

# Solid Waste Management Plan for an Academic Institution: A Case Study

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**Abstract:** Increase in the scope and advancement of technology and science results in increasing the standards of living of the people in the society that led to exploitation of natural resources which in turn increases the pollution. Enormous increase in population over few decades results in increase in number of educational institutions complying with the demands of increasing population. In India, as per a report there are 700 universities and 35000 affiliated colleges having 20 million students studying in it. Imagine the quantum of waste that is being generated by these institutions, The study aims to achieve a sustainable and integrated design, for solid waste management of an institution, specifically solid waste generation from Madhav Institute of technology and science Gwalior and for similar higher educational institutions. Present study embarked on a series of efforts aimed at collection of generated waste data from educational institute and defining the mechanism of composting and vermicomposting, the two processes should be run in isolation, composting should always precede vermicomposting. Hence, to achieve optimal results. By conducting detailed analysis of the steps associated with composting and vermicomposting based on the previous analysis of experiments done by authors, it is envisaged the basis for developing the criteria with which vermicompost units can be designed and operated in an institution.

**Keywords-** Population, Solid waste management, Pre-composting, Vermicomposting, Design.

## Introduction:

Waste generation is a natural phenomenon, when a society of Homo sapiens live, it comes out as a used resultant of products as they used to feed on materials. Not specifically sapiens every living organism on planet is obsessed with producing waste, it is an essential outcome. Solid waste can be any material in the flow pattern that is rejected by the society. Though recycling has changed the definition of what is rejected by the society.

Being producer consumer or decomposers, production of waste is a functional and essential part of routine life cycle, Therefore the management of waste in an integrated and sustainable way is essential and vital to maintain public health standards and aesthetics as accumulation of waste may cause chaos in the society and it can be a hurdle in the developing economy of a nation.

In India generally, Municipal body is responsible for collection, handling and sorting. India is a developing nation and have an enormous mass of population and the generation of waste has bloomed since the last three decades due to rapid urbanization which has caused tremendous increase in the difficulties of municipal corporation from collection to disposal.

The Historical city of Gwalior is located in the heart of India Madhya Pradesh. The city is situated in the north of Madhya Pradesh in the Chambal river valley and is fully landlocked from all the sides. The city is known for its historical fort, buildings and Mesmerising Temples. The climate of Gwalior witnesses the scorching summers where the temperature reaches as high as 48 degree centigrade. On the other hand, the winters here are chilling and the temperature dips to almost Zero degree centigrade as minimum. The city experiences 90 cm. of annual average rainfall, most of which takes place during monsoon months (June-September) only.

**Study area-**

Self-study Report  
Madhav Institute of Technology & Science, Gwalior (M.P.)

**THE EXISTING INFRASTRUCTURE OF MITS CAMPUS**



**Fig. 1: Plan of campus and its infrastructure.**

This study is carried out in Madhav institute of technology and science (MITS Gwalior) which is one of the prominent technical institutions of India. The institute is a home for approximately 5000 students. 8 Activity areas were selected with reference to the existing infrastructure of the campus to cover major waste generating regions in the campus, following are the selected Activity areas-

- Campus main building..... (Activity area 1)
- Hostels..... (Activity area 2)
- Central library..... (Activity area 3)
- Biotechnology building..... (Activity area 4)
- Garden Vicinity area (Trees)..... (Activity area 5)
- Hostel’s mess..... (Activity area 6)
- Canteen..... (Activity area 7)
- Cafeterias and bookstore..... (Activity area 8)

**Waste Survey-**

Ever since when design is of concern, it is mandatory to have a detailed survey of the related entities that can influence the design data directly or indirectly, Hence an assessment of waste in the campus is carried out for the characterization of waste, for the suitability of the site and the type of treatment that will be needed to achieve the objectives i.e. design of treatment unit.

**Sampling Procedure-**

To have a detailed knowledge about the generating waste in the campus sampling needs to be done, The data from all the Activity areas is taken in account for consecutively six days (excluding Sunday) during the month of April 2019. For sampling the waste was collected in assist with campus janitorial staff, They were advised to collect the waste from these areas into large polythene bags and label the bags as A<sub>11</sub>, B<sub>11</sub>,... and So on. Sampling was so executed that the per day collected sampled waste is stored in a polythene bags and later the labelled polythene bags sample are collectively analysed to get the final characterization of the waste. Sampling was performed according to the prescribed standards “**Coning and quartering**” sampling approach recommended by NEERI India.

**Waste survey methodology-**

- Waste characterisation for estimation of the waste quantum was performed at every level of each building in the campus. The Activity area 1 i.e. the main building is a single story building having identical floors in terms of layout and floor level.

- The activity area 2 consisting of two hostels of the campus one is for girls and other one is for boys. For solid waste characterization, per day waste from each bin of both hostels and from all the floors is collected and labelled collectively than further proceeded for sampling.
- The activity area 3 is the central library in the campus, The waste generated here is also included in this study so précising the characterization of the waste in the campus, The waste collected from here is also labelled C<sub>11</sub>.....16
- Activity area 4 comprised of three cafeterias and one bookstore, the waste generated from these cafeterias is stored at common place than collected and analysed. Same characterised waste is observed from here for consecutively 6 days.
- Since variety of the type of waste is generated by the students, therefore all the trash bins in the main campus building, hostels and central library are selected.
- For characterisation of representative waste a consecutive six days waste (excluding Sunday) from the Activity area 1, 2, 3 and 4 i.e. the campus main building, Hostels, Central Library and biotechnology building are collected in polythene bags and the waste collected for the day one was marked as A<sub>11</sub>, B<sub>11</sub>, C<sub>11</sub> and D<sub>11</sub>. Similarly, the waste collected for the consecutive days from the above three activity areas were marked as A<sub>12</sub> B<sub>12</sub> C<sub>12</sub> D<sub>12</sub>, A<sub>13</sub> B<sub>13</sub> C<sub>13</sub> D<sub>13</sub>, A<sub>14</sub> B<sub>14</sub> C<sub>14</sub> D<sub>14</sub>, A<sub>15</sub> B<sub>15</sub> C<sub>15</sub> D<sub>15</sub>, and A<sub>16</sub> B<sub>16</sub> C<sub>16</sub> D<sub>16</sub> Respectively.

Pre-assessment of waste from the different activity areas is carried out for the characterization study and following types of accountable waste is found available in the campus-

Characterization study of waste is performed in the activity areas 1, 2, 3, 4 and 8 this is due to the fact that variety of waste is generated by the student in these areas hence by performing waste surveys in these areas there found that waste is being generated from area 1, 2, 3, 4 and 8 are non-biodegradable whereas the waste generated from activity area 5, 6 and 7 is predominantly bio-degradable.

**TABLE 1: Characteristics of waste.**

S.No.	Waste Types
(1)	Organic
(2)	Inorganic
(3)	Plastic material
(4)	Papers and cardboards
(5)	Polythene bags
(6)	Fine earth
(7)	Cans & bottles
(8)	Paper plates & Cups
(9)	Textiles
(10)	Miscellaneous

**Waste quantum:**

- **Quantum of waste generated from Activity area 1, 2, 3 and 4:**

The collection of waste data from these activity areas were collected from the trash bins placed in these activity areas. The waste from all the trash bins in the vicinity of these activity areas were collected in large plastic bags with the help of the janitorial staff of the premises. The per day calculated waste from each activity area kept in large plastic bags were weighed with a weighing balance and record as below-

**Table 2: Activity area 1, 2, 3 and 4 generated waste.**

Generated Weight → DAY ↓	Activity Area 1	Activity Area 2	Activity Area 3	Activity Area 4
Monday	11.3 Kg.	22.65 Kg.	0.75 Kg.	1.50 Kg.

Tuesday	10.90 Kg.	18.76 Kg.	0.92 Kg.	0.80 Kg.
Wednesday	9.50 Kg.	16.49 Kg.	0.29 Kg.	1.25 Kg.
Thursday	12.65 Kg.	19.10 Kg.	0.46 Kg.	1.92 Kg.
Friday	13.20 Kg.	20.90 Kg.	0.37 Kg.	2.68 Kg.
Saturday	8.73 Kg.	13.84 Kg.	0.20 Kg.	1.10 Kg.
<b>Total</b>	<b>66.28 Kg.</b>	<b>111.74 Kg.</b>	<b>3.00 Kg.</b>	<b>9.25 Kg.</b>

Per day average waste generated from activity areas 1, 2, 3 and 4 =  $190.27 / 7 = 27.18 \text{ Kg. / Day}$

- **Garden vicinity area (cutting and trimmings) i.e. organic waste (Activity are 5):**

Majority of waste generated from this activity area was found to be bio-degradable. The number of trips made by collection vehicles for consecutive seven days is observed & noted and the approximate amount of waste carried out by these vehicles is tabulated in TABLE 3. The daily number of trips made by different categories of collection vehicles and the approximate load carried by these vehicles gives the total quantum of organic waste in the activity area. This study is performed in autumn season since the generation of organic waste blooms in this season to have maximum generated values. The average amount of organic waste generated from this activity area is found out to be **106.43 Kg.**

**TABLE 3: Quantum of waste generated from activity area 5.**

DAY	Weight Collected in Large Tarpaulin Sheets	Weight Collected in Small Tarpaulin Sheets	Weight Collected in Two Wheel Burrows	TOTAL
Monday	136.9 Kg.	—	30.1 Kg.	<b>167 Kg.</b>
Tuesday	72 Kg.	19.16 Kg.	15.3 Kg.	<b>106.46 Kg.</b>
Wednesday	79.8 Kg.	27.94 Kg.	13.6 Kg.	<b>121.34 Kg.</b>
Thursday	81 Kg.	—	14.9 Kg.	<b>95.9 Kg.</b>
Friday	46.3 Kg.	36 Kg.	22 Kg.	<b>104.3 Kg.</b>
Saturday	92 Kg.	—	18 Kg.	<b>110 Kg.</b>

Average 7-day generated waste from Activity area 5 =  $745 / 7 = 106.43 \text{ Kg. / Day}$

- **Waste generated from Hostel's mess and canteen (Activity area 6 and 7):**

The campus has two hostels which is inhabited by approximately 500 students. The strength of girls in the hostel is 290 in comparison of 180 boys. Vegetable peelings and cooked leftover food generated from two hostel messes and canteen is calculated by simply weighing the containers collecting waste by using a digital spring balance for consecutive seven days. The daily generated waste is quantified and an average weight of seven days is recorded. The TABLE 4 and 5 Shows the generation of per day leftover food and vegetable peelings waste from the Activity area 6-

**TABLE 4: per day leftover food waste generated from Activity area 6 and 7.**

DAY	LEFTOVER FOOD WASTE (Boys Hostel's Mess)	LEFTOVER FOOD WASTE (Girls Hostel's Mess)	TOTAL
Monday	54.71 Kg.	104.52 Kg.	<b>159.23 Kg.</b>
Tuesday	62.42 Kg.	93.71 Kg.	<b>146.13 Kg.</b>
Wednesday	64.96 Kg.	110 Kg.	<b>174.96 Kg.</b>
Thursday	60 Kg.	106.3 Kg.	<b>166.3 Kg.</b>
Friday	80.10 Kg.	103.83 Kg.	<b>183.93 Kg.</b>
Saturday	58.21 Kg.	90.19 Kg.	<b>148.4 Kg.</b>
Sunday	82.38 Kg.	117.62 Kg.	<b>200 Kg.</b>

Therefore, average leftover food waste per day =  $1178.95 / 7 = 168.42 \text{ Kg. / Day}$ .

**Table 5: Vegetable peelings waste generated from Hostel's mess and Canteen.**

DAY	PEELINGS WASTE (Boys Hostel's Mess)	PEELINGS WASTE (Girls Hostel's Mess)	TOTAL
Monday	25.15 Kg.	33.19 Kg.	<b>58.34 Kg.</b>
Tuesday	19.88 Kg.	28.40 Kg.	<b>48.28 Kg.</b>
Wednesday	22 Kg.	24.9 Kg.	<b>46.9 Kg.</b>
Thursday	27.91 Kg.	30 Kg.	<b>57.91 Kg.</b>
Friday	19.67 Kg.	32.70 Kg.	<b>52.37 Kg.</b>
Saturday	23.21 Kg.	36.33 Kg.	<b>59.54 Kg.</b>
Sunday	30.43 Kg.	44.40 Kg.	<b>74.83 Kg.</b>

Average vegetable peelings waste per day =  $398.17 / 7 = 56.88$  Kg. / Day

• **Waste generated from Cafeterias and bookstore (Activity area 8):**

**Table 6: The Quantum of waste generated from activity area 8.**

Day → Area ↓	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
C <sub>1</sub>	3.3 Kg	2.1Kg.	2.6 Kg.	1.8 Kg.	2 Kg.	2 Kg.
C <sub>2</sub>	1.2 Kg	0.8 Kg.	0.84 Kg.	1 Kg.	0.9 Kg.	1 kg.
C <sub>3</sub>	0.9 Kg	0.5 Kg.	0.7 Kg.	0.35 Kg.	0.5 Kg.	0.6 Kg.
C <sub>4</sub>	1.8 Kg	1.1 Kg.	1.4 Kg.	1.5 Kg.	2 Kg.	1 Kg.
<b>TOTAL</b>	<b>5.7 Kg</b>	<b>4.5 Kg.</b>	<b>5.54 Kg.</b>	<b>4.65 Kg.</b>	<b>5.4 Kg.</b>	<b>4.6 Kg.</b>

Average per day waste from activity area 8 =  $30.39 / 7 = 4.34$  Kg. / Day.

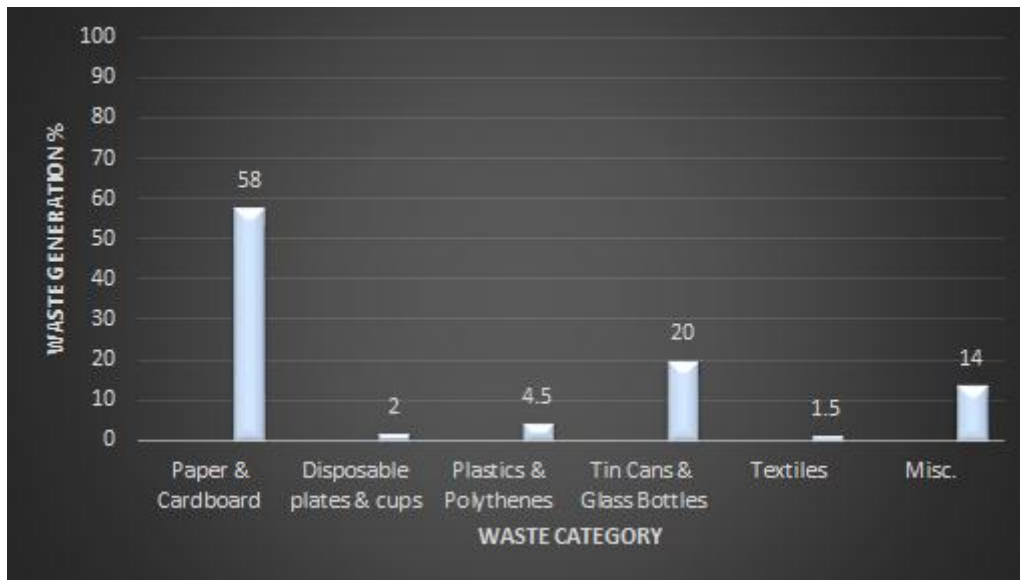
The total bio-degradable waste generating in the campus is calculated and it is found out as "330 Kg. / Day".

**Analysis and compositions of different waste in campus:**

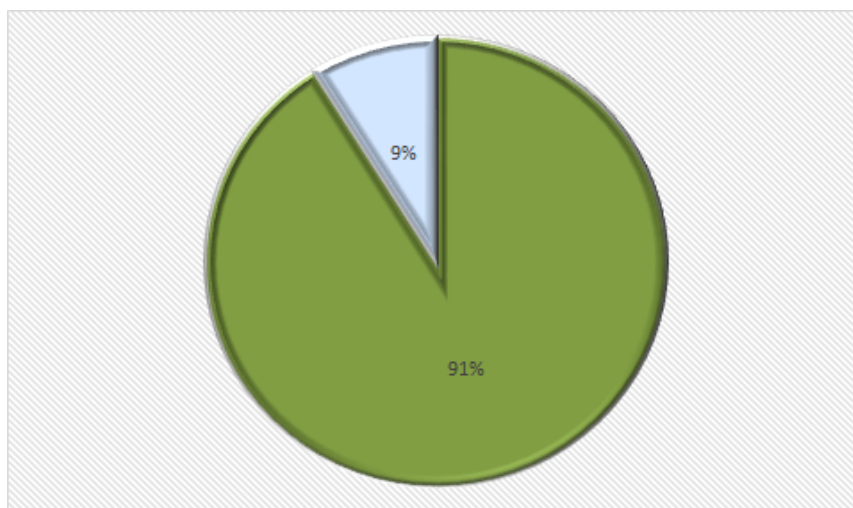
It can be observed from the collective data that the percentage of organic matters in waste stream is very large in comparison to other wastes, behind such a high percentage of organic share in the campus hot and wet conditions of the city can be considered which shows a very large volume of organic waste is generating from the sources like gardens, hostel's Mess and canteen.

since the organic waste composition found very high therefore the mixed waste composition in the activity area 1, 2, 3, 4 and 8 are neglected and the whole waste generated from these areas is considered as non-biodegradable. The percentage composition of different wastes generated in the activity areas 1, 2, 3, 4 and 8 according to their waste categories is shown as-

**Fig. 2: Composition (% by weight) waste generated from activity areas 1, 2, 3, 4 and 8.**



**Fig. 3: Composition (% by weight) of bio-degradable and non-biodegradable waste in the campus.**



The present scenario of the waste management in the campus can be understood by the fact that there are two major dumping zones in the campus one is near the entrance of the campus in the garden’s backyard and other on the entrance from silver jubilee gate, both are near major college routes. The waste generating from the mess and canteen is stored in the buckets till the next day, until collected. The vegetable peelings are thrown in a shallow pit in hostel’s backyard from there a vehicle of municipal authority came in the morning and collect it. The vehicle also collects the generated waste from both dumping zones.

This generated waste from the campus can be optimized with a combination of composting and vermicompost stabilization plant and also the product (or compost) formed can be utilized as manure to in the campus and to maintain lush greenery. Vermicompost not only enhances plant growth but also suppress the disease in plants, increase porosity and microbial activity in soil. Vermicompost also benefits the environment by reducing the need for chemical fertilizers thereby cutting the expenses on fertilizers for plant growth and if manure is generating in excess, revenue can also be generated by selling the manure.

**Proposed treatment (pre-composting followed by Vermicomposting)-**

Worms are unable to feed upon fresh green matter thus the biodegradable waste is initially pre-composted on a compost pad or windrow platform, if vermi-composting operation is initially followed by aerobic composting which facilitates the vermi-composting operation and improves the overall quality of the product.

Pre-composting or aerobic composting is basically decomposition of organic matter into a stable humus like substrate under natural biological processes carried out by micro-organisms in the presence of oxygen and adequate moisture. Bacteria and Fungi in the presence of oxygen breakdown complex organic matter into simpler substances.

Composting worms acts as natural bioreactors and can conduct operations throughout the year as long as environmental conditions favours. Earthworms play a vital role in conversion and breakdown of plant litter in a nutrient rich product or manure this is known from the time of Darwin, Aristotle stated- "Earthworms the intestines of Earth". Darwin was the first one to discover the role of Earthworms that these multicellular creatures can help in break down the organic waste into useful manure of high nutritive value.

### **The Basics: Working with Worms-**

**Bedding-** A stable habitat that serves as a hospitable environment for worms to live, feed and grow is known as bedding. An ideal bedding material protects, provides protection, moisture and allows the flow of oxygen. Mixture of Organic waste with this bedding material accelerates decomposition. Bedding materials can easily be selected as per the local availability. Some common bedding materials can be dry leaves, shredded paper, cardboards, newspaper, hay, horse manure, wood barks, saw dust etc. The efficient bedding should be highly porous as high porosity of the soil favours these creatures to respire through their skin. If a worm's skin dries out, it dies. The water retention of bedding must be fairly well for worms to thrive. Sufficient oxygen is also needed so that worms can grow, multiply and feed easily and make the bedding their rendezvous hence a good bulking potential of bedding

**Worm Food-** Under ideal conditions, a worm can consume food excess to their body weight per day, although the general thumb rule is that they consume approximately the amount of organic waste equivalent to their body weight per day. They eat like monsters and can eat anything organic. Most often these organic waste foods are used as worm feeds. Some commonly used worm feeds are poultry manure, cow dung, sheep and goat's manure, food scraps and peelings, leftover food etc.

**Moisture-** As stated above high porosity is needed to maintain healthy conditions for worms and to maintain high porosity an adequate moisture needs to maintain in the system. Worms are much active in moist soil as compared to the dry one but most of the species of worms found unable to survive flooding, hence an optimum moisture content of almost 50 to 75 percent must be maintained for proper functioning and survival of worms. Available literature suggests that in Indian conditions moisture range of 50 to 60 percent serves every purpose of vermicomposting operations in any system. We are taking this optimum range of moisture for installation of vermicompost system in the premises.

**Aeration-** Worms are oxygen breathers and are unable to survive in the absence of oxygen. Hence a high moisture combined with poor aeration can cause sudden multiple deaths of worms. Proper oxygen is maintained inside the unit with manual turning from shovels or trowels.

**Temperature-** All the species of worms exhibits high growth rate but *E. eugenia* has a wider endurance for temperature in comparison to the other two species which allows the species to often survive in 45 degree Celsius and as low as 5 degree Celsius. Besides these the depth of the wastes cannot exceed 30 cm. due to temperature Harms during the initial thermophilic stage of decomposition.

**pH-** Worms prefers to inhabited under neutral conditions for which the optimum range of pH is 7 to 8. Worms are sensitive to the nature of their surrounding medium. If the pH falls below 6 the worms migrate or killed. Under these conditions pH can be adjusted by adding calcium carbonate if it needs to increase but if it needs to lower the pH acidic bedding can be used.

**Light-** Earthworms are very sensitive to light and they tend to avoid the strong light that's why worms came to the surface only at night i.e. to avoid the light. They detect the light by photoreceptor cells on their skin these cells can trigger pain when exposed to sunlight. Therefore, it is necessary to cover the worms from waste and to prevent the daylight, several techniques can also be used such as use of dark heavy curtains or the system can be covered by banana and palm leaves.

**Predators-** Worms are preyed by many species of snakes, ants, birds, cats, moles, dogs etc. Therefore, safeguard against access to these predators should be provided.

### **Implementation-**

Vermicomposting can be operated in batch, semi batch and in continuous modes. Composting eventually takes 6-8 weeks to form manure whereas the vermicomposting is accomplished as quickly as it takes for a feed to be ingested by an

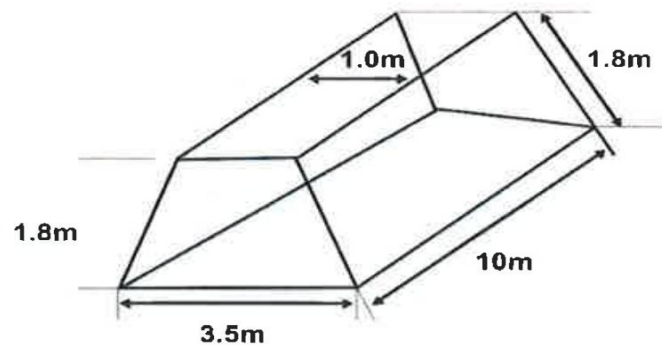
earthworm, digested and excreted i.e. within few hours. This proposed unit uses combination of both pre-composting and vermicomposting, in which the waste is stabilized by pre-composting followed by vermicomposting. In further steps a detailed method to stabilize organic waste where composting was followed by vermicomposting is elaborated-

### **Pre-composting procedure-**

- Firstly, organic waste is segregated from the waste so that no broken glass pieces, gravels or metal pieces are present in the material.
- This segregated organic or biodegradable waste is laid on windrow platforms in long piles to form heaps of waste. Waste is heaped and piled up to a height of 1.5 metre, base width of 2 metre and length can be varied according to the available quantity of waste.

**Fig. 4: Cross-sectional and dimensional view of a Trapezoidal windrow.**

5.



- A care of Temperature and moisture is needed to ensure that sufficient moisture is available in the waste (optimum 55%) and temperature is in a range of 55-60 degree Celsius.
- On each windrow flag boards are placed depicting the age of the waste i.e. from what period decomposition is occurring. The fresh incoming waste is always depicted by "Age 1". The age on the previous windrow is updated by incrementing 1 each day. Thereby changing the numbering on the windrows from Age 1 to Age 2 and Age 2 to Age 3 so on.
- Manually turn waste laying on the rakes at the Day 7 and Day 14, means the Age 7 and Age 14 flag board's windrow are turned. Fresh water is also sprinkled over piles for maintaining adequate moisture if needed.
- Let the process of partial decomposition i.e. pre-composting of waste in the windrows for 14 days hence windrows with flag board Age 14 is ready to transfer for vermicomposting.

### **Vermicomposting of compost procedure-**

- A vermicompost pit of proposed dimension is constructed. Preferably above ground with proper water outlets.
- The waste in the tank is so filled that no greater than 0.75 m. of the depth of the tank is filed, this is done to ensure proper aeration in the tanks and earthworms should not put under high load.
- Prepare the vermibed in the tank by following the below procedure-
  - ✓ Firstly, placing a basal layer vermibed of 3-4 cm. comprising of broken bricks or pebbles followed by a layer of coarse sand to a total thickness of 6-7 cm. to ensure proper drainage
  - ✓ Than 15-20 cm moist layer of sludge is placed. This cattle manure can also mixed with the loamy soil.
  - ✓ Suitable number of earthworms i.e. 1-3 kg/m<sup>2</sup> on an average is introduced into the tank chamber.
  - ✓ Pre-composted biomass can be directly put over the cattle manure in thin layers so that the worms can easily get their food by reaching up to the waste material.



- ✓ The bed is covered with wet gunny bags or palm and coconut leaves to retain the moisture and maintain darkness.
- ✓ Let the bed remain undisturbed, under Indian conditions the entire cycle of vermicomposting takes about 10 weeks. In Pre-composting followed by Vermicomposting 7-8 weeks' time is required.
- During harvesting great care of worms is taken so that they didn't get harmed during their segregation after manure formation. This is done by coning of the vermicompost where the worms move downwards to the bottom, then the vermicompost is carefully scooped out from the top.
- After the tank progressively gets emptied, the last 15-20 cm. layer retaining the worms is used for the next load of waste to be treated.

### 3. Design Specifications-

- **Calculation of waste volume-**

The per day generated waste in the campus = 350 Kg. / Day

Quantum of waste generated in 50 Days = 350 X 50 Kg.

$$= 17,500 \text{ Kg.}$$

#### With reference to CPHEEO Manual-

50 tonnes of waste will generate a total 55 m<sup>3</sup> Volume

Therefore, 1 ton = 55/50 m<sup>3</sup> i.e. = 1.1 m<sup>3</sup>

Volume of 20 Tonnes of waste = 1.1 X 17.5 m<sup>3</sup>

$$= 19.25 \text{ m}^3$$

Volume of organic waste generated in the campus is 19.25 m<sup>3</sup>. This total volume of waste is transferred to the windrows for pre-composting.

According to the CPHEEO Manual there will be 30% reduction in volume of organic waste while Pre-composting in the windrows-

Remaining Volume of waste (m<sup>3</sup>) after pre-composting-

$$= 0.7 \times 19.25 \text{ m}^3$$

$$= 13.475 \text{ m}^3$$

With variation factor of 1.2 total waste = 13.475 X 1.2

$$= 16.17 \text{ m}^3$$

Approximately taking the volume of waste for vermicomposting = 18 m<sup>3</sup>

#### **Dimension of Tanks-**

In design of the tanks for vermicomposting the depth and width of the tanks remain 0.75 m. and 1.5 m. respectively. This needs to be done due to the constraints that the depth cannot be kept greater than 0.75 previously. The width of the tank is taken by keeping into the ease of executing operations like turning and laying of beds from one side of the tank.

Depth = 0.75 metre

Width = 1.5 metre

Total volume of waste = Volume of tank

$$18 = 0.75 \times 1.5 \times \text{Length}$$

Length of the tank = **16 metre**

- Rather than providing a single tank of 16 m. length it would be preferable if 5 tanks of 4 m. length will be provided, an extra tank for maintenance purpose.
- In all the above calculations the depth of the tanks is taken as 0.75 m. but practically it will kept as 1 m., free board of 0.25 m. needs to be provided in all the tanks.

Hence,

**4 tanks need to be provided @ 4 m. X 1.5 m. X 1 m.**

**& an extra tank of same dimension for maintenance purpose**

#### **Calculation of Worms-**

Surface area of one tank =  $4 \times 1.5 \text{ m}^2$

$$= 6 \text{ m}^2$$

Loading rate of worms should be taken in the range of 1-3 Kg. /  $\text{m}^2$

Hence, assuming the loading rate as 1.5 Kg. /  $\text{m}^2$ , number of worms required in a tank will be-

$$6 \times 1.5 = 9 \text{ Kg. of worms}$$

In 4 Tanks, Worms required-

$$9 \times 4 = 36 \text{ Kg.}$$

Approximately each adult worm weights 1 gm. Hence in 9 kg. Of worms there could be approximately 9000 worms. Hence that quantum of worms needs to be introduced into a single tank therefore a total of 36 Kilogram of worms needs to be introduced in the vermicomposting operation in the premises.

#### **Results-**

By following the standard methodologies for waste characterization and calculation in the campus percentage of biodegradable and non-biodegradable waste is found out and it comes to be 91 % and 9 % respectively. The total biodegradable waste generating in the campus from all 8 Activity areas is calculated and it is found out as 350 Kg. approximately whereas non-biodegradable waste is found to be 40 Kg. Approximately. With the data pertaining to the waste calculation in the campus it is calculated that 4 tanks @  $4 \times 1.5 \times 1$  metre and one extra tank for maintenance purpose will be required to stabilize the generating organic waste in the campus. Worms calculations is also made and found out that 9 Kg. of worms need to be introduced in a single tank, hence a total of 36 Kg. worms needed to be introduced into all the tanks. With the above design if the waste generated in the campus is stabilized by following the mentioned procedure it would not only helps the institute to stabilize the generated waste but also helps in the revenue generation if employed on a large scale with proper supervision and execution.

#### **Conclusion-**

A trend of promoting pollution prevention through maximum utilization and calorific production of bio-degradable waste is emerging based on reduce and reuse. Regarding this context, it is proposed here in this paper that every community either they are public or private, institution or hospital should be a part of the solution to manage the generated solid waste. If the waste generating from the institution campus is highly organic in nature, then composting and vermicomposting of compost in combination can be used as a potential alternative for the transformation from unsuitable disposal problem to stabilised manure production for sustainable practices. This would led to increased efficiency in overall management of solid waste by reducing the burden on municipal corporations. Relative simplicity of both the stabilising procedures makes it feasible for everyone to transform bio-degradable waste into end products of higher calorific value that are useful in plant growth. Vermicompost has more beneficial impact on plants rather than normal composting and it is also safer in terms of risk to human and environmental health as compared to direct application of

biodegradable waste on lands or in rivers. In short, vermicomposting preceded by composting should be introduced in the educational institutes so that waste generated can be managed in a more sustainable way.

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