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Composting in the Backyard in Asia: Some Lessons Learned through Euro-Asian Collaboration in the Cases of Vietnam and the Philippines

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Abstract

This paper presents the results of and conclusions from various composting activities implemented in Hanoi and Manila under different socio-economic settings, within the framework of a 2-year joint EU-ASEAN research project. It focuses on recommendations to the Asian partners on how to improve their composting processes, based mainly on the reviewal and assessment of current composting practices in Vietnam and the Philippines.

1 Introduction

Solid Waste Management (SWM) is an important issue in the European environmental policy. Considerable effort has been made in the development of methods and policies aimed at achieving waste minimization, recycling and treatment. Asian countries are also having to face the issue of SWM, since the population and resource consumption are rapidly increasing and existing infrastructures are not able to keep up with the rise in demand. The present study was part of the ISTEAC project funded by ASEAN-EU University Network Program (AUNP) – a co-operation program for European Union and ASEAN higher education institutions. The research and laboratory activities carried out during the project examined composting schemes as waste minimization tools for selected communities in Vietnam and the Philippines. Asian countries have a large number of small and rural communities that produce large amounts of organic waste due also to agricultural activities. There is therefore a significant potential for composting activities with a direct market for the end product in these areas and, accordingly, several attempts have already been made to implement such a scheme for some time. In EU countries a number of home- and small-scale composting schemes have

already been implemented. To this aim, critical analysis of experiences gained was performed in order to enhance planning and improve composting schemes in selected communities in Vietnam and the Philippines.

2 Background

The problems afforded by the solid waste management system in Vietnam have been greatly magnified over the past decade as a result of relatively strong economic growth and uncontrolled urbanization. The latter issues have pushed waste management to the forefront of the environmental challenges that the country must now face. Not only has there been an increase in the amounts of waste generated, but the composition of the waste has also changed (Themelis, 2006). Solid waste generated in Vietnam has been increasing steadily over the last decade; in 1996, the reported generated amount was 5.9 Mt (Nguyen, 2005), whereas just eight years later, MSW alone generated for 2004 was reported at 12.8 Mt, with industrial and agricultural waste contributing another 2.2 Mt (Vietnam Environmental Monitor, 2004). The average amount of waste generated per capita in rural and urban areas ranges from 0.35 to 0.8 kg/d, respectively. Low collection rates (40-70 % in urban areas and 20-40 % semi-rural and rural areas) and inadequate waste facilities characterize the current situation in Vietnam. Available literature points to a scarce need for increased technological expenditure (such as in the case of an incineration plant) and an increased need for a greater understanding of social issues and well-informed education, awareness and community action programs (JICA 2000; Le Thi Huong, 1995). Given the high rates of organic matter (60 %) present in waste and the very high (80-90 %) moisture content, composting plants were assessed to be a potentially viable option by local stakeholders.

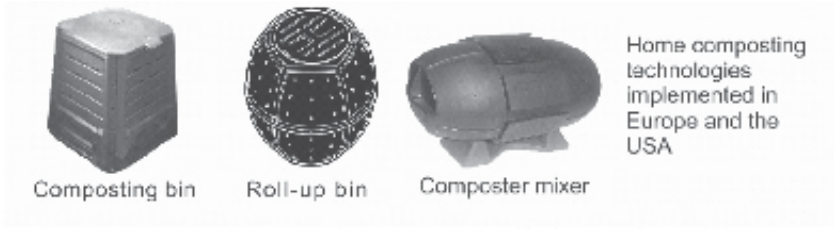
Also in the Philippines, solid waste management is currently acknowledged as one of the most pressing environmental problems, with a total of 10.67 Mt generated in 2000. Filipinos living in urban areas are estimated to generate an average of 0.5 kg of waste per capita per day, while the average collection efficiency is only about 40 %. To respond to this, local government units have intensified their efforts to make collection more efficient. Some have started to shift to sanitary landfills as a more sanitary disposal system (JICA 1998). Metro Manila alone generated in 2000 2.445 Mt of waste and only 10.7 % (i.e. approx. 0.261 Mt) were recycled or composted, while the rest was either hauled to the city's dumpsites, or dumped illegally on private land, in rivers, creeks and the Manila Bay, or openly burned. It is estimated that roughly 150,000 residents of Metro Manila live as scavengers and waste pickers. Even though the SWM system is not fully developed, source segregation is common practice among Filipinos (also linked to religious standpoints) and composting activities can easily be initiated.

3 Methodology

Small-scale composting processes can be implemented successfully in Asian countries as a tool for reducing the amount of waste disposed of. This activity

was found to be quite extensively practiced in Metro Manila on a kind of neighborhood scale. From the scale point of view, this small-scale comporting bears close resemblance to home composting, where compost is returned to the garden, creating a neat recycling loop and involving no transportation of waste (SWAN, 2000). The high organic content in the MSW stream of developing countries but also the climate in wet tropical countries is ideal for composting (Hoornweg et al. 2000). The raw materials which are most appropriate for composting include: vegetable and fruit waste; farm waste such as coconut husks and sugar cane waste; crop residues such as banana skins, corn stalks and husks; yard waste such as leaves, grass and trimmings; sawdust; bark; household kitchen waste; human excreta and animal manure. All these organic materials are readily found in MSW generated in developing countries such as Vietnam and the Philippines. Animal waste, such as carcasses and fish scraps, can be used as well but are more likely to attract unwanted vermin and generate odors. Other organic matter such as wood, bones, green coconut shells, paper and leather decompose at a much slower rate and may hinder the composting process if used in excessive amounts. Parameters that influence the composting process include micro-organisms, C/N-ratio, pH, porosity, structure, texture, particle size, aeration and temperature.

Based on preliminary research findings regarding available composting technologies (cf. also Figure 1) and specific requirements in order to produce acceptable compost, various composting activities were performed both in Hanoi and Metro Manila. In the Philippines a management scheme for sanitary waste produced in the campus of Miriam College (an exclusively female multi level educational establishment) was planned and implemented, whereby various composting methods were tested aiming to identify the optimum approach for managing sanitary waste in the entire campus. On the other hand, the composting activity



in Vietnam focused on home-composting technologies, for two selected areas in Hanoi, with parallel conduct of experiments and the development and installation of pilot composting equipment.

Fig. 1: Examples of composting technologies implemented in Europe and the USA.

4 Planning of a management scheme for sanitary waste in Miriam College

4.1 Sanitary waste generation

Used sanitary feminine napkins are usually considered as residual waste and end up in dumpsites and sewages. However, they can be composted since their main components are wood pulp and non-woven cotton, which are compostable materials. As an all-girl's 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 student population of about 3,800 females in the High School and College levels, it was estimated by a survey conducted in early 2004, that an average of 38,000 napkins are disposed of in the campus every month. However, the subsequent collection of used sanitary napkins indicated that the rate of generation was actually much lower, as according to initial school estimations, students were thought to be in the campus five days a week; however, a closer actual inspection showed that students were not present in the campus on an everyday basis and, therefore, did not generate the initially estimated amount of used sanitary napkins.

4.2 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. Posters concerning segregation and composting were placed in each ladies' room, while signboards were posted on the walls of each cubicle in the room (Figure 2). Articles were also written in the school's newsletter. It was observed that the majority of the students did segregate properly by not wrapping their used sanitary napkin in plastic and placing their used sanitary



napkin in the biodegradable bin. The objective of the information campaign was to raise awareness about the composting of used sanitary napkins and to obtain the participation of students and staff in the proper segregation of used sanitary napkins.

Fig. 2: Signboards of the information campaign in Miriam College.

4.3 Selected methods and equipment of the experiments

The experiment was conducted within the grounds of Miriam College. Two activators, namely, Trichoderma harzianum (Tricho) and Effective Microorganisms (EM), were used, including also a control group in which no activators were used. Experiments were organized both for *shredded* and *unshredded* sanitary napkins.

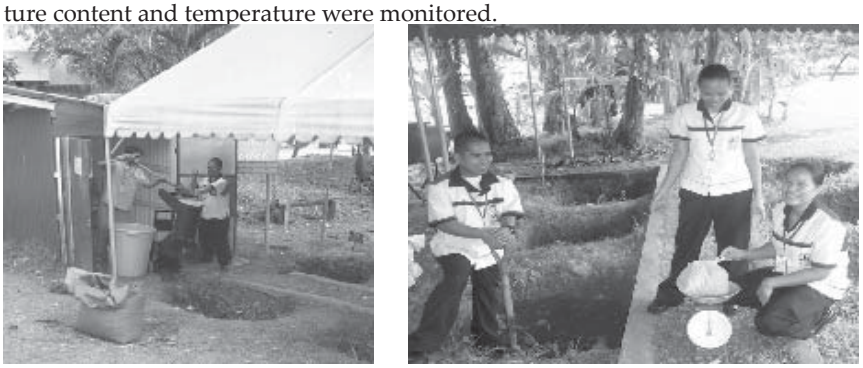


Different low-cost and low technology alternatives (Figure 3) were used as composting containers such as the compost pit, rotating drum, and rice sack (12 of each type were used).

Fig. 3: Waste segregation and composting methods (pits on the left and drums on the right) used in Miriam College.

4.4 Experimental phase

Within the frame of this activity three experimental phases lasting 7 months took place. The experiment consisted of two stages; stage 1: application of activators to the napkins, and stage 2: observation of the decomposition process. The whole experiment lasted about 10 weeks. During the first week, activators were applied to both shredded and unshredded napkins. A control group was maintained where no activators were applied, whereas the parameters C/N ratio, pH, moisture content and temperature were monitored.



The experimental set-up was organized both for shredded and unshredded

samples (Figure 5). In the shredded samples, three composting vessels were employed and for each composting vessel, three set-ups were selected: (1) the control set-up with no activators used; (2) the Tricho set-up; and (3) the EM set-up.

Fig. 4: Shredding of raw material. **Fig. 5:** Weighing of sanitary waste.

4.5 Experiments and results

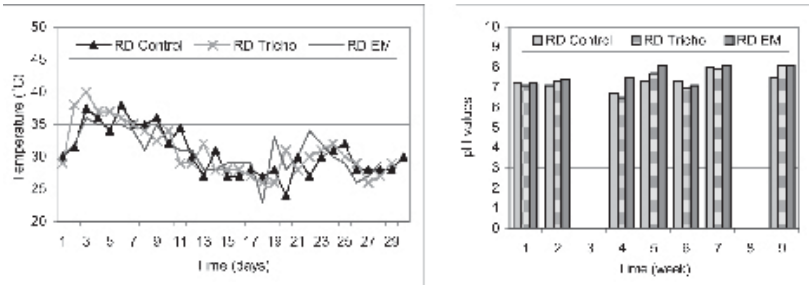
The first experimental phase, conducted from mid July to mid September 2004, faced flooding during two consecutive typhoons that brought heavy downpour. This caused the overflow of water, particularly in composting pits containing different activators, resulting in the failure of experiments. In addition, temperature readings were only between 25 to 34° C, far from the expected temperature range of 50 to 60° C. It was confirmed that the low temperature readings - the main problem during the composting process - were caused by the limited input of raw materials (i.e. sanitary napkins). Therefore it was suggested that organic wastes (such as green wastes) should be mixed with the sanitary napkins and additionally soil, which was already used in the raw material, should be avoided. Finally it was proposed that leaves and tissue paper (generated by the school) should be added in order to facilitate further decomposition.

The second experimental phase was performed from mid October, 2004 to mid December, 2004. As suggested, used tissue paper was included to increase the volume of raw materials, while leaves were also added during the shredding process, in order to increase the level of nitrogen. The second experiment showed a slight increase in temperature compared to the first experiment. As of the 5th week in the rotating drums, the Tricho activators and the Control group showed faster decomposition than EM. Raw material in Tricho and Control groups was still present but at significantly lower levels compared to EM groups. In addition, the leaves in Tricho groups also decomposed faster than the Control or EM groups. The rotating drums showed faster decomposition compared to pits and sacks, mainly due to the frequent aeration resulting from turning the rotating drums twice each day. Notable decrease in the volume of raw materials (2nd phase) was observed after 5 weeks. It was observed that the volume of raw materials decreased by 50 % in the rotating drums, while weather conditions did not cause any problems during the second and third experimental phases.

The third experimental phase was conducted from early November 2004 until the first week of January 2005. Temperature, pH and C/N ratio were monitored during the experiment. Temperature readings were taken every day, except during weekends, whereas the pH values of each set-up were taken every week (Figure 8). The C/N levels were also tested (a) before the experiment started, (b) after its third week, and (c) after virtual completion of composting. General observations showed that the time required by decomposition process in the Control and Tricho samples of the rotating drum were very similar and decomposition in the EM samples of the rotating drum was slower compared with the Control and

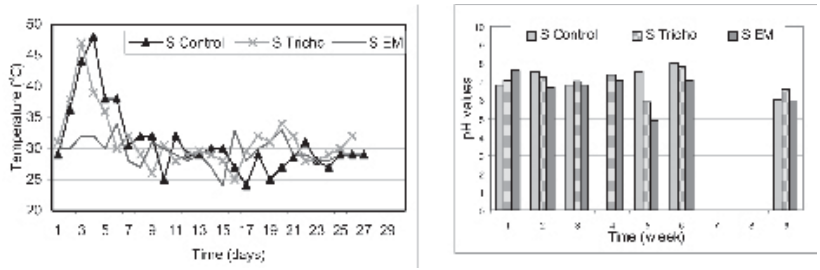
Tricho samples. Samples contained in sacks and compost pits showed a slower rate of decomposition compared with that in the rotating drum. Drum rotation allowed air to be mixed with the samples, facilitating aerobic digestion. Mixing in the sacks and compost pits was not used. The results indicated that there is no need to use activators in the composting of used feminine napkins, as the Control sample of the rotating drum decomposed faster than the other samples.

5 Planning of composting schemes for selected communities in

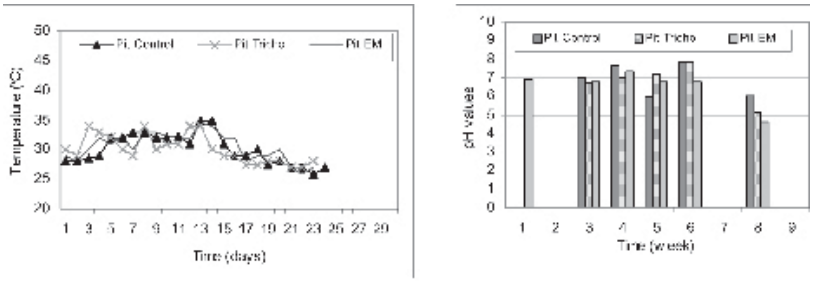


Vietnam

Parallel to the composting activity in the Philippines, in Vietnam a home-com-



posting scheme for two selected areas near Hanoi was organized. This research part consisted of four individual tasks: a) selection of communities and data com-



pilation, b) selection of the composting technology, c) conduction of experiments,

and d) assessment of the results.

Fig. 6: 3rd experiment: Temperature and pH readings in rotating drums.

Fig. 7: 3rd experiment: Temperature and pH readings in sacks.

Fig. 8: 3rd experiment: Temperature and pH readings in pits.

5.1 Selection of the communities and data compilation

Two areas were selected near Hanoi: Gia Lam and Phung communities (population: approximately 353,000 and 132,000 respectively). Both are semi-rural communities producing large amounts of organic waste, while the main activity in the area is agriculture; they were therefore considered appropriate for testing the implementation of home-composting schemes. The composition of solid waste in the selected areas was investigated in the field, revealing a very low presence of metal and paper components and organic waste content between 53 and 63 %. In particular, organic waste had a water content ranging between 80-90 % and relative high C/N ratio above 60:1.

Requirements and constraints for waste composting and the adoptability of the Roll-Up or Drum composting method were provided. Moreover, technical issues concerning the adjustment of C/N ratio in the composting input, methods to ensure the required porosity and aeration of the material, the determination of the water content, as well as methods for the pre-processing of the input material were addressed. Finally, the pre-treatment of the raw material until water content reaches approximately 55 % and C/N ratio is about 30:1 was suggested.

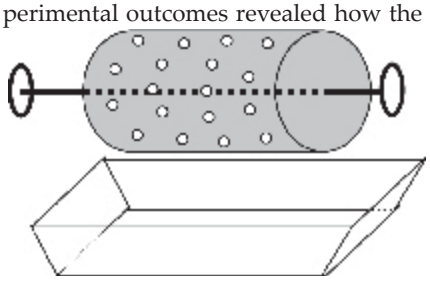
5.2 Selection of the composting technology

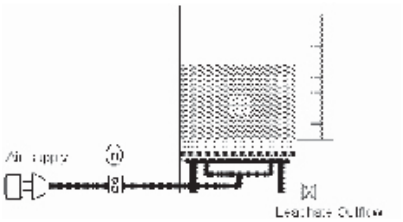
Based on laboratory results of organic waste characterization, the composting technology selected was a Roll-Up system (in-vessel composting reactor). The reactor's technical features were: volume: 200 L; length: 1.2 m; diameter: 0.46 m, and included a rolling and an aeration mechanical system. This system was the most suitable technology; however, in actual operation several problems were encountered, including high moisture content in the samples and the resulting need for pre-treatment of the input material.

5.3 Experiments and results

The selected Roll-Up system (Figure 9) for household scale was designed to work under the following conditions: aeration regulation, leachate recycling, thermal and aeration control and effective micro-organism additives. The first experimental phase lasting 21 days included experiments in a stationary unit (Figure 10) with air supply. The whole process consisted of 3 experimental groups with the same component and the same amount of input material (60 kg of organic MSW together with 4 kg of straw). C/N ratio was measured, whereas the 1st experimental group was subjected to an aeration velocity of 2 L/min. The 2nd followed with an aeration velocity of 3 L/min and 4 L/min. Finally, the 3rd group followed with

leachate collection and recirculation through the organic mass of the composting pit. The second experimental phase took place by using the selected Roll-Up system and the degradation process lasted 15 days. During this phase, the material was rolled at 50 cycles/min and resulted in a lower amount of odor generation compared to results obtained in the 1st experimental phase. Evaluation of the experimental outcomes revealed how the degradation process in the Roll-Up sys-





tem was shorter than in a stationary unit (15 days instead of 21 days), also leading to the release of fewer odors. However, it was found that several parameters in the Roll-Up system could not reach the appropriate standards of the process (e.g. temperature curve). The unit's fast rolling may have resulted in these problems and it was decided to reduce rolling speed to less than 50 cycles/min.

Fig. 9: Roll-Up home-composting unit. **Fig. 10:** Stationary unit.

6 Discussion

During the experimental processes in both Asian areas, problems were manifested due to weather conditions, quantity and composition of raw material, as well as the lack of previous experience in composting process. Collaboration between EU and Asian researchers resulted to an exchange of knowledge and experience on various SWM issues and on composting in particular. The composting activity in Miriam College faced problems with adverse weather, since the composting area was hit by two typhoons and therefore experiments were invalidated. During the following experimental phases, two main issues were addressed; the quantity and composition of the raw material, as well as retention time. The first issue was solved by increasing the amount of organic waste, by adding green waste and by avoiding the use of already used soil. Leaves and used tissue paper were added to the input material in order to prevent plastic linings from sanitary napkins sticking to the blades of the shredder and to improve the composting process by attaining the appropriate C/N values. All three experiments showed that sanitary napkins should be shredded prior to composting and that the use of rotating drums with either Tricho or no added microorganisms were the most efficient solutions. With regard to retention time, it was suggested that this be

increased, since it was initially very limited. This was an interesting observation apparently suited to a number of applications. Indeed, both during and between experiments, a number of neighborhood composting facilities in Metro Manila were visited and examined by the research group (with both Asian and EU partners present). At these facilities, source separated organic MSW was mixed mostly with saw dust and introduced into elevated rotating drums for composting. However, a low product quality was observed (rather 'enriched sawdust' instead of compost'), which was attributed to low residence time, as the operators were in a hurry to remove the compost in order to produce more! Unfortunately, in this way, the majority of the material produced did not pass through the screen and was dumped.

The main setback in composting activity in Vietnam was represented by the high water content in the organic waste, approximately 90 %. Therefore, pretreatment aimed at checking the water content was considered essential. To achieve a suitable input material for composting process, the organic waste from selected communities needed to be mixed with other material (used paper and wood waste) in order to reach the desired C/N ratio of about 30:1; water content of approximately 55 % and adequate aeration levels. The results showed that the rotating drum technology adapted well to the specific composting requirements, thus constituting a possible solution for the pressing issue of SWM in Vietnam.

Prior to this project, both Asian research teams had limited experience in SWM reduction tools such as composting. However, following the performing of the experiments described significant know-how and experience was gained, leading to composting becoming a very important parameter in planning a broader range of SWM activities in their Communities. It is worth mentioning that the sanitary napkin management scheme has become a permanent activity within the SWM program of Miriam College, whereas the environmental authorities (URENCO) of Hanoi have adopted the developed home composting technique for broader application throughout the city.

7 Acknowledgement

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8 Acronyms

AUNP	ASEAN-EU University Network Program.
EM	Effective Microorganisms.
ISTEAC	Integration of SWM Tools into specific settings of European and Asian Communities.
MSW	Municipal Solid Waste.
SWM	Solid Waste Management.
Tricho	Trichoderma harzianum.

References

Hoornweg, D. et.al. (2000): Composting and Its Applicability in Developing Countries. Waste Management Working Paper Series 8 published by World Bank.

JICA (1998): The Study on SWM for Metro Manila in the Republic of the Philippines. Master Plan Report. Japan International Cooperation Agency and Metro Manila Development Authority.

JICA (2000): The Study on Environmental Improvement for Hanoi City in the S.R. of Vietnam. Draft Final Report. Japan International Cooperation Agency and Hanoi People's Committee.

Le Thi Huong (1995): Urban Waste-Derived Compost in Hanoi, Vietnam: Factors Affecting Supply and Demand. Thesis Paper for B.Sc. St. Petersburg, published by AIT, Bangkok.

Nguyen, Thuy Thuc Thi (2005): Audit and Separation of Compostable Solid Wastes at Households in Danang, Vietnam. University of Toronto, pp.103.

Themelis J. N. (2006): Solid Waste Management in Vietnam: An Industrial Ecology Study by Thao Nguyen, School of International and Public Affairs. University of Columbia, USA.

Strathspey Waste Action Network (SWAN) (2000): The Adopt-A-Composter Project, January.

Vietnam Environment Monitor (2004): World Bank, MoNRE and CIDA, pp.65.