Toolkit

PREPARING CITY SOLID WASTE ACTION PLAN UNDER SBM 2.0

Managing biodegradable waste

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Managing biodegradable waste

Research direction: Atin Biswas

Research: Subhasish Parida

Research support: Shailshree Tewari

Editor: Arif Ayaz Parrey

Cover and design: Ajit Bajaj

Production: Rakesh Shrivastava and Gundhar Das

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41, Tughlakabad Institutional Area
New Delhi 110 062
Phones: 91-11-40616000
Fax: 91-11-29955879
E-mail: sales@cseinida.org
Website: www.cseindia.org

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Introduction

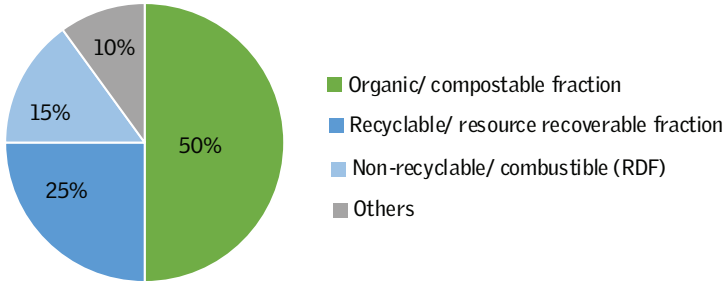
Increasing urbanization, population growth and economic expansion have resulted in the challenge of mounting quantities of solid waste in many developing countries. This holds true for India as well. Managing solid waste has become crucial in order to avoid being drowned under the weight of the waste we generate. Approximately 1,432,000 metric tonne (MT) of municipal solid waste (MSW) is generated from urban areas of the country. This roughly translates to 300–550 g per person per day. Per capita waste generation is higher in metros and other bigger cities and lower in small towns and cities.

Table 1: Per capita waste generation in India

S. no	Urban local body's population category	Per capita waste generation (g)
1	> 10 lakh	550
2	1–10 lakh	450
3	< 1 lakh	300

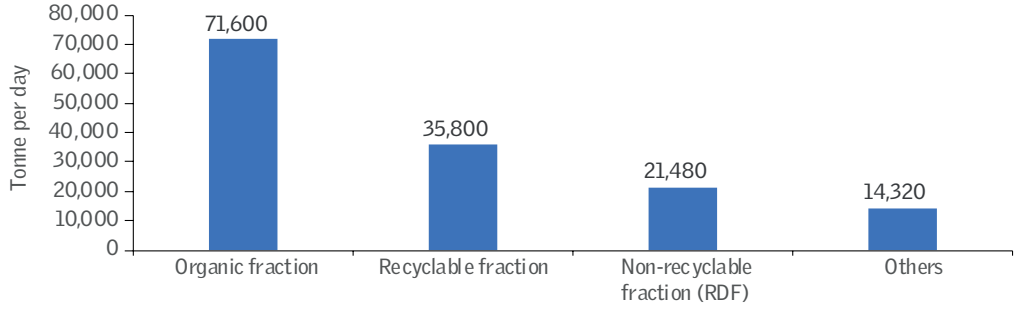
Source: Swachh Bharat Mission 2.0

Graph 1: Composition of municipal solid waste as per Swachh Bharat Mission 2.0



Source: SBM 2.0 guidelines

Graph 2: Share of different fractions in municipal solid waste



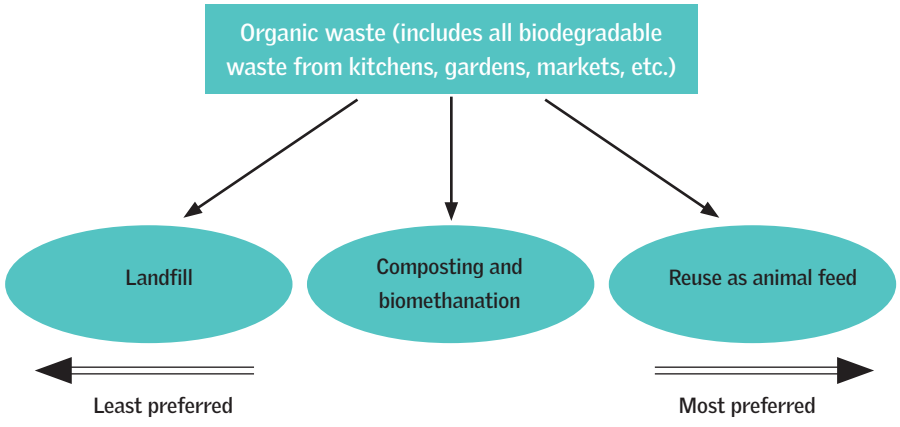
Source: CSE analysis

Organic waste is the largest waste stream in India. About 71,600 MT of organic waste is produced daily in the country. If dumped without any treatment, this waste can generate climate-warming gases like methane and carbon dioxide. According to United States Environment Protection Agency (USEPA), one tonne of legacy waste (in the form of a mixture of different types of municipal solid wastes dumped in a dumpsite without any treatment) has the potential to generate 27.7 kg of methane and 692.5 kg of carbon dioxide every year.

Studies have also found that approximately 60–70 per cent of organic waste by weight is water. Thus, smaller cities without proper processing facilities spend nearly Rs 700–1,000 per tonne on transporting and disposing of what is essentially water, and big cities spend nearly Rs 1,000–2,500 on the same. If management of organic waste is improved, the overall burden of municipal solid waste on cities will be reduced by almost half.

The best way to manage organic waste is to do it at source or as close to the source as possible. Certain types of organic waste can be used as animal feed. Wherever this option is not available, organic waste can be processed through other methods. Home composting and community composting are readymade methods to process waste. Only concrete block composting requires some time as it involves a bit of civil construction. Technologies for ward- and zone-level composting do not usually require more than three months of construction work, if all the associated steps such as land selection, sensitization of local citizens, administrative and financial approvals, and planning have already been completed.

Figure 1: Ideal hierarchy for organic waste management as per Swachh Bharat Mission 2.0



Source: SBM 2.0 guidelines

Under the Swachh Bharat Mission-Urban (SBM) 2.0, a total outlay of Rs 1,41,600 crore has been earmarked, which is nearly 2.5 times that of the total outlay of SBM–Urban 1.0. Of the total budgetary allocation under SBM 2.0, 39,837 crore have been explicitly assigned to proper and scientific solid waste management, with a focus on source segregation, material recovery facilities and waste processing, phasing out single-use plastic, construction and demolition waste management, and remediation of legacy dumpsites in the country. SBM 2.0 has mandated the formulation of City Solid Waste Action Plans by all urban local bodies to achieve 100 per cent scientific municipal solid waste processing. These action plans have to be submitted to respective state urban development departments. The plans must include details about processing plants, including capacity in tonne per day (TPD), estimated cost and date of commissioning.

State urban development departments consolidate all City Solid Waste Action Plans of the state and submit them to the Central Ministry of Housing and Urban Affairs (MoHUA). If the entry condition—identification and earmarking of land for setting up solid waste management facilities in all urban areas of a state—has been met, MoHUA will release the first instalment of 40 per cent from the budgetary allocation of SBM 2.0 to the state urban development department. The second instalment of 40 per cent will be released by MoHUA to state urban development departments on submission of a Utilization Certificate (UC) showing that at least 75 per cent of the money allocated in the first phase has been spent and at least 25 per cent physical progress in each subcomponent (processing plants, material recovery facilities or MRFs, scientific landfill and legacy dumpsite remediation) has been made. The third and final instalment of 20 per cent will be released to a state only after submission of a UC showing at least 75 per cent utilization of the money allocated in the second instalment and physical progress of at least 60 per cent in each subcomponent (processing plants, MRFs, scientific landfill and legacy dumpsite remediation).

Therefore, it is imperative that urban local bodies start planning immediately for setting up decentralized organic waste processing units for efficient and channelized waste management. This toolkit will, hopefully, help these bodies to choose the most suitable technologies for processing and treating organic waste.

Approach to planning

Treatment of organic waste can be planned in two ways:

1. Centralized manner
2. Decentralized manner

Table 2: Centralized and decentralized treatment systems—comparison

Centralized treatment system	Decentralized treatment system
Needs massive land for storage, pre-processing and processing of waste	Requires small land area for storage, pre-processing and processing
Capital expenditure (CAPEX) and operational expenditure (OPEX) are high	Capital expenditure (CAPEX) and operational expenditure (OPEX) are low
Malfunctions affect the whole system of waste processing	Malfunctions do not affect the whole waste processing system
It takes significant time to get the clearances (i.e., environmental clearances, consent to establish and consent to operate) for the project	As per Solid Waste Management Rules, 2016, no authorization is required for setting up decentralized facilities with less than five tonne per day capacity
There is a chance of pollution if environmental monitoring is not in place	Small-scale processing units do not result in environmental issues
Cost of transportation becomes prohibitive as these plants are generally located on the outskirts of cities	Are typically in close vicinity of the source of waste, so cost of transportation is significantly lower
Are highly mechanized and require trained personnel to operate	Lower level of mechanization means jobs for the informal sector and opportunities for small entrepreneurs
Cannot be modified to suit the climatic, social and economic conditions in various localities within a larger urban area	Can be tailored for local waste streams; and climatic, social and economic conditions

Source: CSE

A centralized management system is an approach where all of a city's solid waste is collected and transported to a single place for processing and treatment. A decentralized management system is based on the processing and treating of the city's municipal solid waste in several locations, including the household, community, ward, and zone levels, to reduce the quantity of organic waste at the source itself. The strength and challenges of both centralized and decentralized waste management systems are given in *Table 2*.

Keeping in consideration the humongous quantities of solid waste generated by Indian cities, and the historical problems associated with centralized waste management, decentralized waste management is obviously a better option. The 2016 Solid Waste Management (SWM) Rules also provide clear policy guidance to cities on implementing community-based waste management and emphasize decentralized waste management.

2. Decentralized management of biodegradable waste—key considerations for urban local bodies

- **Population:** One of the most critical factors that needs to be considered during a city's solid waste management planning. Most urban local bodies go by the data of 2011 Census, but knowledge of a city's current population and floating population is required in planning decentralized waste management. The formula to calculate current population is as follows:

  Formula: **Pb = Pa (1+r) t**

  Pb = Population of the year for which projection is to be made

  Pa = Population of the base year

  r = Rate of growth divided by 100 (generally considered as 0.02)

  t = The number of years between 'a' and 'b'
- **Households:** Urban local bodies need to identify all households having gardens, terraces and balconies with plantations and should target them first to start home composting. Urban local bodies should also provide saplings free of cost to other interested households to encourage them to adopt home composting and grow plants.
- **Bulk waste generators:** Urban local bodies need to identify all bulk waste generators (generating 100 kg or more of waste per day) within their jurisdiction through a detailed survey. Land available to every bulk waste generator should be ascertained during the survey. Bulk waste generators that have space should be served a notice by the urban local body's office to set up on-site processing plants for organic waste within a month of receiving the notice, failing which the urban local body can take action against them. For space-constrained bulk waste generators, urban local bodies can make provisions to collect waste (by themselves or through agencies appointed for end-to-end waste management), but on payment of user fee that is higher than that imposed on households for collection of organic waste.
- **Waste quantification and characterization:** The composition of municipal solid waste changes with the location. Even samples taken from the same location on the same day but at different times can have considerably different properties.

Waste generation rates are calculated by weighing collection vehicles at a municipal or private weighbridge in the city.

At least 100 representative sample locations per 100,000 population, including low-income, middle-income, and high-income households; trading companies; institutional generators; hotels; function rooms; vegetable markets; sports complexes and facilities; and places of worship should be chosen. Waste can be collected daily for at least seven consecutive days and weighed on a sensitive scale immediately after collection. A record of the waste generated by different categories of waste generators should be kept. Waste collected from each type may be mixed category-wise and segregated component-wise. Therefore, each component needs to be weighed separately to arrive at the waste characterization for different categories of waste generators. When extrapolated to the entire urban local body and divided by the total population, this representative waste quantity will yield the per capita waste generation rates.

- **Land requirement:** Land requirement varies with the scale of the processing unit. Land for household- and community-level processing units can be managed locally, but for setting up ward- or zone-level processing units, urban local bodies must identify suitable land during the planning phase. Space required for setting up different units is described in detail in the "Treatment method and technologies..." chapter.
- **Fine-tuning the logistics:** Once all the aforementioned points have been taken care of, logistics need to be fine-tuned. At this stage, wards with decentralized treatment and processing facilities need to be mapped, vehicles with facilities need to be tagged, vehicle route charts need to be prepared, and facilities constructed.

  Every decentralized waste processing unit usually caters to a few wards. Making use of historical data on increase in waste generation, the likely growth curve of ward-wise waste generation can be estimated. The capacity of a decentralized waste processing unit and the number of wards it can cater to can be calculated using these estimates, so that the processing unit is reasonably future-proof (usually for 15 years or so).

  The width of roads and streets should be kept in mind in the selection and tagging of vehicles. Pushcarts and tricycles might work well in slums and under-planned low-income neighbourhoods, while as auto-tippers can be more effective in planned neighbourhoods. Similarly, vehicles with larger capacity can better serve areas with commercial and bulk waste generators.

  Once an urban local body has obtained the land, construction work needs to be started because the other parameters will be in place by the time the construction is finished, thus streamlining the whole process.

3. Treatment methods and technologies for decentralized management of biodegradable waste

There are three methods of treating organic waste:
1. Aerobic composting
2. Vermicomposting
3. Anaerobic digestion or biomethanation

Composting of biodegradable solid waste can occur at different levels, i.e., household, community, ward, and zone. They can be described as follows:[1]

Household-level treatment

It is possible to process organic waste by aerobic composting and anaerobic digestion at the household level as long as space is available and the household can afford the process financially. Vermicomposting is not feasible at the household level as it requires a larger area and minute monitoring.

Process of aerobic composting

- A layer of compost is spread over the bottom of the composting unit before filling it up with waste for composting.
- Waste is cut into smaller pieces for better decomposition.
- Waste is spread uniformly over the compost layer at the bottom.
- Dry leaves or soil may be spread in layers over the waste daily to avoid foul smell.
- Water is sprayed or sprinkled over the mixture to maintain the moisture content in the unit.
- Buttermilk, curd or cow dung slurry can be added to act as an effective microorganism media to speed up composting.
- Waste is raked well for proper aeration every five to seven days.
- The procedure is repeated until the unit is full. The unit is closed by spreading a layer of soil on top.
- Once the first unit has been closed, the process is repeated for other units.

1 Disclaimer: All methods described in this document were shortlisted on the basis of cost effectiveness and ease ofmanagement, and not to promote any specific brands.

METHODS OF DECENTRALIZED WASTE TREATMENT

Aerobic composting

It is the decomposition of biodegradable organic matter in a controlled environment in the presence of oxygen by the action of bacteria and other microorganisms. Segregated organic fraction of solid waste is a suitable substrate for composting. The output product is compost that contains essential plant nutrients and minerals beneficial for plant growth.

Vermicomposting

It is an aerobic process of organic waste degradation with the help of earthworms in a controlled environment. Earthworms feed on the waste and produce vermicompost. Vermicompost has higher levels of nutrients than compost, and can be used in agriculture as a soil conditioner and nutrient supplier.

Anaerobic digestion

Anaerobic digestion is also called biomethanation. It is a process of biochemically decomposing organic matter through bacterial activity in an oxygen-free environment. The products of anaerobic digestion are methane gas and liquid fertilizer, which is nearly stabilized but may contain pathogens. Anaerobic digestion also produces hydrogen sulphide (H_2S) in varying proportions, depending on the sulphur content in the system (in the form of protein, sulphate, etc.). Municipal solid waste in India has high organic and moisture content, so biomethanation is a technically viable option to treat waste in the country.

- Once the compost is ready, the unit is emptied, and stored in a cool, dry place for seven days and then used.

Important points to remember in aerobic composting

- Use multiple units for the same composting methods, e.g., three pits, three buckets, etc.
- Make a shed to protect the unit from rain. Keep the units in a dry place.
- Always maintain green (fresh kitchen waste) to brown (dry leaves or coconut peat) ratio. The initial green-to-brown ratio is 1:1; after stabilization, the ratio can be 2:1.
- Do not add excess water (which will start to leak from the waste) as it can lead to anaerobic conditions in the mixture.

Process of anaerobic digestion

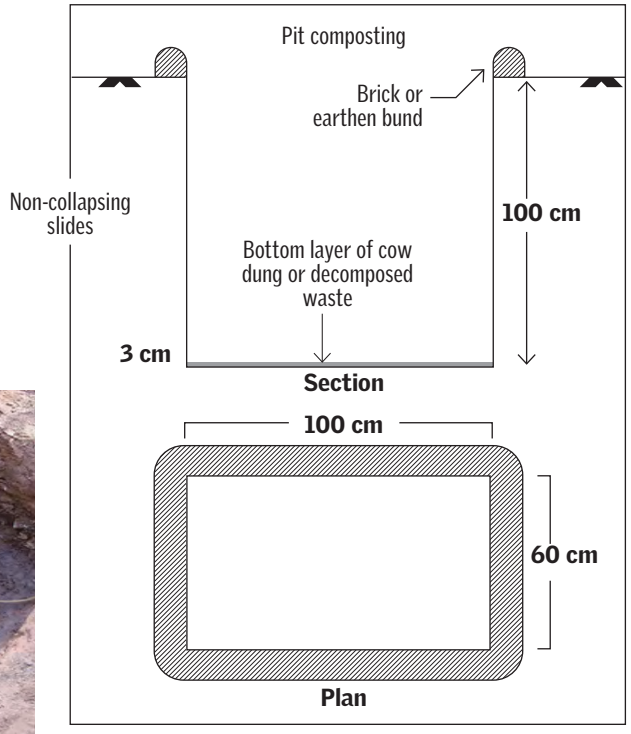
- The digester tank is filled up to 70 per cent with slurry from another biogas plant or fresh cow dung.
- Unwanted matter is removed from the fresh cow dung, and then it is mixed thoroughly with water to prevent solid and liquid separation within the digester.
- In general, 1 kg of dung requires 1 litre of water.
- The tank is left intact for 14 days after the initial feeding is done.
- Methane is collected in the overhead gas holder tank.
- After fourteen days, kitchen and other degradable waste is fed into the digester tank in slurry form through an inlet.
- For faster digestion, waste is chopped into one-inch pieces and fed daily into the digester tank.
- Overflowing slurry is collected from the outlet pipe to prevent gas pressure inside the digester from increasing and blocking the flow.
- Nutrition-rich slurry collected can be used as a fertilizer.
- Methane gas generated is supplied to households via a gas outlet pipe and used in cooking.

Important points to remember in anaerobic digestion

- Fresh cow dung should never be used to make the initial feeding slurry since the heat inside the digester might kill the microorganisms in the slurry.
- Never add more waste than the appropriate daily capacity.
- During winters, digestion process is slower, so warm water should be added along with the daily feed to maintain the temperature inside the unit.
- The overhead gas holder tank should be allowed to float over the water jacket so the overhead gas holder tank rises with the formation of methane.
- Do not place any sharp objects in the vicinity of the unit.
- Only add organic waste to the system.

Figure 2: Pit composting

Earthen pit

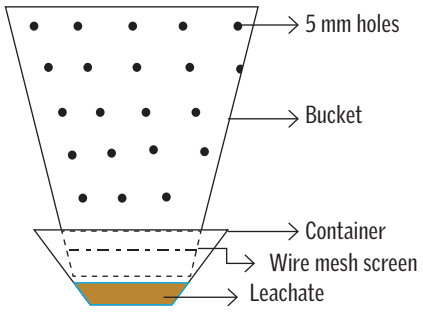


Section and plan of pit for composting

Parameter	Standard
Land area required	2 sq. m for pits and 1 sq. m for working area
Coverage	One household with six members
Waste treated	Up to 1 kg per day (up to 30 kg per month)
Processing time	Four months
Labour cost	Earthen pit: Can be easily managed by the household without any cost Brick or concrete pit: Rs 2,000–3,000
CAPEX	Nil (if earthen pit is used) Approximately Rs 10,000 (if a brick or concrete pit has been constructed)
OPEX	Nil (as no manpower is required for operation and maintenance)

Source: Decentralized Management of Segregated Organic Waste, CSE 2021

Figure 3: Bucket composting

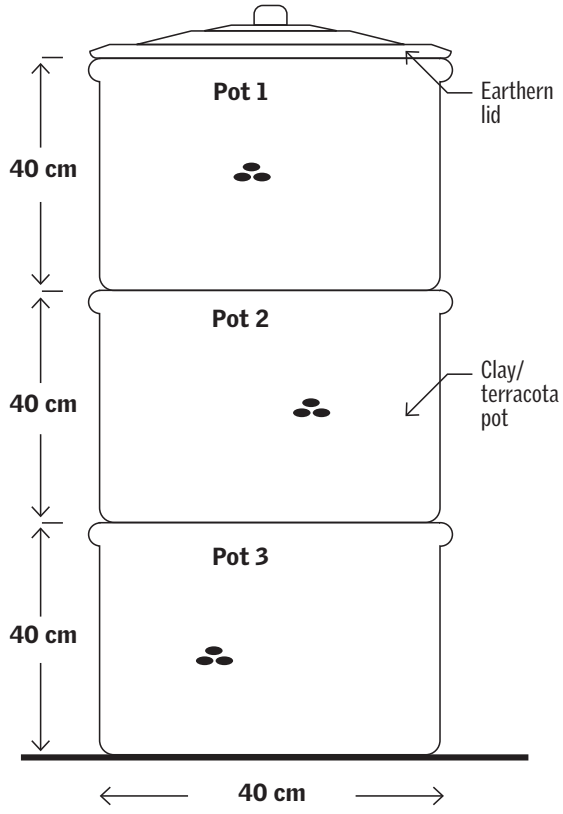


Section diagram of bucket composting

Parameter	Standard
Land area required	1.5 m^3 for the buckets and 1 m^3 for the working space
Coverage	One household with five or six members
Waste treated	Up to 1 kg per day
Processing time	60 days
Labour cost	Can be easily managed by the household without any cost
CAPEX	Rs 2,000 for three 60-litre buckets Rs 500 for three wire-mesh screens
OPEX	Rs 200 for 2 kg of biocompost (that can be used for five to six months) Rs 200 for 1 kg of bioculture (that can be used for five to six months)

Source: Decentralized Management of Segregated Organic Waste, CSE 2021

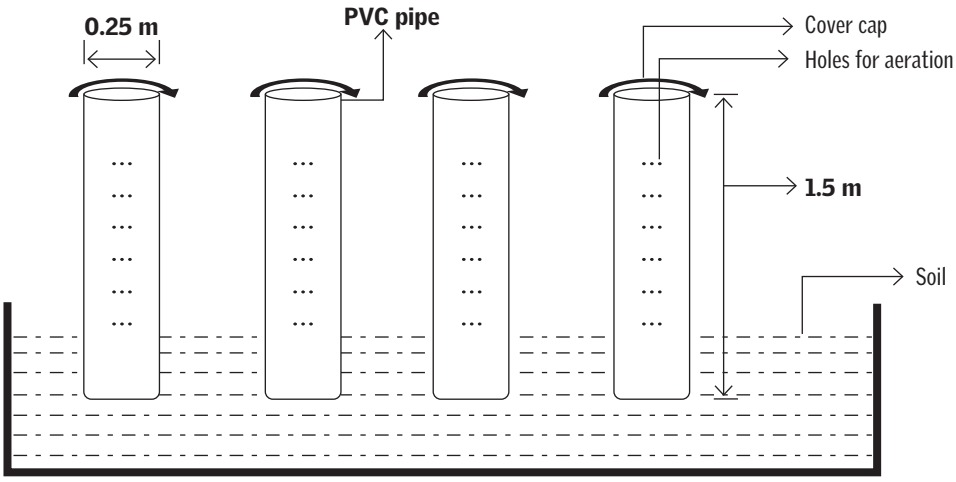
Figure 4: Tri-pot composting



Parameter	Standard
Land area required	0.5 m^3 for the pots and 1 m^3 for the working space
Coverage	One household with five or six members
Waste treated	Up to 1 kg per day
Processing time	45 days
Labour cost	Can be easily managed by the household without any cost
CAPEX	Rs 1,500 for three pots
OPEX	Rs 200 for 2 kg of biocompost (that can be used for five to six months) Rs 200 for 1 kg of bioculture (that can be used for five to six months)

Source: Decentralized Management of Segregated Organic Waste, CSE 2021

Figure 5: Pipe composting

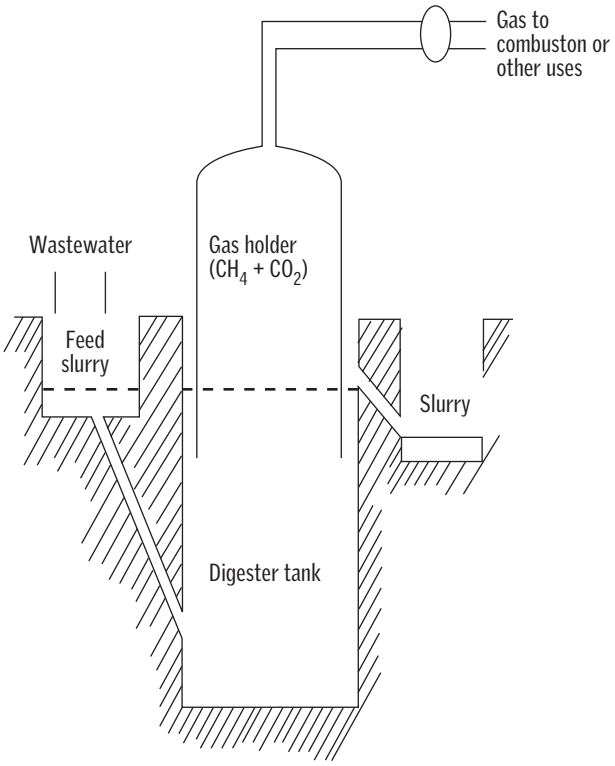


Parameter	Standard
Land area required	1 m^3 for the pipes and 1 m^3 for the working space
Coverage	One household with five or six members
Waste treated	Up to 1 kg per day
Processing time	30 days
Labour cost	Can be easily managed by the household without any cost
CAPEX	Rs 1,000 for a 6 m x 0.25 m (diameter) pipe
OPEX	Rs 300 for 5 kg coco-peat (that can be used for five to six months)

Source: Decentralized Management of Segregated Organic Waste, CSE 2021

Figure 6: Mini-biogas plant

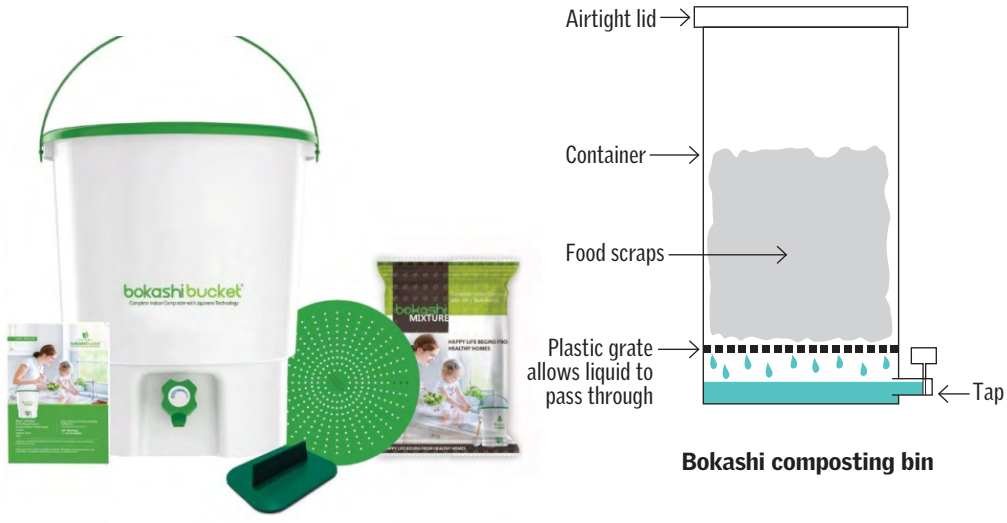
Portable household biogas plants



Parameter	Standard
Land area required	0.5 m^3 for the tank and 1 m^3 working space
Coverage	Two households with eight to ten members
Waste treated	Up to 2 kg per day
Processing time	14 days
Gas and slurry production	Two kg of waste gives around 0.2 m^3 of methane gas that can be used to cook for up to 20 minutes on a single burner. The volume of waste fed into the tank in the form of slurry provides an equivalent volume of liquid fertilizer in the form of slurry
CAPEX	Rs 3,600 for two containers
OPEX	Rs 200 per annum

Source: Decentralized Management of Segregated Organic Waste, CSE 2021

Figure 7: Bokashi anaerobic digestion



Parameter	Standard
Land area required	0.12 m^3 for the container and 1 m^3 for the working space
Coverage	One household with five or six members
Waste treated	Up to 1 kg per day
Processing time	40 days
Labour cost\	Can be easily managed by the household without any cost
CAPEX	Rs 3,600 for two containers
OPEX	Rs 300 for 1 kg bokashi powder (that can be used for one to two months)

A Bokashi unit's working principle is anaerobic digestion. At the bottom of the unit, just above the screen, crushed jaggery is spread evenly. Waste is added on top of it daily. Over the waste, bokashi powder is added. After that, the waste is pressed to remove excess air from the unit. The lid of the unit should be airtight. After four–five days, the tap should be opened to collect the liquid (bokashi tea). The liquid can be used as a fertilizer.

Source: Decentralized Management of Segregated Organic Waste, CSE 2021

Advantages of household treatment

- Organic waste from households is treated at source through recycling.
- No secondary segregation is required.
- Can be set up at nominal cost and operated out of a small area.
- No skilled manpower needed to operate.
- Easy to use and maintain.
- Organic compost can be utilized as a fertilizer.
- Chemical compost is not required.
- Promotes organic kitchen gardening.
- The overall burden of municipal solid waste on municipal authorities is reduced.

Incentives to households engaged in home composting

As per Swachh Survekshan, the first target for urban local bodies is to ensure that 10 per cent of the households within their jurisdiction are engaged in home composting. This percentage should steadily rise to 100 per cent. To achieve these targets, urban local bodies can provide various incentives to households, as follows:

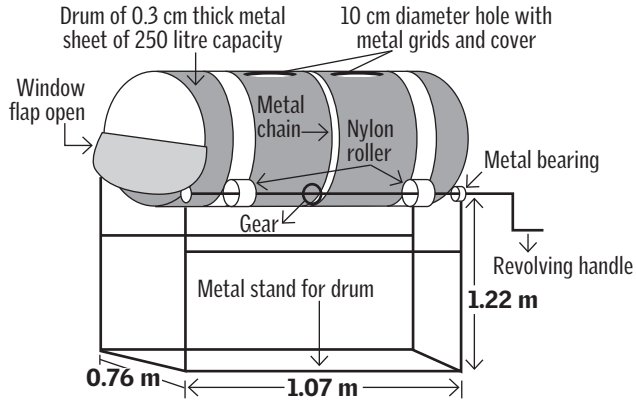
- Provide tax relief to households practising on-site composting.
- Declare households as "Swachh" households, providing them a sense of achievement.
- Felicitate members of households engaged in home composting during special ward-level events.
- Form a special cell in the urban local body office to provide technical support to households engaged in home composting.
- Provide subsidies to households for setting up home composting units like biogas plants.

Community-level treatment

When organic waste is composted collectively by a neighbourhood or community, it is termed community-level treatment. As per Solid Waste Management (SWM) Rules, 2016:

- Biodegradable waste generated by bulk waste generators (those producing more than 100 kg of waste per day) must be collected, treated, and disposed of on-site as much as possible through composting or biomethanation.
- Resident welfare and market associations, apartment buildings, and educational institutions with more than 5,000 sq. m area; and hotels and restaurants must ensure waste segregation and in-situ processing of biodegradable waste through composting or biomethanation in collaboration with the local body.

Figure 8: Rotary drum composting



Parameter	Standard
Land area required	8 m^3 for the composting units, 2 m^3 working space
Coverage	Fifty households
Waste treated	Up to 50 kg per day
Processing time	20 days
Workforce	Two semi-skilled labourers
CAPEX	Three composting units: Rs 90,000 Handheld sieve: Rs 2,000
OPEX	Monthly salary (of two labourers working three–four hours daily): Rs 12,000 5 kg bioculture (that can be used for two or three months): Rs 300

Source: Decentralized Management of Segregated Organic Waste, CSE 2021

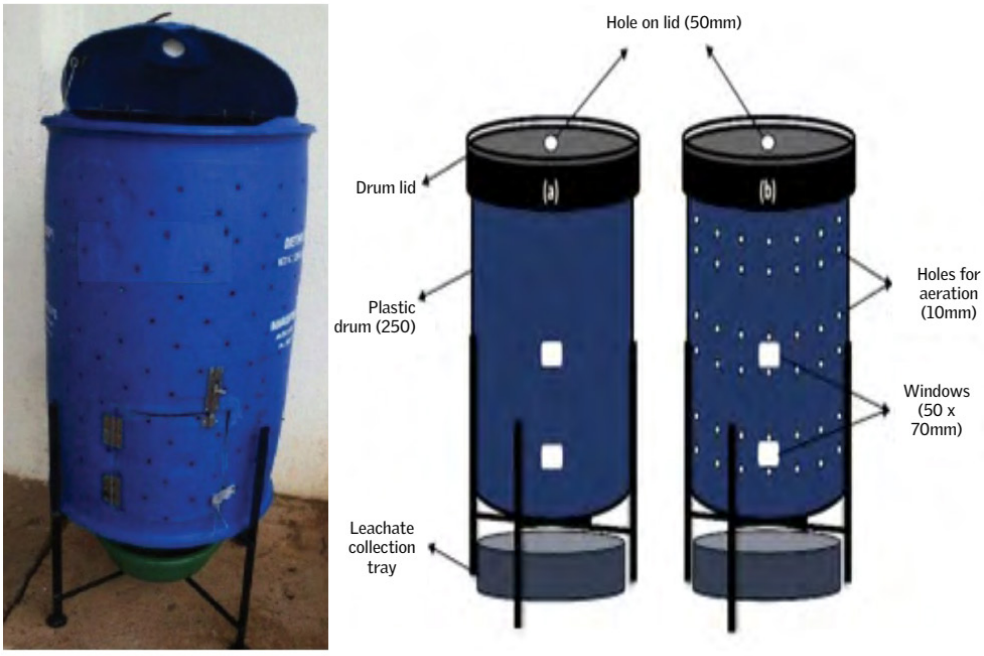
INSTANT COMPOSTING MACHINES

In many parts of the country, bulk waste generators use instant composting machines to get rid of organic waste. Manufacturers claim that these machines can digest waste within 24 hours. However, the output cannot be called compost as most of the organic carbon inside the waste is burnt. Some of the other disadvantages of the machines are:

- They produce toxic smoke.
- They use heating coils, purportedly to remove moisture and maintain an optimum temperature inside the machine chambers, which increase energy consumption.
- Sometimes the output is so hot that handling it can cause burn injuries.
- The fixed cost of purchasing the machine and the operating cost (of electricity, etc.) makes this method expensive compared to traditional composting.

Hence, this type of machinery should be avoided for composting, and instead of using it, focus should be on making use of conventional methods of composting.

Figure 9: HDPE composting

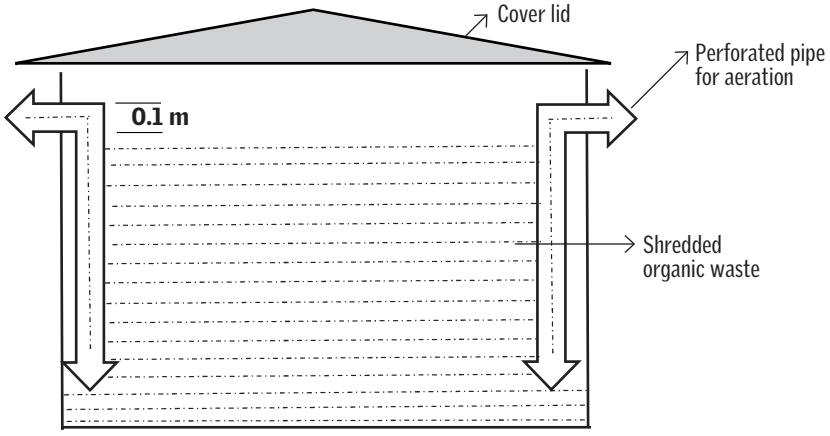


High-density polyethylene (HDPE) drums for composting

Parameter	Standard
Land area required	6 m^3 for the composting units, 2 m^3 working space
Coverage	Seventy households
Waste treated	Up to 70 kg per day
Processing time	45 days
Workforce	Three semi-skilled labourers
CAPEX	Construction of the unit: Rs 50,000 Handheld sieve: Rs 5000 Rack: Rs 1,000
OPEX	Monthly salary (of three labourers working for three to four hours daily): Rs 20,000 5 kg biocompost (that can be used for two to three months): Rs 500 5 kg bioculture (that can be used for two to three months): Rs 300

Source: Decentralized Management of Segregated Organic Waste, CSE 2021

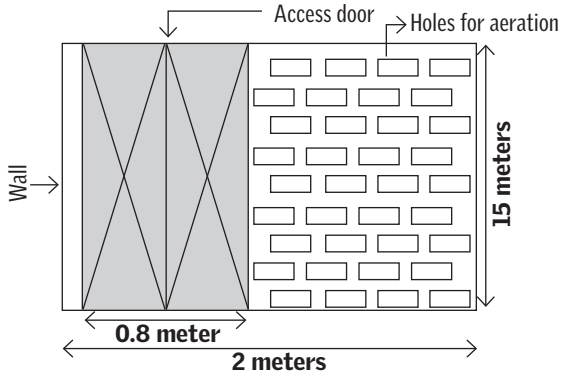
Figure 10: Byo bin composter

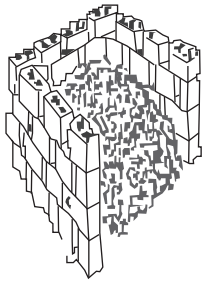


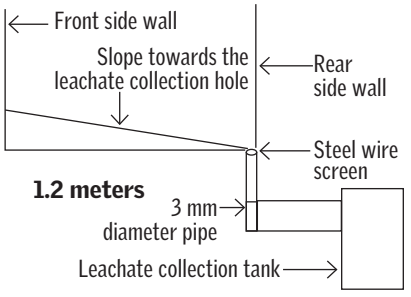
Parameter	Standard
Land area required	7 m^3 for byo bin units and 2 m^3 working space
Coverage	Hundred households
Waste treated	Up to 100 kg per day
Processing time	25 days
Workforce	Three semi-skilled labourers
CAPEX	Two byo bins: Rs 90,000 Handheld sieve: Rs 5000 Rack: Rs 2000
OPEX	Monthly salary (of three labourers working six hours daily): Rs 24,000 5 kg biocompost (that can be used for two to three months): Rs 500 5 kg inoculum powder (that can be used for two to three months): Rs 300

Source: Decentralized Management of Segregated Organic Waste, CSE 2021

Figure 11: Concrete block composting







Cross-section view

Parameter	Standard
Land area required	10 m^3 for two blocks and 2 m^3 for working space
Coverage	200 households
Waste treated	Up to 200 kg per day
Processing time	35 days
Workforce	Four semi-skilled labourers
CAPEX	Construction of the unit: Rs 3,50,000 Handmade sieve: Rs 5,000 Rack: Rs 2000
OPEX	Monthly salary (of four labourers working for five to six hours daily): Rs 50,000 5 kg bioculture (that can be used for two months): Rs 300

Source: Decentralized Management of Segregated Organic Waste, CSE 2021

TREATMENT OF LEACHATE

Leachate is a black liquid generated from organic waste during aerobic composting. While large-scale composting units can invest in proper leachate treatment, smaller, on-site composting units and community-level composting units may not be able to do so. Leachate generated from small-scale community composting can be utilized as inoculum in the composting unit after diluting it with water in a 1:10 ratio. Leachate from community units can also be diverted to in-situ septage treatment plants through proper channels.

Advantages of community treatment

- Cost of community composting, mostly done using traditional methods and tools, is reasonable.
- Community composting units are easy to operate and maintain.
- By involving the local community, it increases awareness among the people about issues related to solid waste management.
- Overall burden of municipal solid waste management on municipal authorities is reduced.

Incentives provides for community composting

The following incentives may be provided to communities and bulk waste generators to encourage them to process the organic fraction of the waste they produce by themselves:

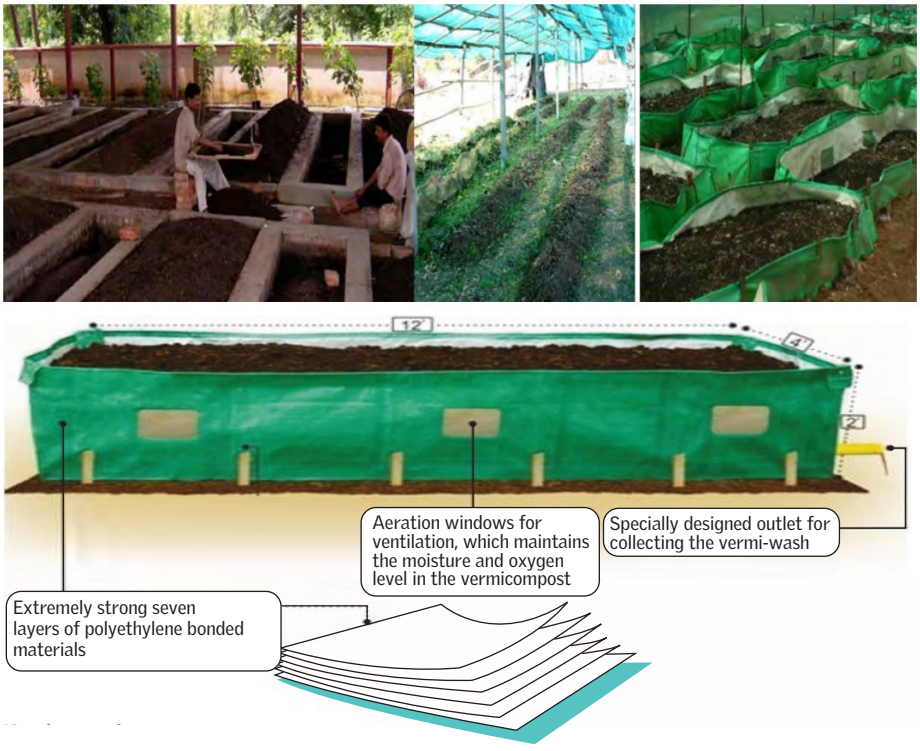
- Provide tax relief to communities practising on-site composting.
- Declare a community as Swachh community to instil a sense of achievement.
- Felicitate members of the community at events organized by the urban local body at the ward level or on special occasions.
- Declare the head of the community as a Swachhata Ambassador.
- Publish the names members of the communities in the local media to highlight their work.
- Arrange organic waste processing competitions among communities to improve their performance.
- Form a special cell of experts to provide technical support to communities practising composting or interested in it.
- Urban local bodies should expedite the approval process for communities seeking to establish permanent structures for on-site composting.

Ward- and zone-level treatment

Ward- and zone-level processing of organic waste happen at a larger scale than community-level treatment. According to the 2016 Solid Waste Management (SWM) Rules, if the capacity of a waste processing, treatment or disposal facility

(including a waste-to-energy unit or sanitary landfill) exceeds 5 MT per day, the urban local body, facility operator or agency has to make an application in Form-I to the State Pollution Control Board or the Pollution Control Committee for authorization to set up the facility or unit. Ward- and zone-level treatment falls within this capacity category.

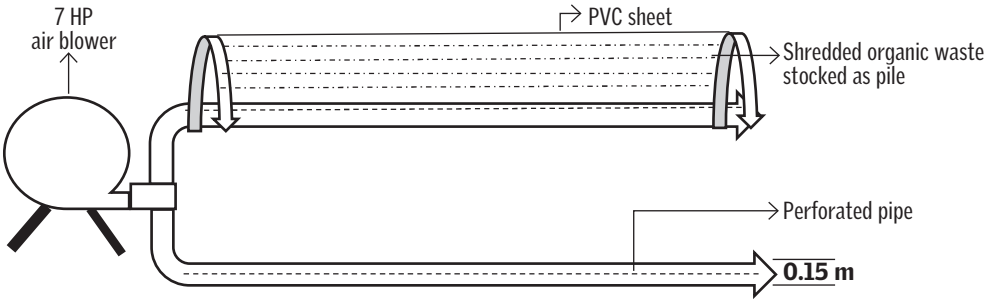
Figure 12: Vermicomposting



Parameter	Standard
Land area required	4,000 sq. m
Coverage	5,000 households
Waste treated	Up to 5 tonne per day
Processing time	45 days
Workforce	Two skilled and two semi-skilled labourers
CAPEX	Infrastructure: Rs 15,00,000
OPEX	Monthly salary (of four labourers working for six to eight hours daily): Rs 55,000 Maintenance: Rs 10,000

Source: Decentralized Management of Segregated Organic Waste, CSE 2021

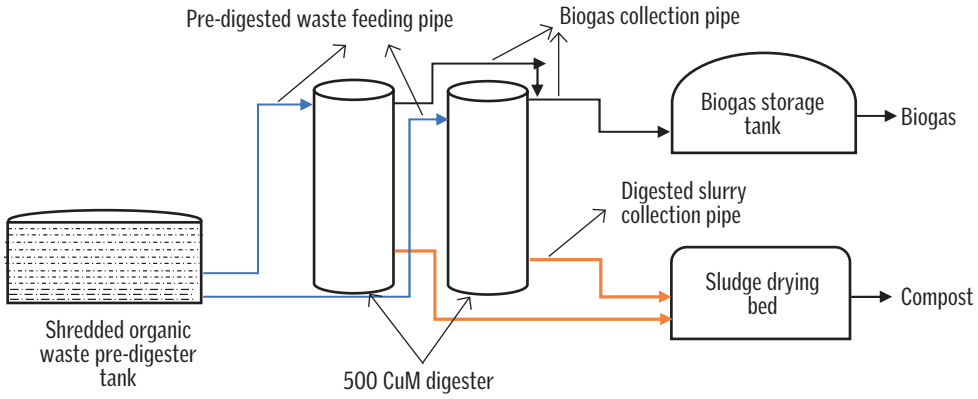
Figure 13: Aerated static pile composting



Parameter	Standard
Land area required	350 sqm
Coverage	5,000 households
Waste treated	Up to 5 tonne per day
Processing time	42 days
Workforce	Two skilled and three semi-skilled labourers
CAPEX	Infrastructure: Rs 25,00,000 Shredder: Rs 6,00,000 Mechanical sieve: Rs 4,00,000 Electric blower: Rs 2,00,000
OPEX	Monthly salary (of five labourers working six to eight hours daily): Rs 55,000 Electricity: Rs 10,000 Maintenance: Rs 10,000

Source: Decentralized Management of Segregated Organic Waste, CSE 2021

Figure 14: Medium-sized biomethanation unit

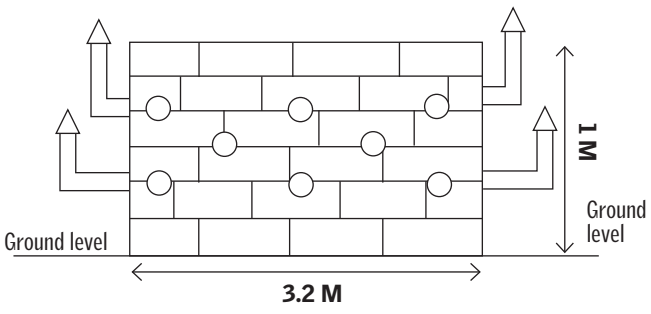


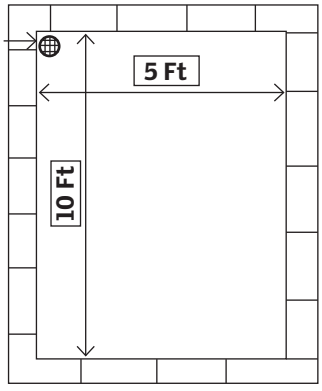
Parameter	Standard
Land area required	2,000 sq m
Coverage	5,000 households
Waste treated	Up to 5 tonne day
Processing time	21 days
Workforce	Three skilled and five semi-skilled labourers
CAPEX	Infrastructure: Rs 1,76,00,000 Shredder: Rs 10,00,000 Pump: Rs 10,000
OPEX	Rs 15,00,000 per annum

Source: Decentralized Management of Segregated Organic Waste, CSE 2021

Figure 15: Multiple tubs composting

Micro-composting centre, Paradeep, Odisha





Parameter	Standard
Land area required	600 sqm
Coverage	5,000 households
Waste treated	Up to 5 tonne per day
Processing time	40 days
Workforce	Two skilled and three semi-skilled labourers
CAPEX	For infrastructure: Rs 50,00,000 For shredder: Rs 10,00,000 For mechanical sieve: Rs 7,00,000 For pump: Rs 10,000
OPEX	Monthly salary (five labourers working eight hours daily): Rs 55,000 Electricity: Rs 10,000 Maintenance: Rs 10,000

Source: Decentralized Management of Segregated Organic Waste, CSE 2021

Advantages of ward and zone processing

- Since organic waste generated in a ward or zone is treated within the ward or zone, instead of sending it to far-off centralized facilities or landfills, transportation costs are reduced substantially.
- Ward and zone level processing receives and processes waste in a fresher state, compared to centralized facilities where it is collected and processed over a longer period of time. This ensures lower levels of GHG emissions from processing organic waste at the ward or zone level compared to processing at centralized facilities. It also ensures that the quality of compost is better.
- Larger organic waste processing facilities are more prone to leachate generation, therefore processing at ward or zone level instead of centralized processing reduces the chances of leachate generation.
- Production of compost at decentralized facilities ensures its uptake by the compost developers themselves or locally (since easy and hassle-free availability promotes demand). Large centralized facilities do not share these advantages.
- Zone or ward level composting units are easy to operate, maintain and monitor.
- The overall burden of solid waste management on municipal authorities is reduced.

Incentives provided for ward and zone composting

A 5 tonne per day plant requires a land area of about 5,000–6,000 sq. ft. Such a large area may not be easy to set aside for zone or ward level authorities. To sweeten the deal, and encourage local leaders and authorities to invest in such a plant, the following incentives may be provided by the urban local body:

- Declare the ward(s) as "garbage-free", which could be a point of pride for the local leadership and residents.
- Felicitate elected member of the ward(s) in special programmes organized by the urban local body.
- Declare elected members of the ward as Swachhata Ambassadors.
- Publicize the names of the ward(s) leadership in the local media.
- Arrange competitions among garbage-free wards for better performance
- Form a special cell of technical experts to provide technical support to wards that are already practising decentralized composting or plan to do.
- Certify the quality of the compost at regular intervals in coordination with the district agricultural department.
- Create a market for sale of compost.

4. Key considerations for a sustainable decentralized system

- **Policy level consideration:** The first and foremost thing to consider in the creation of a sustainable decentralized system of organic waste management is policy. Without good policy, the other elements cannot come together nor can processes be streamlined. Urban local bodies need to formulate bye-laws as per the Solid Waste Management Rules, 2016. These bye-laws can be tweaked to suit local conditions. They must be detailed and contain provisions on taxes, rebates and other extended benefits as well as the fines and penalties against defaulters to promote decentralized organic waste management.

- **Information, Education and Communication–Behaviour Change Communication (IEC–BCC):** Successful implementation of large-scale programmes requires public participation, which can only be ensured through sustained IEC–BCC programmes informing the public about the benefits of the programmes and their various stages and requirements. This can be achieved through mass education efforts and:
  - Use of print media, TV, radio and the Internet to disseminate information about the programmes
  - Screening films containing information or promoting the programme in cinema halls
  - Performing street plays and puppet shows on the themes of the programme
  - Creating posters, pamphlets and hoardings containing messages and information about the programme
  - Stickers could also be put up in public transport system for wider dissemination of information about the programme
  - School children, religious leaders, medical practitioners and women's associations can also be involved to promote the programme

- **Capacity building:** Capacity building of officials and workers involved in the decentralized management of organic waste—in terms of funding, monitoring and implementation—is another essential element to consider. Capacity building may consist of both on-site training and field visits to get a better idea about their roles and responsibilities. Although capacity building may take

time and require some finances, its extended benefits make it well worth the effort.

Beyond technology and economics, capacity building should include:

- An understanding of the management systems of waste and related activities
- An understanding of the need to decentralize waste management to achieve better results in solid waste management
- Delineating strategies for the sustenance of achievements

Capacity building should be aimed at:

- Elected representatives
- Senior officers
- Field workers
- Transportation staff
- Waste processing staff
- Non-governmental organizations, community-based organizations and residents associations
- Waste generators

- **Monitoring:** A proper monitoring system helps urban local bodies to keep an eye on the overall management of waste. Smaller, fund-constrained urban local bodies can harness virtual technology such as Global Positioning System (GPS), Geographic Information System (GIS) and Global System for Mobile Communication to track collection vehicles; mark attendance of the sanitation staff; maintain records of incoming, processed, disposed of waste; and to create platforms (like mobile apps) to raise complaints related to sanitation. Besides the virtual system for monitoring, urban local bodies should also engage local self-help groups for manual monitoring and institute surprise visits by officials to various facilities to check authenticity in real-time.
- **Promote PPP models for operation and maintenance of treatment facilities:** Many a time, urban local bodies are financially constrained. At such times, public–private partnership (PPP) models can be adopted. The advantage of a PPP model is that a significant percentage of the overall funding required is taken care of by the private concessionaire. The urban local body is responsible for providing the concessionaire vacant and litigation free land(s) for setting up the processing facility(s), overall monitoring, and performance evaluation of the concessionaire. In such case, the contract should be transparent and purely performance-based. The scope of the work must be clearly spelled out so that the possibility of future disputes between the urban local body and the PPP operator is minimized. The concessionaire should be made accountable for successful and sustainable project implementation.

- **CSR fund for CAPEX:** Sometimes urban local bodies should not leave the overall end-to-end waste management to private contractors. Instead, they should opt for CSR funding for setting up of processing facilities. Most urban local bodies in India have a waste collection and transportation system in place. However, in some places it is irregular and scattered, which can be regularized with some effort. Hence, CSR funds should be utilized in the CAPEX for setting up processing units. In lieu of the financial assistance, urban local bodies may name the facility(s) after the corporation providing the CSR funds, or permit the corporation to advertise their brand in the city or agree to any other acceptable conditions as benefits.

- **Integration of the informal sector and self-help groups:** Once the phase of decentralized waste management has been completed, implementation is the next stage. In the implementation phase, the requirement of the workforce increases. Urban local bodies should engage their manpower first, and the additional requirement should be filled with informal waste workers and members of local self-help groups. Due to adoption of decentralized waste processing, many informal waste workers may lose their livelihood. It is the responsibility of the urban local body to generate livelihood opportunities for them. Members of self-help groups and informal sector workers can be trained by the urban local body officials regarding optimum solid waste management practices. After their training, they may be deployed on field, but they need to be assisted and their work needs to be closely monitored by the urban local body officials. Once they get a proper hold over the nitty gritties of the work, they can start working independently. The best place to deploy these workers is in the overall operation and maintenance of waste processing facilities. In the beginning, the urban local body should support them financially for their monthly wages. Once the system has been streamlined, e.g., after the creation of a market for compost selling, these groups should be able to take care of the facility independently.

ODISHA'S POSITIVE EXAMPLE

Women self-help groups have been engaged in the overall municipal solid waste management in all the 114 urban local bodies of Odisha. Among other things, the groups are responsible for selling compost and other processed materials. The revenue generated is utilized to provide them salary and for operation and maintenance of the facility.

Paradeep, an urban local body in the state, has engaged transgender groups in one of its waste processing facilities. The groups are working efficiently, earning respect and a new identity of *Swachhata Karmis* through the work they perform.

- **Marketing of compost and quality monitoring:** At present, most of the compost generated at the household and community level is used by the residents themselves, but when it comes to ward- and zone-level composting, almost all urban local bodies face the problem of channelizing the product, i.e., compost, properly. Compost generated from these two sources often does not get sold due to quality and marketing issues. To overcome these issues, urban local bodies should ensure quality checking of the compost samples at regular intervals. As per the Solid Waste Management Rules, 2016, it is the responsibility of the ministry of agriculture to set up laboratories to test the quality of compost produced by local authorities or their authorized agencies; hence urban local bodies should approach the district agriculture department for testing and certifying compost samples. Once a sample has been tested, a market for selling the compost is the next step. Urban local bodies need to approach the agriculture, horticulture and forest departments so that they can buy the certified compost at a reasonable price as per their requirement. The urban local body may also open outlets at various locations to sell the compost. These outlets can be handed over to self-help groups for operation.

Notes

Notes

Decentralized processing is increasingly being viewed as a smart way to manage organic waste. This toolkit is designed to be a hand-on guide for practitioners, officials of urban local bodies and other stakeholders in improved organic waste management.

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062
Phones: 91-11-40616000 Fax: 91-11-29955879
E-mail: cseindia@cseindia.org Website: www.cseindia.org