What is composting and what are its current uses in India?

Composting is the process of converting decayed organic material into plant fertilizer. There are three primary methods to this end: in-door, windrow composting, and vermicomposting.

In-door composting procedures involve storing damp organic matter (i.e. a ratio of green, carbon-rich waste and brown, nitrogen-rich waste) in compost bins or turners so the materials break down into humus (i.e. organic topsoil).

Windrow composting procedures are rely on the same as in-door composting procedures: given time, oxygen, water, and temperature, organic material breaks down into fertilizer on its own. In windrow, compost is piled in spaced, triangular-pointed rows, and aeration occurs by flipping the row into the space preceding it.

In vermicomposting, earthworms, typically red wigglers and white worms, are fed a mixture of kitchen and garden wastes (e.g. fruits, vegetables, peels, coffee grounds, leaves and grass clippings). Their worm manure is then used as a nutrient-rich organic fertilizer and soil conditioner.

In India, composting is an alternative to landfills, for both economic and environmental reasons alike. Villages that compost instead of landfill their wastes save money from buying fertilizer, even earning money by selling superfluous compost. According to one source, each family in the village of Medak can potentially make a profit of $20,000 by using the organic manure to produce vegetables for their family and selling remaining compost.

Composting is not without difficulty. Without proper aeration and water, composting can become an anaerobic process that produces methane and hydrogen sulfide, which induces a rotten smell. And, if the temperature rises above 71 degrees celsius in compost, spontaneous combustion can result, which might lead to the outbreak of fire. Having improper ratios of compost can also lead to inefficiency (i.e. too much green waste, too little brown waste to catalyze reactions) or pollution (i.e. too much brown waste, which can cause ammonia formation and lead to odor or run-off pollution).

So here at Georgia Institute of Technology we are conducting research to design a compost system that will be applicable and functional in India. This report summarizes the basic research completed over Fall 2013 - Spring 2014.

Small Scale In-door Composting

A proposed solution for the area is a small scale system where a group of families will be given a container or area to compost in. The resulting compost can be used in a garden or sold for commercial benefit. This provides for a sustainable method of disposing of organic waste in a small village (so that the waste does not pile up) and a new way of starting a small village business.

In order for the composting to occur, the system will need to be about 1m^3. This is the minimum size for the organic material reach the appropriate temperature to degrade fast enough (2-3 weeks); if the composting system is smaller than that it will take a considerably longer amount of time to degrade. This is because composting relies on the center of the system reaching very high temperatures, if it is not large enough then the material will not decompose fast enough.

The container can be anything that promotes aeration and holds the compost well. A proposed container is a plank box that is built by combining several wooden planks on each other. The gap between the planks allows for area to pass through the system rather easily.

The compost will need to consist of a layer of soil, a layer of kitchen wastes and scraps, a layer of ‘brown’ wastes such as leaves, bark, and sawdust, and a final optional layer of garden soil. Garden soil provides the bacteria needed to compost and might help mask any odors. However this may be difficult to obtain in areas such as India.

The carbon to nitrogen ratio is extremely important in composting and around a 30:1 ratio will work best to decompose the materials and to make the center of the pile hot enough. The materials must be finely shredded or chopped because that allows for the surface area of the compost to be large enough. Breaking down the compost into smaller pieces helps the bacteria that causes composting to move through the pile easier. Another important factor is oxygen; the pile of compost will need to be mixed around every week. This allows for the heat in the center of the pile to be distributed and for the compost to degrade faster. In order to do this, the person in charge for the week (since there will be several families, they can take turns) will simply need to take a shovel and move the pile around, allowing for the hotter areas to be pushed outward and the cooler areas on the outside be pushed inward. The amount of time that this entire process will take will vary from several weeks to several months depending on the temperature, humidity, type of compost material, and the size. So proper time limits cannot be given at this time but a rough estimate is about 2-4 months for a 3x3 cubic feet sized compost.

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- Amount of Compost per Month: 138.5 kg/month
- Time: 2-4 months, average of 3 months
- Labor: 1 hr/week
- Start-up Cost: ~$75
- Land Requirements: 1m^2
- Mass Worms: N/A
- Green Waste: 1 kg per batch
- Maintenance Cost: N/A
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Small Scale Vermicomposting

In the event of space not being available for a large scale compost solution, this is a proposed small-scale compost method that would be used per every 2-3 families (in a surrounding area).

This small-scale vermicomposting method would employ a 2 bin system with 10 gallon bins where the initial food and bedding, and then worms, would be added to the bottom bin.The top bin (initially) would be empty. However, both bins would have holes poked in the bottom for drainage and worm movement. After a couple days, bedding and new food scraps could be added to the top bin. When done with the bottom bin, the worms would then travel up to top bin. This process takes about 2 weeks. After, the worms will have migrated, leaving behind castings in the bottom bin. This is the point where one would remove the bottom bin (being careful of leakage), remove the castings, and reinsert this bin on the top (so that the initial top bin is now full of worms at the bottom). Now, one can begin to add new food scraps to the top bin. There is also a lid underneath this 2 bin system. The lid collects the compost drainage (leachate, or compost "tea"), which is a useful fertilizer. Wooden blocks keep the bin system raised and stable.

Earthworms are active and will consume organic wastes in a relatively narrow aerobic layer of 6–9 inches,that is close to the surface of a bed or container. The key to successful vermicomposting lies in adding organic wastes to the surface in successive thin layers at frequent intervals.

To create the bin system, drill 20+ 1/4″ holes on the bottom of both bins – for drainage and worm travel.Then, drill 1/16″ holes along the side of both bins, near the top. Then drill 30+ 1/16″ holes in the top lid of ONE of the bins (not both). Place bedding in ONE bin only (leave other bin empty) – mix shredded paper with a shovel full of black dirt and spray with enough water to lightly dampen. This will be your bottom bin. Add a pound of worms and stir it all up. Cover the mixture with damp piece of cardboard then place the empty bin on top of the cardboard and cover with the ventilated lid. Place the non-ventilated lid upside-down, position your 4 blocks on top of it, then place the bins atop the blocks. Bedding inside the bins should be damp/moist, but not soggy. Bins should be kept in darker places.

Acceptable types of compost include kitchen waste (bits of lettuce, tomatoes, etc) moistened strips of newspaper or cardboard, compostable plates and cups, dry coffee grounds, filters, tea bags, plate scrapings, vegetable peels, leftovers (raw or cooked), soft garden waste. An occasional sprinkling of garden soil in the bin gives the worms the grit they need to digest food. Meat, dairy, greasy or spicy foods, foods high in cellulose content, fish, bones, metal, and plastic should not be put into the bin.

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- Amount Compost/Month: 20 kg
- Time: ~2-3 weeks
- Labor: ~1 hr/week
- Start-up Cost: $60
- Land Requirements: 10 Gallon Bin (>1m^3)
- Mass Worms: 1 pound
- Green Waste: 12 kg of food waste can be processed per month
- Maintenance Cost: Minimal
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Large Scale Windrow Composting

Another potential method for composting is windrow composting. This method entails placing all the waste in large rows, where the lengths vary based upon material. The width will be between 3-5 meters, and the height can be up to 3.5 meters if the material isn't dense (like leaves). It is reasonable to expect a combination of dense and light material, so the optimal height of the pile should be around 1-2 meters. The lengths of the windrows (the rows of compost) can extend up to whatever the space can accommodate.

One problem with placing these composts in piles is that the center of the piles may get dry or too hot. Usually, windrows require turning of the pile to address these problems, but that would be difficult with large rows. One way to address the problem is to build a fixture of PVC that would be placed in the center of these piles and extend out the sides. These PVC pipes would have holes drilled in them, and they allow air to circulate through the center of the piles. You could also pour water or connect these pipes to a hose and moisturize the center. Air will naturally pass through the pipes, providing fresh air to the inside of the pile. This method would take a little bit longer (about 2-3 months).

To expedite the composting process, a blower could also be connected to the pipes that would force air through the center of the pile. The blower would be used intermittently, for example, 5 minutes every week. This would reduce the composting time to about 1-2 months, but also increase the manpower required. The blower would require energy input, increasing maintenance and start-up cost.

This style of composting is very land intensive. The sheer size of the windrows means that it must take place outdoors, unless a building is abandoned or erected. In essence, the most cost effective way would be to place it outdoors. After looking at the map of Zari, there seems to be plenty of space near the landfill at the entrance of town: that would be one potential spot to place these large Windrows. Since the pile is outdoors, a tarp would be needed to ensure that wind or rain does not disrupt the pile.

The maintenance costs depend on the method chosen. Once every week, water should be sent through the pipes. If the blower is chosen, then for five minutes every week the blower should be turned on to ensure that the center of the pile is aerated.

Large scale windrow composting offers the opportunity to consolidate waste from 10 to 100 houses, and generate compost rapidly.

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- Amount of Compost/Month: 33 kg/month
- Time: can range from 1-3 months
- Labor: 5-6 hours to transport material and install the PVC; then after 1-2 hrs/week
- Start-up Cost: $100 for PVC per pile + $20 per sq foot of tarp
- Land Requirements: 50 m^3 per pile
- Mass Worms: N/A
- Green Waste: 50 kg per pile
- Maintenance Cost: (??)

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