Review Article

Management of Municipal Solid Waste by Vermicompost- A case study of Eluru

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ABSTRACT

Solid waste is an unwanted byproduct of modern civilization. Land fills are the most common means of solid waste disposal. But, the increasing amount of solid waste is rapidly filling existing land fills, and new sites are difficult to establish. Alternatives to land fills include the use of source reduction, recycling, composting and incineration, as well as use of land fills. Incineration is most economical if it includes energy recovery from the waste. Energy can be recovered directly from waste by incineration or the waste can be processed to produce storable refuse derived fuel (RDF). Information on the composition of solid wastes is important in evaluating alternative equipment needs, systems, management programs and plans. Household surveys are done in six divisions of Eluru Municipal Corporation, A.P, India and per-capita waste for the corporation is estimated. Pulverization of municipal solid waste is done and the pulverized solid waste is dressed to form a bed and the bed is fed by vermi's which converts the bed into vermi compost. The obtained vermi compost is sent to recognized lab for estimating the major nutrients i.e., Potassium (K), Phosphorous (P), Nitrogen (N) and Micro-nutrient values. It is estimated that 59 – 65 tons of wet waste is generated in Eluru per day and if this wet waste is converted to quality compost 12.30 tons of vermi compost can be generated. If Municipal Corporation of Eluru(MCE) manages this wet waste an income of over rupees 0.89 crores per anum can be earned by MCE which is a considerable amount for providing of better services to public.

Keywords: Municipal Solid Waste (MSW),Vermi Compost , landfill, garbage, Municipal Corporation Of Eluru (MCE).

1. Introduction

There has been a significant increase in MSW(Municipal solid waste) generation in India in the last few decades. This is largely because of rapid population growth and economic development in the country. Solid waste management has become a major environmental issue in India. The per capita of MSW generated daily, in India ranges from about 100 gm in small towns to 500 gm in large towns [1]. The population of Mumbai grew from around 8.2 million in 1981 to 12.3 million in 1991, registering a growth of around 49%. On the other hand, MSW generated in the city increased from 3 200 tones per day to 5355 tones per day in the same period registering a growth of around 67% (CPCB 2000) [2]. This clearly indicates that, the growth in MSW in our urban centres has outpaced the population growth in recent

years. This trend can be ascribed to our changing lifestyles, food habits, and change in living standards. MSW in cities is collected by respective municipalities and transported to designated disposal sites, which are normally low lying areas on the outskirts of the city. The limited revenues earmarked for the municipalities make them ill-equipped to provide for high costs involved in the collection, storage, treatment, and proper disposal of MSW. As a result, a substantial part of the MSW generated remains unattended and grows in the heaps at poorly maintained collection centres. The choice of a disposal site also is more a matter of what is available than what is suitable. The average collection efficiency for MSW in Indian cities is about 72.5% and around 70% of the cities lack adequate waste transport capacities (TERI 1998). The in sanitary methods adopted for disposal of solid wastes is, therefore, a serious health concern. The poorly maintained landfill sites are prone to groundwater contamination because of leach ate production. Open dumping of garbage facilitates the breeding for disease vectors such as flies, mosquitoes, cockroaches, rats, and other pests (CPCB 2000). The municipalities in India therefore face the challenge of reinforcing their available infrastructure for efficient MSW management and ensuring the scientific disposal of MSW by generating enough revenues either from the generators or by identifying activities that generate resources from waste management.

1.1 Per capita quantity of municipal solid waste in Indian urban centers

The quantity of waste from various cities was accurately measured by NEERI. On the basis of quantity transported per trip and the number of trips made per day the daily quantity was determined. The quantity of waste produced is lesser than that in developed countries and is normally observed to vary between 0.2-0.6 kg/capita/day. Value up to 0.6 kg/capita/day is observed in metropolitan cities in the table [1] below. The total waste generation in urban areas in the country is estimated to be around 38 million tones per annum [3]. Forecasting waste quantities in the future is as difficult as it is in predicting changes of waste composition. The factors promoting change in waste composition are equally relevant to changes in waste generation. Storage methods, salvaging activities, exposure to the weather, handling methods and decomposition, all have their effects on changes in waste density.

Table 1: Quantity Of Municipal Solid Waste In Indian Urban Centers

Population Range (in million)	Number of Urban Centers (sampled)	Total population (in million)	Average per capita value (kg/capita/day)	Quantity (tones/day)
<0.1	328	68.300	0.21	14343.00
0.1-0.5	255	56.914	0.21	11952.00
0.5-1.0	31	21.729	0.25	5432.00
1.0-2.0	14	17.184	0.27	4640.00
2.0-5.0	6	20.597	0.35	4640.00
>5	3	26.306	0.50	13153.00

1.2 Town Profile

Eluru, previously known as Helapuri and has a rich cultural and political history. It was a part of Buddhist Kingdom called Vengi. During the Chalukyas (700 AD – 1200 AD), Eluru was a province. Later on Eluru remained a part of Kalinga Empire. During division of

Northern cirkaras into district, Eluru made a part of Machilipatnam district. Later it was included in the Godavari district in 1859. Subsequently, Eluru made part of Krishna district. Finally in the year 1925, West Godavari District was formed with Eluru as its headquarters. Eluru town is situated at 16.7^0 N latitude and 81.1^0E longitude on the Kolkata – Chennai National Highway (NH5). The Visakhapatnam – Chennai railway line passes through the town. .Eluru was a selection grade municipality of Andhra Pradesh. It has been upgraded to Municipal Corporation on 09.04.2005. The area of Eluru Municipal Corporation is 14.55 Sq.km with a population of 1,90,062 as per 2001 Census. It would be seen that during the last decade Eluru experienced a negative population growth [4].

1.3 MSW availability

It is understood by house hold survey, that 70 to 75 tones of MSW in ELURU is being generated every day. The available quantities can safely and conveniently generate about 3 MWs of power or can be converted in to vermin compost as manure for farmers.

1.4 House Hold Survey

To collect the house hold garbage first of all pick 10% of houses in the division so that the sample shall be correct. In collecting sample there must include all the type of constructions like schools, colleges, factories, hostels, hospitals etc., The samples are collected separately i.e., wet (vegetable waste, kitchen waste etc) & dry waste (papers, room waste, bags, boxes etc). This sampling process is continued for seven days so that we can predict the average value. The results of the analyses show that MSW contains Organic matter and miscellaneous materials (bricks, fine dust, rubber, wood, leather, wastewater, etc.). The percentage of recyclable materials (glass, paper, plastic, metals) has been found to be very low. This may be due to rag pickers, who collect and segregate recyclable materials from collection points and disposal sites. The results from the survey reveal that the per capita MSW generation rate is nearly 0.12 kg/capita/day. The per capita generation rate for various areas in Eluru city calculated. This rate varies from 0.14 kg/capita/day in Division-23 to 0.09 kg/capita/day in Division-50 where as 0.6 kg /capita/day generation of MSW observed in metro cities. The house holds are selected randomly from the divisions so that the entire area of the division is covered. The opinion of the public regarding the services of MCE collected from the questionnaires.

2. What is Vermiculture

Vermicompost is an organic manure (bio-fertilize) produced as the vermicast by earth worm feeding on biological waste material; plant residue. Earthworms are small, soft, cylindrical bodied invertebrates that play a vital role in soil ecosystem maintenance. Earthworms greatly influence soil properties and cast production, which results in the continuous turnover of the soil and mixing of minerals and organic constituents. Worms that live in the soil are the farmer' and gardener's friends. Vermi compost, the end product, is extremely useful for enriching and fertilizing the soil. It is odorless and safe to handle. It is rich in hormones, antibiotics and vitamins that produce healthy plant growth. Although its nitrogen, phosphorus and potassium values are not as high as for chemical fertilizers, it is a multi-purpose compost that provides all the ingredients needed to improve most soils and is much better for the environment as well. Vermi compost is also seven times richer than compost that has been rotted without introduction of worms, so only one seventh of the quantity is needed to enrich the soil. Tests in India have shown that vermin compost application can

double wheat yields and quadruple yields of fodder. For best effect vermin compost needs to applied before the growing season over a two or three year period [5].

Table 2: Nutrient Content Of Vermicompost

NITROGEN	0.8 to 1.0 %
PHOSPHOROUS	0.8 to 1.0 %
POTASH	0.8 to 1.0 %
CALCIUM	0.44%
MAGNESIUM	0.15%
IRON	27.3 ppm
MANGANESE	16.4 ppm
ZINC	18.0 ppm
COPPER	7.6 ppm

Table 3 - Dosage Of Compost

FIELD CROPS	2 tones / ha
HORTICULTURE CROPS	200 gm / plant (Young) 5 Kg / tree (Matured)
FOREST	200 gm / plant (Young)
ORNAMENTAL	50 gm / pot

2.1 Method of Preparation of Vermicompost

A thatched roof shed preferably open from all sides with unpaved (katcha) floor is erected in East-West direction length wise to protect the site from direct sunlight. A shed area of 12'X12' is sufficient to accommodate three vermin beds of 10'X3' each having 1' space in between for treatment of 9-12 quintals of waste in a cycle of 40-45 days. The length of shed can be increased/decreased depending upon the quantity of waste to be treated and availability of space. The height of thatched roof is kept at 8 feet from the centre and 6 feet from the sides. The base of the site is raised at least 6 inches above ground to protect it from flooding during the rains. The vermin beds are laid over the raised ground as per the procedure given below [6]. The site marked for vermin beds on the raised ground is watered and a 4"-6" layer of any slowly biodegradable agricultural residue such as dried leaves/straw/sugarcane trash etc. is laid over it after soaking with water. This is followed by 1" layer of Vermi compost or farm yard manure. The loaded waste is finally covered with a Jute Mat to protect earthworms from birds and insects. Water is sprinkled on the vermin beds daily according to requirement and season to keep them moist. The waste is turned upside down fortnightly without disturbing the basal layer (vermin bed).The appearance of black granular crumbly powder on top of vermin beds indicate harvest stage of the compost. Watering is stopped for at least 5 days at this stage. The earthworms go down and the compost is collected from the top without disturbing the lower layers (vermin bed). The first lot of Vermi compost is ready for harvesting after 2-2 ½ months and the subsequent lots can be harvested after every 6 weeks of loading. The vermin bed is loaded for the next treatment cycle. A tractor load of MSW is collected and it is dumped in the dump yard.

- The MSW is segregated i.e all the dry wastes such as clothes, carry bags and other dry wastes are segregated from wet waste.

- The wet waste is pulverized and arranged in the form of bed of dimensions as per the table below.

Table 4 - Dimensions of the Vermi Bed

LENGTH	60 inches
WIDTH	49 inches
HEIGHT	23 inches

- The bed is wetted and the compost is prepared according to the above procedure shown in images[1] to [11].
- There will no changes in the dimensions of bed and in the weight of MSW when it changes to vermin compost.
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2.2 Multiplication of Worms in Large Scale

Prepare a mixture of cow dung and dried leaves in 1:1 proportion. Release earthworm at the rate 50 numbers/10 kg. Of mixture and mix dried grass/leaves or husk and keep it in shade. Sprinkle water over it time to time to maintain moisture level. By this process, earthworms multiply 300 times within one to two months. These earthworms can be used to prepare vermin compost.

Figure1 : Pulverisation

Figure 2: Segregation

Figure 3: Separation

Figure 4: Preparation Of Vermi Bed

Figure 5 Vermi bed

Figure 6: Watering of bed

Figure 6: Images of gradual change of MSW to Vermicompost

Table 5 - Nutrient Values Of Prepared Vermi Compost By Lab Analysis

SL.NO	***TESTS***	***UNITS OF MEASUREMENT***	***RESULTS OBTAINED***
1	**NITROGEN (as N)**	% by mass	1.02
2	**PHOSPHORUS (as P)**	% by mass	0.13
3	**POTASSIUM (as K)**	% by mass	0.27
4	**MAGNESIUM (as Mg)**	% by mass	0.06
5	**ZINC (as Zn)**	% by mass	0.010
6	**BORON (as B)**	% by mass	<0.001
7	**COPPER (as Cu)**	% by mass	0.003
8	**IRON (as Fe)**	% by mass	0.41
9	**MANGANESE (as Mn)**	% by mass	0.03

3. Applications of Vermicompost

Add 15 - 20 gms of Vermi Compost to a liter of water and use this to water potted plants daily. Use 1 part of Vermi Castings, 1 part sand and 1 part garden soil and mix well before use. Sprinkle Vermin Compost on surface of the soil and water as usual. Repeat every 40 - 50 days. Prepare the nursery bed, mix vermi castings, with top soil (1 Kg / Sq. m) plant and water the grass. For Crop like Paddy, Ragi and Legumes, Sugercane, Cotton, Vegetables etc., apply 300 to 500 Kg / acre by broadcasting. Apply 1 - 3 Kgs / tree (depending upon age) twice a year. For Crops like Coconut, Rubber, Groundnut, Mango, Cashew and other plantation crops like:

Table 6: Application of Vermicompost for different fields

BANANA	1 metric ton / acre
FLOWERS	2 metric ton / acre
GRAPES	1.5 metric ton / acre
TEA	1.5 metric ton / acre
COFFEE	1 metric ton / acre
MULBERRY	1 metric ton / acre

Table 7: Vermicast vs. Chemical fertilizers in soil

CRITERIA FOR COMPARISON	***CHEMICAL FERTILIZERS***	***VERMICAST***
Macro nutrient contents	Mostly contains only one (N in urea) or at the most two (N &P in DAP) nutrients in any one type of chemical fertilizer	Contains all i.e nitrogen (N), Phosphorus (P) & potassium (K) in sufficient quantities
Secondary nutrient contents	Not available	Calcium (Ca), magnesium (Mg) & Sulphur (S) is available in required quantities
Micro nutrient contents	Not available	Zinc (Zn), boron (B), manganese (Mn), iron (Fe), copper (Cu),molybdenum (Mo) and Chlorine (CI) also present
pH balancing	Disturb soil pH to create salinity and Alkalinity conditions	Helps in the control of soil pH and checks The salinity and alkalinity in soil
EC errection	Creates imbalance in soil EC affecting Nutrients assimilation	Helps in balancing the EC to improve plant Nutrient adsorption
Organic carbon	Not available	Very high organic carbon and

		humus Contents improves soil characteristics
Moisture retention capacity	Reduces moisture retention capacity of the soil	Increases moistures retention capacity of the soil
Soil Texture	Damages soil texture to reduce aeration	Improves soil texture for better aeration
Beneficial bacteria & fugi	Reduces biological activities and thus the Fertility is impaired	Very high biological life improves the soil Fertility and productivity on sustainable basis
Plant growth hormones	Not available	Sufficient quantity helps in better growth And production

3.1 Total Vermicompost that Can Be Obtained From Eluru Town

Total waste generated in ELURU per day = 58.55 tons

45-60% of food and garden waste is available in total waste for low income cities

Total food and garden waste available per day = 58.55*0.525

= 30.74 tons

Compost obtained from the solid waste = 30.74*0.4

= 12.29 tons

3.2 Cost Analysis

Estimated cost of 0.001 ton of compost : Rs. 2/-

Estimated cost of 12.3 tons of compost : Rs. 24,593

Income that can earn by MCE per day : Rs. 24,593

Income that can earn by MCE per anum : Rs. 0.89 crores

Table 8: Wages for workers engaged in the collection of MSW

SL.NO	POST	WAGES PER ANNUM in Rs.
1	Senior permanent workers	1,08,000
2	Junior permanent workers	84,000
3	Dokras	46,800

3.3 Expenditure of MCE In The Collection Of MSW

Senior permanent workers = Rs. 1,08,000*100 = Rs. 1.08 Crores per annum

Junior permanent workers = Rs. 84,000*250 = Rs. 0.67 Crores per annum

Dokras= Rs. 46,800*145 = Rs. 0.06 Crores per annum

Fuel = 64 Liters*33 Rs*300 Day = Rs. 0.06 Crores per annum

Total expenditure per Annum = Rs. 3.91 Crores

Therefore, by managing the wet waste generated in the town MCE can earn Rs 0.89 Crores per annum, which is a considerable amount for providing better services.

4. Conclusions

The municipal corporations being the responsible authority in India for MSW in addition to wide range of responsibilities related to health and sanitation, have not been very effective as far as MSW services are concerned. Collection, transportation and disposal of all the three components of waste lack in terms of infrastructure, maintenance up-gradation however, the weakest link in the chain of waste management in Indian situations is the collection of waste.

This analysis unambiguously shows that recycling impact is of importance in the prediction of solid waste generation. The degree of accuracy of this model is determined by the reliability of the published information, which has been provided by MUNICIPAL CORPORATION OF ELURU.

Experience indicates the estimation of solid waste generation is crucial for the subsequent system planning of solid waste management in the metropolitan and rural regions from both short and long term perspective. However, a complete record of solid waste generation and composition is not always present. The central idea of VERMICOMPOST is not only to manage the solid waste system by producing wealth from it but also to save the environment from pollution..

5. References

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