Integrated Recycle System of Organic Urban Waste with EM Technology

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Abstract. *The increase of developmental success in urban areas has caused a rapid increase of urban population. The growth of urban population also causes various problems of environmental pollution due to their daily activities. Bali which is internationally famous for its tourist resort, continuously strives to complete facilities and infrastructure, both in maintenance as well as tourist resort conservation, and one of the efforts is by integrated urban waste management to create a clean and healthy Bali and to develop tourism with an environmental insight.*

EM Technology is one of the organic fermentation technologies which was found by the second author in 1980, and is applied to process urban organic waste. This research is a model of integrated organic urban waste recycling with EM Technology, which may be applied in a smaller scale all over the cities in Indonesia as well as other countries. The benefit of integrated organic waste management are:

- *Save costs for final disposal as more than 50 per cent of all organic waste is reprocessed and utilized for the purpose of agriculture and animal husbandry on a wider scale.*
- *No environmental pollution, thus water, air and soil pollution may be reduced. Urban people may be healthier and more dynamic as they live in a healthy environment.*
- *Provide source of income, employment opportunity for organic fertilizer and animal breeding industries – providing organic fertilizer and cattle feed at cheap cost.*
- *Increase tourist visits, as the city is clean, tidy and friendly to the environment. Tourists also tend to see how to manage urban organic waste.*
- *Provide education, research and developmental facilities for integrated urban waste management with EM Technology.*

The recycle system of integrated organic urban waste is divided into 10 units of integrated works, which can be developed into a big scale as : separation of organic and inorganic waste; distribution of organic waste as cattle feed; fermentation organic fertilizer production unit; unit of cow and goat breeding; worm breeding unit; plant seedling unit; mushrooms plantation unit; research and development unit, training and education; tourism unit and marketing unit of organic / inorganic products.

This research is also completed with economical analysis of various units of works in integrated organic waste management with EM Technology. The result of this research is very exciting to be applied in big cities in Indonesia because of its various benefits. In a short time, this recycle system of integrated organic waste

management with EM Technology will be applied in Bali on a bigger scale as a model for other cities in Indonesia and other countries.

Introduction

The increase of development success in urban areas has caused the increase of urban populations. This increase has caused various environmental pollution problems as a result of social and economic activities in their daily life. Contamination of soil, water, and air is inevitable as most peoples' activities produce wastes. When more people live in a area more problems are to be faced.

Bali island which is well known as a tourist destination internationally has never given up attempts to complete facilities and infrastructure, either in the field of maintenance as well as conservation of tourism resorts, and one of the efforts is the commitment to fight against the waste by various ways of prevention, to keep Bali clean and healthy and to improve tourism development which is friendly with the environment.

Denpasar as the Capital City of Bali Province and as a center of government activities has realized the importance of waste prevention which is completed with facilities and infrastructure that may be used to prevent rubbish quickly and efficiently, by saving time and cost so that it may be applied widely by government.

This article provides a description on the result of application of EM technology in the field of integrated recycling of organic urban waste, which has been implemented in the Training and Education Center of EM Technology in Bali.

Recycling of Organic Urban Waste with EM Technology

Urban waste in general is handled by burying in a disposal hole with soil of a certain thickness or layer that is known as the landfill system. This system is costly to fill the land and to provide an area for waste disposal, where in a certain period of time this area will be full. Accumulation of wet waste also causes heat and obnoxious gas so that it may contaminate air and soil water and during the dry season may cause explosion and fire hard to be blown. Continued waste burning may cause higher air pollution due to the smoke, and cause an explosion which may cause death for people working in the area of waste disposal.

To prevent problems of urban waste, recycle efforts should be done integratedly so that organic energy in the waste may be recycled and utilized by cattle breeding industries as cattle feed and for farmers as organic fertilizers.

EM Technology which has been developed by Prof. Teruo Higa from the University of the Ryukyus is a fermentation and synthetic microorganisms and it is very effective to be applied to fermented organic substances to become organic fertilizer and increase the protein of animal feed (Wididana and Higa, 1997). EM Technology has been widely applied in Indonesia in the field of agriculture, animal husbandry, environment as well as health (Higa, 1993; 1994).

EM Technology application on a wide scale prevents problems which may exist in handling organic urban waste with an expectation to provide new hope to reduce the heat and bad odour, reduce fly population and reduce pathogen microorganisms in the piling of rubbish.

Integrated recycle system of organic urban waste that we have developed provide a solution in that organic waste which is integratedly managed will be a recycle organic energy from a unit of production to an other unit of production with an assistance from EM Technology and other supporting technology, to produce products with a high value to finance waste management as a whole and gain profits from such efforts.

Method of Handling Organic Waste in Integrated Way

Method of handing organic rubbish can be done by way of:

1. Transporting the organic and inorganic waste from temporal disposal and household to the final disposal by truck.
2. Separation of organic and inorganic waste by manpower.
3. Separation of organic based on the types (plastic, bottle, rubber, paper, iron, aluminum etc.) and then marketed to factory to be recycled.
4. Separation of organic waste based on the types:
    a) Which is eaten by cows and goats
    b) Which can be directly used for fermented organic fertilizers (Bokashi).
    c) Which can be used for worm feed
5. Dung of cows and goats are used for worm feed
6. The remains of cattle feed is used for Bokashi
7. Dirt of worm is used for organic fertilizer
8. Organic rubbish is chopped by using chopper and then fermented with EM for 3 weeks to become Bokashi.
9. Chopped organic waste is sterilized by hot steam and it can be used as a medium for mushroom cultivation
10. The waste of mushroom media can be used for Bokashi and worm feed.

The Scheme of handling organic waste integratedly can be described as in Figure 1

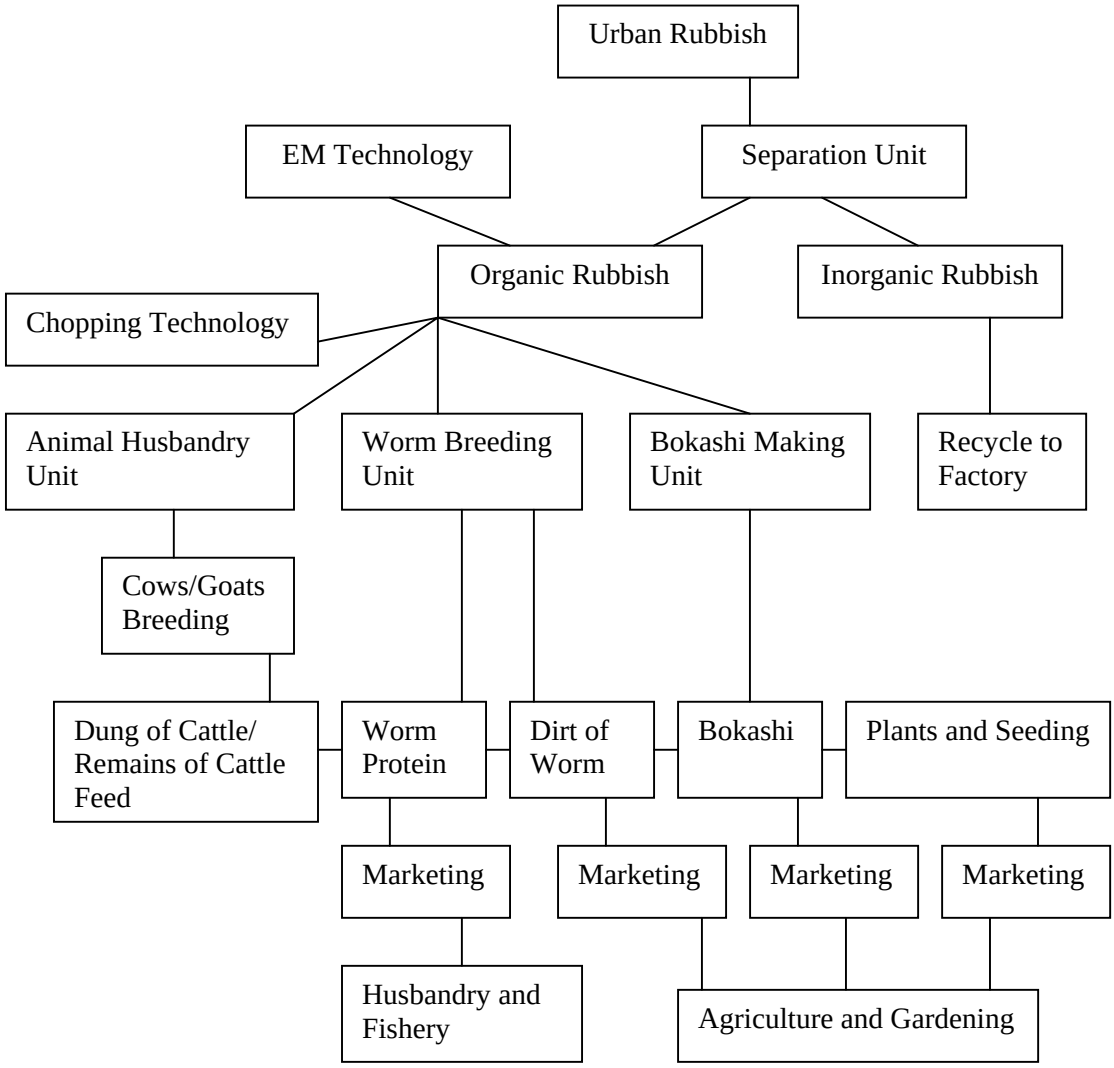

Figure 1. Scheme of Integrated Handling of Organic Waste.

Production Unit Making to Support Recycling

Integrated recycle system of organic urban rubbish is done through production units, where each production unit utilizes organic waste as its raw materials of its productions. Each production produced by each production unit can be distributed or marketed to support agriculture, gardening, fishery and animal husbandry. Production unit and method of implementation supporting recycle is explained in Table 1.

Table 1. Method of Implementation in Production Unit of Handling of Organic Waste Integratedly.

	Production Units	Method of Implementation
1.	Separation unit between organic and inorganic rubbish.	Rubbish collectors, manual
2.	Distribution units of organic rubbish as cattle feed.	Rubbish collectors, manual.
3.	Production unit of fermented organic fertilizer/bokashi.	Chopper machine, fermentation mixing and packing machine
4.	Cattle breeding of cows and goats.	Penning up
5.	Worm breeding unit.	Breeding boxes
6.	Plantation seedling unit.	Plantation in pot/polybags
7.	Mushrooms plantation unit.	House of mushrooms
8.	Education. training and research, development unit.	Field school, field laboratory, research with institution/ universities.
9.	Tourism Unit.	Cooperative promotion with hotels and travel agencies
10.	Marketing of organic/ inorganic waste products.	Distributors/direct selling

Cost Analysis

Integrated recycle of urban organic waste in a management scale of 150 tons of urban waste a day (organic and inorganic) provides an interesting description, that waste management is a profitable business if it is professionally managed. Income analysis from integrated urban waste recycle is described in Table 2.

Table 2. Income Analysis from Integrated Urban Waste Recycle (150 ton waste per day)

No.	Description	Income / day US $	Income /Month (30 days) US $
1	Bokashi (80% contained organic waste, 30% become Bokashi, US $ 0.016 / Kg 80% x 150.000 kg x 30% x US $ 0.016 36.000 kg x US $ 0.016 = 576	576	17,.280
2	Cattle fattening (100 animal units) Assumption : weight increasing of 0.3 kg / day = US $ 0.5 / day 100 x U$ 0,5 = 50	50	1,500
3	Goat fattening (100 animal units) Assumption : weight increasing of 0.1 kg / day = US $ 0.067 100 x 0.067	6.7	201
4	Worm's protein Assumption : Harvesting of 100 kg / kg @ US $ 1.67 100 x US $ 1.67	167	5,010
5	Plant seedling and ornamental plant	12	360
6	Mushroom Assumption : Harvesting of 100 kg / day @ US$ 1.67 100 x US $ 1.67	167	5,010
7	Marketing of recycle anorganic waste (plastic, iron, aluminium, glass, etc) Assumption : 5% from total waste are marketable, US $ 0.034 / kg 5% x 150.000 x US $ 0.034	255	7,650
	Total Income	**1,233.7**	**37,650**

Table 3. Investment Cost and Working Capital of Organic Waste Recycle Project

No.	Description	Investment (US $)	
A	**Investment**		
1	Fermentation Building 120 m x 23 m	83.333	
2	Store house 23 x 60 m	46.000	
3	Office Building 300 m^2	25.000	
4	Cattle stall (100 animal units)	8.333	
5	Goat stall (100 animal units)	4.167	
6	Worm culture building	4.167	
7	Plant seedling house	4.167	
8	Mushroom culture house	16.667	
9	Chopper machine	83.333	
10	Packaging machine	33.333	
11	Sterilizer machine for mushroom culture	3.333	
12	Other machines	6.667	
13	100 Animal units of cattle	25.000	
14	100 Animal units of Goat	5.000	
15	100 Kg of worm seed	1.667	
16	Truck 2 unit	11.667	
	Sub Total		**361,834**
B	**Working Capital (4 Months)**		
1	Labour 128 persons US $ 4/day/persons 128 x 4 x 30 x US $ 4	61.440	
2	Manager & management staff	13.333	
3	EM (1000 l / month, US $ 2.5 / l) 1000 x 4 x US $ 2.5	10.000	
4	Mollas (1000 l/month, US $ 0.3 / l) 1000 x 4 x US $ 0.3	1.200	
5	Gasoline (3000 l / month, US $ 0.167 / l) 3000 x 4 x US $ 0.167	2.004	
6	Diesel fuel (6000 l / month, US $ 0.083 / l) 6000 x 4 x US $ 0.083	1.992	
7	Packaging material	5.000	
8	Concession fee of land (US $ 833.3 / months) 4 x US $ 833.3	3.333	
	Sub Total		**98,302**
	Grand Total		**460,136**

Socialization Program through Training and Sampling

To socialize integrated recycle system of organic urban waste, it is done through training and sampling. Training programs are directed to the students, private and government institutions, environmental observers, senior high school and university students and common people who are interested in handling urban rubbish.

Sampling model on urban waste management on a small scale provided in Institute for Natural Resource Development (IPSA) can give a clear understanding on integrated system applied in each production unit.

Integrated recycle system of organic urban rubbish on a larger scale is done in the final disposal. The purpose is to apply integrated system professionally. Socialization Program of Organic Urban Waste Recycle is described in Figure 2.

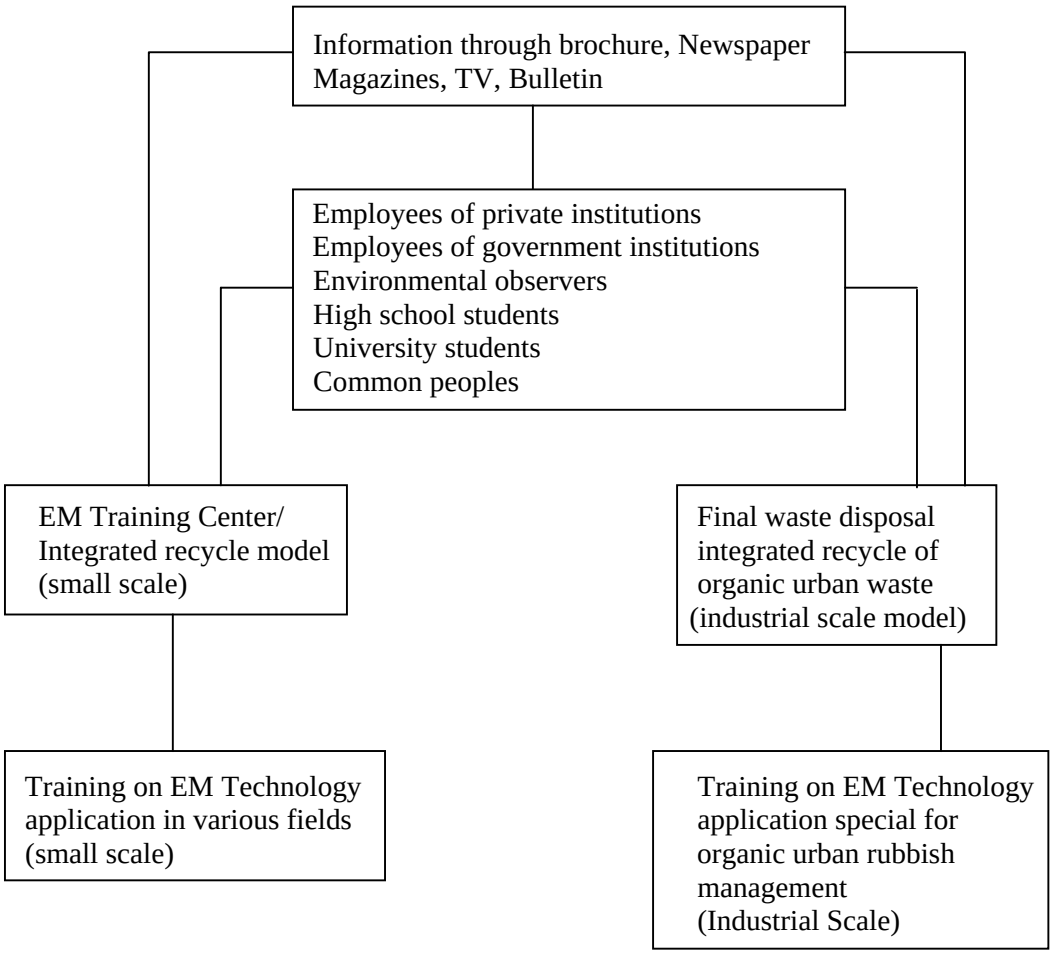

Figure 2. Socialization Program of Organic Urban Waste Recycle.

Towards a Healthy, Clean and Beautiful City

Handling integrated recycle of organic urban waste with EM Technology provides benefits for environmental conservation, health and benefits economically. In brief, the benefits which may be obtained from integrated recycle business of organic urban waste can be described as follows:

1. **Benefit Economically**

Organic urban waste management provides benefit through saving of area utilization cost of final disposal to 50 percent, as all organic waste is reprocessed and utilized for the purpose of agriculture and cattle. Production

unit supporting organic waste management system will produce organic products with additional values and are useful as sources of energy for the development of agriculture, cattle breeding, fishery and gardening. Urban organic waste which is well processed and managed may provide a source of income, work opportunity for organic fertilizer industries and animal husbandry industries, that is to provide organic fertilizer and cattle feed with a low cost.

2. **Friendly Environment**

Processing and management of urban organic waste can conserve environment, free from pollution to the soil, water and air. With EM Technology, organic matter is fermented so that it can be utilized as organic fertilizer, cattle feed, worm feed and mushrooms cultivation.

3. **Healthy and Clean**

Organic urban waste management can create a clean city, urban garden is greener and beautiful. Agriculture is more fertile and has high production as it is provided with organic fertilizers as a result of fermentation of organic waste. Soil, water and air pollution and spread of diseases due to the piling and spoilage of waste in the city can be eliminated to a minimum limit. Urban people become healthier and dynamic as they live in a healthy environment and have a healthy food.

4. **Tourist Attraction**

Tourist visits will increase rapidly if the cities are clean, tidy and friendly to environment. Tourists also want to learn and see how to process urban waste well.

5. **Facilities of Education and Environmental Research**

Final disposal can be used as a field school to study and train on how to process urban waste. The people who will visit final disposal will be diverse and many and they will look for information and knowledge. Elementary school students to university students, teachers, lecturers, researchers and environmental observers, from government and private institutions and all people will want to learn how to process rubbish well.

Sampling model of integrated organic rubbish management in a small scale has been applied successfully in Training and Education Center of EM Technology in Bengkel Village, Busungbiu District, Bali Province, Indonesia. Sampling model of integrated urban organic management on an industrial scale is applied in the Final Disposal in South Denpasar in cooperation with Cleaning and Gardening Service of Denpasar Municipality and Government of Denpasar Municipality.

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For a field visit on integrated urban organic waste management please contact Training and Education Center of EM Technology, Institute for Natural Resource Development, Jl. Pulau Komodo 38 X, Denpasar-Bali, Telephone/Fax. 0361-224917, 262854.
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