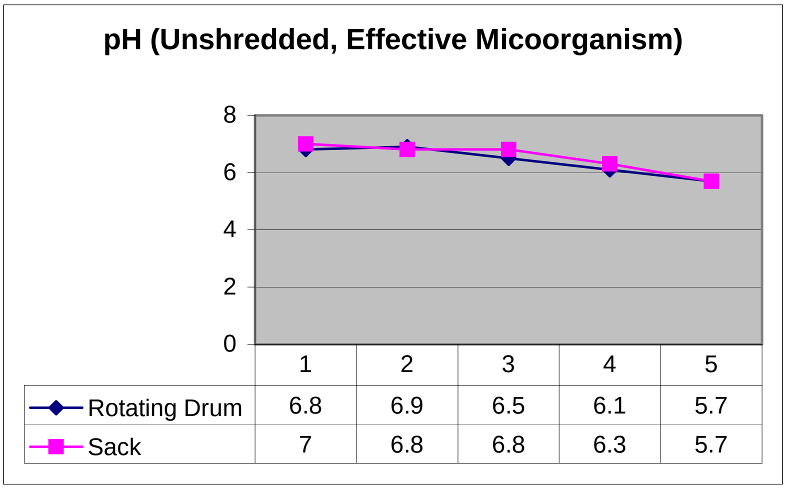


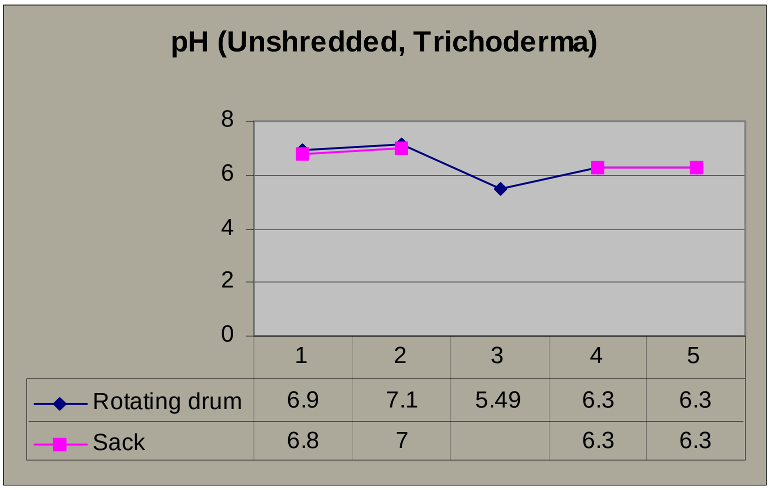
Figure 8: Moisture content of the shredded group.



	1	2	3	4	5
Rotating Drum	6.7	6.6	6.3	6.2	5.8
Sack	6.4	6.8	6.7	6.5	6

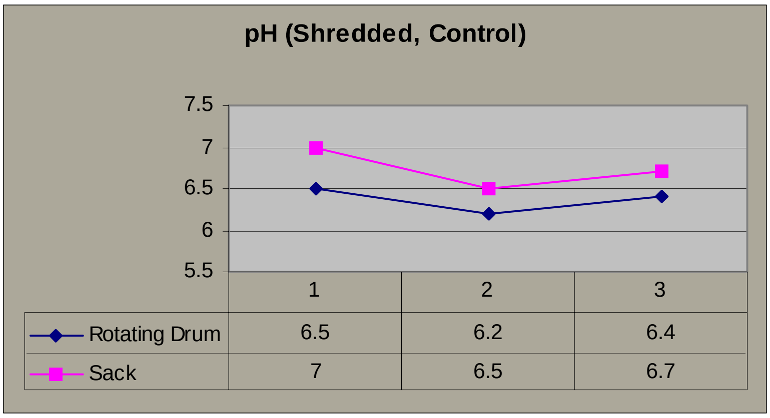


	1	2	3	4	5
Rotating Drum	6.8	6.9	6.5	6.1	5.7
Sack	7	6.8	6.8	6.3	5.7

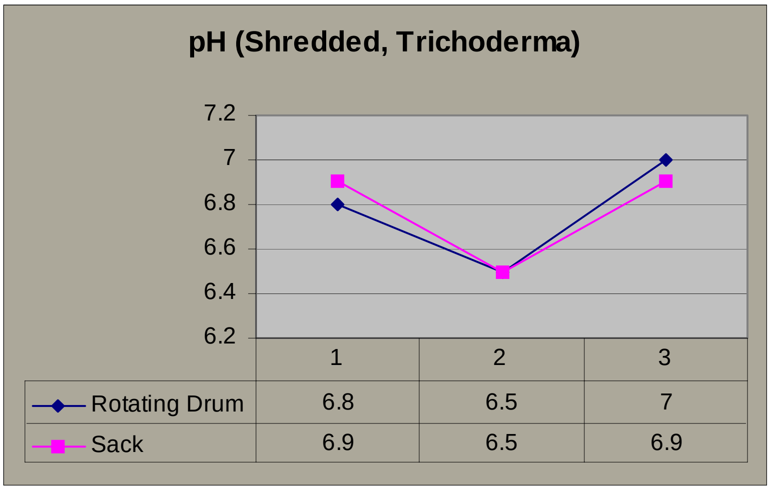


	1	2	3	4	5
Rotating drum	6.9	7.1	5.49	6.3	6.3
Sack	6.8	7		6.3	6.3

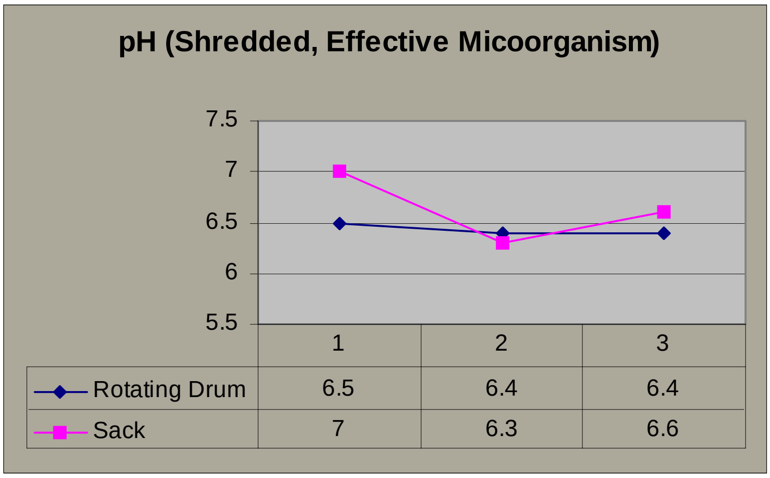
Figure 9. pH readings of the unshredded group.



	1	2	3
Rotating Drum	6.5	6.2	6.4
Sack	7	6.5	6.7



	1	2	3
Rotating Drum	6.8	6.5	7
Sack	6.9	6.5	6.9



	1	2	3
Rotating Drum	6.5	6.4	6.4
Sack	7	6.3	6.6

Figure 10. pH readings of the shredded group.

Figure 9 and 10 shows the pH readings for the unshredded and shredded cases respectively. For the unshredded group, pH values in all three cases in both the rotating drum and sack media lie between 6 and 8, and are decreasing over the five-week period that data were gathered. For the shredded group, pH values in all three cases in both the rotating drum and sack media decreased and then increase; pH values range from 6 to 8.

Experiments 2 and 3 are conducted from October until December, 2004. The following results, taken from Experiment 2, are incomplete. The results for Experiment 3 have not been received. Hence, analysis could not be made at this time.

However, some general observations can be made. The second experiment has shown a slight increase in temperature compared to the first experiment. As of the fifth week in the rotating drums, the activators Trichoderma harzianum (Tricho) and Control have shown faster decomposition than Effective Microorganisms (EM). Raw materials of Tricho and Control are still present but much less compared to EM. In addition, the leaves in Tricho have also decomposed faster than the Control or EM. The rotating drums have shown faster decomposition compared to pits and sacks mainly due to the frequent aeration that comes from turning the rotating drums twice each day. Notable decrease in the volume of the raw materials (2nd phase) was observed after 5 weeks. It can be said that the volume decreased by 50% for raw materials in the rotating drums.

The third experimental phase was conducted from November 3, 2004. The same exact procedures were applied. It was during this phase that the highest temperature reading was taken at 48 degrees Celsius for the sack (Control). Observations are likewise ongoing until December.

Experiment 2

<u>RD Control</u>

		Total Nitrogen	Organic Carbon	pH
Week 1	Oct 12 F-490	0.26	1.96	7.4
Week 2	Oct 19 F-517			7.0
Week 3	Oct 26 F-548			6.9
Week 4	Nov 2 F-556			7.2
Week 5	Nov 9	unavailable		

<u>RD Tricho</u>

		Total Nitrogen	Organic Carbon	pH
Week 1	Oct 13 F-491	0.25	1.97	7.3
Week 2	Oct 20 F-520			6.6
Week 3	Oct 27 F-547			6.7
Week 4	Nov 3 F-557			7.0
Week 5	Nov 10	unavailable		

<u>RD EM</u>

		Total Nitrogen	Organic Carbon	pH
Week 1	Oct 14 F-508	0.36	9.27	6.8
Week 2	Oct 21 F-523			7.0
Week 3	Oct 28 F-546			7.0
Week 4	Nov 4 F-551	unavailable		
Week 5	Nov 11	unavailable		

Experiment 2

Sack Control

		Total Nitrogen	Organic Content	pH
Week 1	Oct 15 F-510	0.36	2.43	7.7
Week 2	Oct 22 F-542			7.2
Week 3	Oct 29 F-549			to check
Week 4	Nov 5 F-564			7.3

Sack Tricho

		Total Nitrogen	Organic Content	pH
Week 1	Oct 18 F-509	0.27	6.07	7.2
Week 2	Oct 25 F-543			6.3
Week 3	Nov 1 F-553			6.9
Week 4	Nov 8 F-563			7.1

Sack EM

		Total Nitrogen	Organic Content	pH
Week 1	Oct 19 F-518	0.36	1.60	6.7
Week 2	Oct 26 F-540			7.0
Week 3	Nov 2 F-554			6.6
Week 4	Nov 9 F-565			6.6

Experiment 2

Pit Control

		Total Nitrogen	Organic Carbon	pH
Week 1	Oct 20 F-521	0.81	2.02	7.2
Week 2	Oct 27 F-545			7.0
Week 3	Nov 3 F-555			6.9

Pit Tricho

		Total Nitrogen	Organic Carbon	pH
Week 1	Oct 22 F-			
Week 2	Oct 29 F-552			7.0
Week 3	Nov 5 F-562			7.1

Pit EM

		Total Nitrogen	Organic Carbon	pH
Week 1	Oct 21 F-524	.08	4.65	8.2
Week 2	Oct 28 F-541			6.9
Week 3	Nov 4 F-550			7.3

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