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Conversion of Solid Waste into Bio Fertilizer by Vermicomposting- a Case Study of Padmanadapuram

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ABSTRACT: Solid waste is one of the major environmental harms of Indian super cities. Nowadays most of the landfills are covered by solid waste because of this it is very difficult to set up new sites so we are in the need of managing solid waste .Solid waste management (SWM) is the effective process for managing solid wastes. Solid waste can be managed by the methods that are Incineration,composting,gasfification,refuse derived fuel(RDF).By using incineration we can convert the wastes into energy and the waste can also be modified into storable RDF.SWM comprises actions related with generation, storage, collection, carrying, handling and clearance of solid wastes. Useless administration of solid waste is hazardous to human beings and it also a foundation for a severe environmental harms. In this paper we have taken solid waste management regarding Padmanadapuram municipality (PM), Tamilnadu, India and we converted the solid waste into fertilizer by ecological method Vermicomposting. Household surveys are done in four divisions of PM and annual waste from the municipality is calculated.Waste from the municipality undergoes pulverization technique then the grinded solid wastes are arranged as a bed .we just fed up the bed with vermi's that converts the bed into vermicompost.
The gained vermi compost is sent to standard lab for assessing the major nutrients i.e., Potassium(K), Phosphorous (P) Nitrogen (N). By using this vermicomposting technique we can produce compost of 0.8 ton from 2 tons of degradable waste. In our study we conclude that PM can produce 9.36 lakhs per annum using this vermicomposting method. This is a noteworthy turnover for providing better facilities to public.

KEYWORDS: Solid Waste Management (SWM), Vermicompost, Recycling, landfills, Padmanadapuram Municipality (PM).

I. INTRODUCTION

Inthe last few decades, there has been a tremendous increase in MSW production in India. This is mainly due to the growth of population and economic growth in the country. Indian population increased by more than 181 million during 2001 – 2011, a 17.64% increase in population, since 2001.Solid waste management is one of the main environmentalissues in India. The per capita of MSW generated daily, in India ranges from about 120gms insmall towns to 530 gms in large towns [1]. The population of Mumbai grew from around 18million in 2000 to 24.3 million in 2014, listing a growth of around 49%. On the otherhand, MSW generated in the city improved from 5455 tons per day to 8549 tons per day inthe same period listing a growth of approximately 67% (CPCB 2000) [3].This shows that MSW increases with population. The Solid Waste Management (SWM) is one of the important obligatory functions of the urban local bodies in India. Over the years, the Solid waste is generated by different category of waste producers like domestic, Household, organizationsand Factories etc. Solid waste management is one among the major challenges faced by the state governments in urban areas. These solid wastes are collected and disposed by the municipality. Solid Waste Management is a science associated with the management of generation, storage, collection, transportation, processing and disposal of solid waste using the best principle and practices of public health, economics, engineering,

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conservation, aesthetics and other environmental conditions. Because of low revenues in municipalities they are ill-equipped to manage solid waste effectively. The inadequately maintained landfill sites are more prone to groundwater contamination because of leach ate production.

Open dumping ofgarbage provides the way for the breeding of disease vectors such as flies, mosquitoes, cockroaches, rats, and other pests.Inorder to effectively manage the solid waste here we are going to use vermin composting method. Nonstop use of chemical fertilizers more than the years without concerning for sustaining the soil balance has become counterproductive. Scientists are getting worried about the condition and suggesting to use bio-fertilizers. In order to maintain the soil balance, they also suggest to use some other organic manures in enough quantities Farmers are now influenced about the importance of organic manures but availability of the good worth organic manures is the crisis. Within short time good quality organic manure will be created by vermicomposting. A increasing number of individuals and institutions are having interest in the manufacture of compost exploiting earthworm activity.

Vermi-compost is nothing but the manure produced as the vermi-cast by earth worms. Earthworms are fed up by biological waste material and plant residues. The resulting compost is a fragrance-free, clean organic material with adequate quantities of N, P, K and several micronutrients vital for plant growth. By adding 11 tones vermi-compost per hectare, 23%-52 % of nitrogen can be condensed. It not only reduces the fertilizers cost but also improves and increases the yield by 5-10 per cent.The concentration of the available nutrients will be higher than the ordinary FYM.Because of this the plants will have the ability to fight against insects, pests and diseases. Due to the presence of soil required nutrients, it enhances soil arrangement and improves physical properties of the soil like soil-air, soil-temperature, soil-water conservation and soil perfunctory impedance. Vermi-composting offers the nutrients and growth enhancing hormones compulsory for plant growth. The flowers, vegetables, fruits and other plant yield grown-up using vermicompost are accounted to have better maintenance quality [4].

A.PER CAPITA MSW GENERATION OVER YEARS IN INDIA

Per capita waste generation is the amount of waste generated by one person in one day in a country or region.Based on the region's lifestyle and the size of the city, waste production rate ranges from 2000 to 5000 tons/day. The per capita waste creation is growing by about 1.3% per year in India [6]

Table 1: Per capita urban MSW generation [6]

Year	Population(millions)	Per capita	Total waste generation (Thousand tons/year)
2001	196.4	0.476	32.64
2011	261.2	0.500	48.30
2021	343.9	0.570	72.20
2031	452.9	0.653	110.01
2036	519.7	0.699	131.24
2041	597.5	0.750	160.96

From the table we come to know that population in 2001 dramatically increases by 26% in 2041.Based on the population, per capita solid wastes also get increases.

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B.ABOUT PADMANADAPURAM MUNICIPALITY

Padmanadapuram municipality is the second largest municipality in the Kanyakumari district in Tamilnadu. As per 2001 census the Population is 20075 and as per 2011 census the population is 21151. Total Number of Quantity of waste/day is 4.0 Metric ton.There is only one disposal site which is located at Marunthu Kottai, 3 Km away from the town. And the Total area of the Disposal site is 6.31 Acres. There are 42 sanitary workers in this municipality. In this Municipality the process of collection of waste in two methods one is Primary Collection and Other one is Secondary Collection. There are various forms of vehicle used for the collection of waste. Based on primary collection there are 30 push carts and one auto. In secondary collection there are two lorry and one dumper placer lorry and 20 bins. The collection time of wastes is 6am-11am and 2pm-5pm.[2]

C.HOUSE HOLD SURVEY

For this first we should select 10% of houses from each division in order to get correct sample.From each house garbage's are get collected. Here constructionslike schools, colleges, factories, hostels, hospitals etc., also must be included. The samples are collected separately i.e., wet (vegetable waste, kitchen waste etc.) & dry waste (papers, room waste, bags, boxes etc.). This sampling process must be continued for seven days so that we can calculate the average value. The analysed result shows that MSW containsboth Organic matter and miscellaneous materials (bricks, fine dust, rubber, wood, leather, wastewater, etc.). Only very low percentage of recyclable materials (glass, paper, plastic, metals) has been found. The results from the survey reveal that the per capita MSW generation rate is nearly 500 kg/capita/day. The per capita generation rate for four divisions in PM is calculated. The households areselected randomly from the divisions so that the entire area of the division is covered.

II. VERMI COMPOSTING

Vermi Composting is a bio oxidation and stabilization process of organic matter that involves the joint action of earthworms and bio organisms and does not involve thermophilic agent. Vermicompost is nothing but the excreta of earthworms, which is rich in humus and nutrients. In this process the organic waste gets breakdown and fragmented by earthworms resulting in a stable nontoxic material with good humus material that can be used as a soil conditioner. The earthworms are in fact, used in this process as the agents for turning fragmentation and aeration. Only segregated wastes or domestic food waste can be composted through this process. Vermi pits are generally made having a maximum depth of 2'6", width of 5 to 6 feet and can have any suitable length.

A.FEEDING FOR EARTHWORMS

Earthworms are mainly fed up with the decomposing organic matter found in the soil. They usually eat leaf, vegetable wastes that is available on the soil. They do not feed any oil items, dairy products, salty foods, meat, bone and all.

Helpful worm feeding tips

The given food must be cut into smaller pieces. This cutting process decreases the feeding time of worms. Worms usually eat bacteria emerging on the food waste. Along with the bacteria it also takesvery small portion of food. Food must be exposed to the external surface. Whenever food exposes to outer surface more, it will breakdown easily so the worms can easily eat their food. Avoid mixing the food, because mixing will make the food to release water so our vermicompost will be too wet. Small pieces of food are healthier and better.[5]

B.NUTRIENT CONTENT

Vermicompost consist of many essential nutrients. Vermicomposting process is organic, non-burning. Vermicompost contains eight times as many microorganisms as their feed, which promotes healthy plant growth .one ton of earthworms will produce same one ton of organic compost [4].

When compared with soil, worm casts also contain:

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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

In addition to the nutrients listed above it also rich in acids. These acids are very important to maintain soil to have perfect pH balance and to have more plant growth factors.

C.**BEDDING MATERIALS**

Suitable bedding materials include:

1. Shredded or mulched paper such as newspaper (non coloured)
2. Cardboard
3. Shredded fall leaves
4. Chopped up straw
5. Sawdust
6. Dried grass clippings
7. Peat moss
8. Fibrous garden matter such as corn husks

D.TEMPERATURE

The optimum temperature for earthworms is between 55-77 degrees. To remain active during winter, the system should be maintained at a temperature above 10°C. Surrounding soil temperature plays important role in reproduction. Temperatures between 60 and 70 degrees Fahrenheit are more suitable for cocoon production and hatching.Worms can't live in temperatures below icy or above 95 degrees Fahrenheit. Worms consume and digest their food at temperatures greater than 77 degrees Fahrenheit. Growth and activity of earthworms mainly based on the temperature we maintain.

E.SUNLIGHT

Earthworms dislike bright lights. It mostly found in dark and under soil. One hour's exposure to ultraviolet rays from strong sunlight is more than enough for their healthy growth. A worm breathes only by their blood capillaries.Capillaries take oxygen from the air or water. If the body covering of the worm dries up, the worm suffocates. So vermicompost bed should not be exposed to sunlight for a long time.

F.ADVANTAGES OF VERMICOMPOST

- Vermicompost contains more needed plant nutrients. It also helps in overall plant growth especially the growth of new shoots / leaves.
- Vermicompost does not have any bad odour so it is easy to store and handle.
- It advances soil structure, quality, ventilation, and water holding capacity and also avoids soil erosion.
- Vermicompost have earthworm eggs so the population automatically gets increasing and activity of earthworm also increases in the soil.

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- It counterbalances the soil fortification.
- It prevents the increased use of chemical fertilizers. Vermicompost plays down the commonness of pest and diseases.
- It boosts the disintegration of organic matter in soil. It contains valuable enzymes, hormones and vitamins.

G.PROCESSING OF VERMICOMPOST

The operating procedure for vermicomposting is explained as follows as day to day manner.
1. First of all we have to pulverize the collected degradable waste from the municipality. Pulverization is nothing but the process of grinding solid substances into loose tiny particles.
2. After that we should allot specific sq feet of surface to make bedding with the pulverized waste and bedding materials to make compost. Then we should arrange the wet waste and bedding material as per dimension below

- LENGTH 60 inches
- WIDTH 49 inches
- HEIGHT 23 inches

3. Then purchase Eisenia Foetida species of earthworm and put 40 earthworms for 10 kg waste. This bed must be kept in shed.
4. Moisten the bed frequently for effective production of earthworms.
5. Add some amount of soil to the bedding and put earthworms to it.
6. Add food for the earthworms on the top. Within 3 months nearly 300 earthworms will be created.
7. After eating and digesting the food, the worm will produce castings. When more casting is present, vermicompost is ready to be harvested. Remove the worms, whenever compost is ready.
8. After removing the worms, the whole vermicompost can be removed and store it for later use.
9. Replace the bedding and reintroduce the worms.

Fig 1: Filling with Solid degradableWaste

The waste collected from the municipality undergoes separation process in which degradable (paper, vegetable waste, wood, leaves) and non-degradablewastes (plastics, batteries etc.) are get separated. Fig 1 shows the resulting waste.

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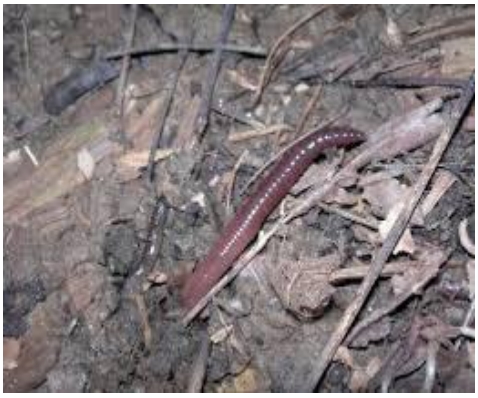

Fig 2: Mixing of worms.

After the preparation and moistening of waste bed, we introduced earthworms into it after 8 days as shown in fig 2.

Fig 3: After 20 days

Earthworms eat and digest their food from the waste. Their excreta get mixed with the bed and it looks like fig 3.After 20 days compost preparation started.

Fig 4: Final Fertilizer

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After 40 days, the compost is ready to harvest. It looks in dark brown colour. Separate the fertilizer from the earthworms and store it for later use.

III.EXPERIMENTAL DETAIL

The amounts of solid wastes are taken as 5 kg for the sample. The solid wastes have been taken for samples are bio-degradable wastes like paper, wood, vegetable waste, dry leaves etc.

B.QUANTITY TAKEN FOR EXPERIMENT

Table 3: Sample 1

Item	Quantity in Kg	Percentage %
Paper	0.5	10
Dry Leaves	1	20
Vegetable waste	3	60
Wood	0.5	10

Totally we took 5 kg degradable solid waste as sample 1.which consist of paper(0.5 kg), Dry leaves(1 kg), vegetable waste(3 kg), wood(0.5 kg).

Table 4:Sample 2

Item	Quantity in Kg	Percentage %
Paper	2	40
Dry Leaves	1	20
Vegetable waste	1.5	30
Wood	0.5	10

Totally we took 5 kg degradable solid waste as sample 2.which consist of paper(2 kg), Dry leaves(1 kg), vegetable waste(1.5 kg), wood(0.5 kg).

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IV. RESULTS AND ANALYSIS

A.NUTRIENT VALUE OF THE SAMPLES ANALYSED

From the sample 1 we got soil essential nutrients like Nitrogen(N), Phosphorous(P), Potassium (K).The amount we obtained is described in the table 5.

Table 5 Nutrient Value Of Sample 1

Sl. NO	Chemical Parameters	Content
1	pH	7.1
2	Salt EC(dSm^{-1})	1.2kg
3	Nitrogen(N)	0.44kg
4	Phosphorous(P)	0.257kg
5	Potassium(K)	1.1kg

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From the sample 2 we got soil essential nutrients like Nitrogen (N), Phosphorous (P), and Potassium (K) .The amount we obtained is described in the table 6.

Table 6 Nutrient Value Of Sample 2

Sl. NO	Chemical Parameters	Content
1	pH	8.41
2	Salt EC(dSm^{-1})	0.8kg
3	Nitrogen(N)	0.92kg
4	Phosphorous(P)	0.35kg
5	Potassium(K)	1.6kg

B.TOTAL VERMICOMPOST THAT CAN BE OBTAINED FROM PADMANADAPURAM

Total waste generated per day = 4000 Kg
Total bio degradable waste available per day = 4000x0.5= 2000 Kg
Compost obtained from the solid waste
= 2000x0.4= 800 Kg

C.COST ANALYSIS

Estimated cost of 1 Kg of compost = Rs. 5/Estimated
Cost of 800 Kg of compost = Rs. 4000
Income that can earn per day = Rs. 4000
Income that can earn per annum
= Rs. 14.40 lakhs

D.EXPENDITURE OF MSW

Senior permanent workers =Rs. 1, 20,000 per annum
Junior permanent workers =Rs. 96,000 per annum
Labours= Rs. 2, 88, 000 per annum
Total expenditure per Annual = Rs. 5.04 lakhs
Profit = 14.40-5.04 = Rs. 9.36 lakhs

V. CONCLUSION

This analysis explicitly shows that recycling impact plays main role in the prediction of solid waste production. The degree of accuracy of this model is determined by the reliability of the published information, which has been provided by PADMANABAPURAM MUNICIPALITY .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 but also to save the environment from pollution. From this vermicopost we can earn more money. In our study we conclude that we can earn 9.36 lakhs per annum using this vermicompost method in padmanadapuram municipality.

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