MANAGING ORGANIC MUNICIPAL WASTE

Introduction

Organic waste often forms as much as 75% of household waste generated in developing countries, compared with just 30% in industrialised countries. In many cities in developing countries, per capita waste generation rates are in the order of 500g/day, some 300g of which may be organic. Thus a city of 1 million population may produce 300 tonnes of organic waste daily. Organic waste is a major issue!

This technical brief begins by describing the characteristics of organic waste, its sources and the particular hazards, challenges and opportunities it presents. It goes on to present a number of options for processing organic waste, including use as animal feed, biogas digesting, and composting. Many composting techniques are simple, and compost is relatively easy to make. However, sourcing uncontaminated raw materials, making a high-quality product, and making composting viable, can be difficult. This technical brief discusses some of the challenges and how to overcome them.

Figure 1: Composting in Colquencha, Bolivia.
Photo: Alfredo Quezada / Practical Action

This brief would be useful for anyone facing the challenge of managing organic waste. It is particularly intended for project engineers, planners or managers in municipalities, NGOs and businesses.

Organic waste

Organic waste in towns and cities is generated by households, businesses, industries and local authorities. It consists of kitchen waste (e.g. potato peelings), waste food (e,g, leftovers in restaurants, spoiled fruit and vegetables from markets), garden waste (e.g. grass clippings and hedge trimmings) and industrial waste (e.g. from agricultural and food processing factories). Of course agriculture produces vast quantities of organic waste such as rice husk, straw and manure. However, this rarely becomes mixed with domestic or commercial organic waste so is not discussed in this brief. In addition, most farmers compost it themselves, as do many urban and peri-urban nurseries.

Unlike other components of household waste such as metals, glass and paper, organic waste is considered low-value and is rarely collected from recycling or processing by the informal sector or businesses. This can be explained by its density (it is composed predominantly of water), the cost and difficulty of transportation, the land required for processing, and the relatively low-value of resultant products.
Particularly in warm climates organic waste tends to begin decomposing quickly -- within a day or so. Rotting organic waste is often responsible for the foul smell in bins, vehicles and

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disposal facilities. The products of decomposition are corrosive, and containers and vehicles need to be designed with this in mind, and cleaned frequently to reduce this problem.

In industrialised countries much organic waste is disposed of in landfills where it decomposes anaerobically, producing methane. It also produces leachate: the liquid which filters down through the layers of waste picking up soluble chemicals and metals on its way. It can be highly toxic and poses a serious environmental and health risk unless carefully confined and treated. In developing countries, organic waste is often left to rot on streets where it is eaten by animals and birds, blocks drains, and generally causes a public nuisance and health hazard.

In view of the quantities of organic waste produced and the problems associated with transporting and disposing of it, finding alternative solutions is a high priority.

Dealing with organic waste
There are three main ways of dealing with the organic portion of municipal waste:

- Feed for animals;
- Feedstock for anaerobic digestions (i.e. biogas plants);
- Aerobic composting.

This technical brief focuses primarily on composting, which is often the most straightforward and lowest-cost option. However we will briefly discuss the first two options.

Feed for animals
Using organic waste as animal feed is outlawed in many industrialised countries because of concerns of disease transmission, and the risk of introducing toxic chemicals into the human food chain. However, some countries do allow this, and it may be a suitable solution, for example, for using waste from a food processing factory or a vegetable market where quality is relatively easy to control. Check with national regulations. The following box presents an example of the use of organic waste to feed pigs in the Philippines.

Pig-feeding in Metro Manila

In the outlying urban areas of Manila, backyard pig- rearing has long been a traditional source of income. Commercially produced feed for this activity is expensive and pig raisers often turn to organic scraps to supplement or replace the commercial product. A network of collectors collects organic waste from restaurants in the city centre, and then distributes it among backyard farmers. The farmers can purchase the waste at about half the price of the commercial feed. A cost comparison showed that profit was more than doubled by feeding the pigs on organic scraps, even after all other costs, such as veterinary costs, transport, fuel, etc., are taken into consideration. Animal feeding happens in many other countries such as Egypt, Turkey, India and Pakistan.

Such ventures are beneficial not only to the pig raisers, but also to the municipality who would otherwise have to dispose of the waste in a landfill.

Anaerobic digestion
Anaerobic microorganisms thrive in environments with no oxygen. Many such microorganisms occur naturally; in the absence of air these will prevail and decompose the organic material.

Anaerobic decomposition gives rise to methane. Methane is a potent greenhouse gas which over a period of 100 years is thought to be 23 times more harmful to the environment than carbon dioxide (CO_2). Therefore, where anaerobic digestion is employed as a treatment method, it is vital that the methane is captured and used. One such example of a controlled anaerobic digestion system for organic waste is biogas digester. These are most often used for human and animal waste, but there are examples of their successful use with organic waste.

Innovative small-scale biogas plant in India

The Appropriate Rural Technology Institute (ARTI) in Pune, India recently won an Ashden Award for its design of a biogas digester which can be fed with household organic waste. It can also accept spoiled grain, fruit, oil cake and so on. Costing around $350, the plant is made using two plastic water containers. One contains the digesting materials, the other is inverted to capture the gas.

Users apply 1Kg of organic waste daily and add 10 litres of water. In return the plant will produce around 250 g of methane per day, enough to cook a full meal for a family of five. This is an impressive input: output ratio. The gas could also be fed into a generator to provide around 1 kWh of electricity.
One of the main advantages of using organic waste as the feedstock compared with dung or excreta, is that its calorific value is considerably higher. After all, it has not already been digested using microorganisms in a cow's intestine!

See www.arti-india.org

Biogas is a source of energy with one of the lowest relative carbon footprints of all. Methane can be burnt cleanly on simple stoves, producing mainly carbon dioxide and water, making it a very clean household fuel. As with all organic waste processing techniques, one of the most significant challenges of using digesters is ensuring the quality of raw materials. Contamination from plastic, sand and soil can reduce the effectiveness of the plant, and chemical contamination could compromise the microorganisms, as well as contaminate the resultant compost.

Compost and composting

Compost is a stable, dark brown, soil-like material which can hold moisture, air and nutrients. Contrary to popular belief compost does not smell rotten: often it will smell as fresh as a forest floor (which is, of course, naturally-made compost).

Compost contains some plant nutrients including nitrogen, phosphorus and potassium (NPK), though not as much as animal manure or chemical fertilisers. Compost can also contain a range of minerals and microorganisms beneficial to plant growth. However, its main benefit is as a soil conditioner. Soil is made up of sand and 'humus': stable organic matter which retains nutrients and water. Adding compost to soil can lessen the need for chemical fertilisers because it holds nutrients in the soil, it can also help reduce soil erosion, and improve the structure of the soil thus benefiting drainage and plant roots.

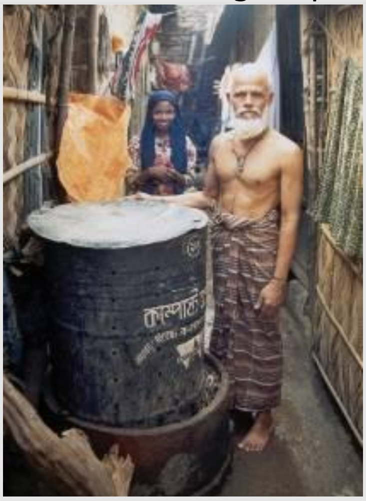
Compost is a product of controlled aerobic decomposition of organic matter made using aerobic microorganisms, insects and worms. Microorganisms thrive in a moist, warm environment with an abundance of organic matter and air. If conditions are too hot, cold, wet or dry, the composting process will be compromised. The activity of the microorganisms generates heat which can act to kill pathogens and denature seeds. The composting process can take as little as two months. Ideally compost is matured for 3 – 4 months before use. In cold weather, high altitudes or very dry conditions, the composting process may slow or even stop.

Compost - technical data

- The ideal moisture level of raw materials for compost is 40%. If they are much drier, microorganisms cannot access nutrients and composting will slow or stop. If it is wetter anaerobic microorganisms will prevail.
- The centre of a compost heap should reach temperatures of around 65°C. Turning compost, although not always necessary, can help ensure that all organic matter has been exposed to high temperatures during production.
- The carbon: nitrogen (C:N) ratio is important for microorganisms to thrive. Generally 'brown materials' such as wood chips and sawdust are high in carbon, while 'green materials' such as leaves and grass are high in nitrogen. The ideal ratio is between 25:1 and 40:1. This can often be achieved by a 50:50 mixture of green and brown materials, though this differs according to the exact types of waste.

There are many methods of making compost, ranging from small-scale home composting techniques to large-scale industrial plants requiring significant capital investment. The following box presents some of those most commonly used. Technologies may be selected according to a number of criteria, including the volume of raw materials available, budget, land availability, the cost and availability of water and electricity, and costs of labour. The nature of the market for compost may also affect technology choice.

Methods of making compost



Jonathan Rouse

Barrel composting (Dhaka, Bangladesh)

This barrel is installed in a low-income area in Dhaka, Bangladesh. It receives organic waste from around four families. High-quality compost is made because the waste is uncontaminated. It is sold to a local NGO.

Each barrel can produce around 160 kg of compost before requiring emptying, from around 600 kg of organic waste. Compost is sold at Tk2/ Kg (around US$0:03). In view of generation rates, this could generate an income of around Tk30/ family/ month.

Barrels cost around Tk2000, meaning relatively long payback periods.

Johannes Paul

Vermi composting (Bais City, Philippines)

Vermi composting predominantly uses worms to digests the waste, rather than microorganisms. Raw materials are spread daily in thin layers and cannot be piled very high, so the technique requires much more space than other methods. Worms are also more vulnerable to extreme temperature and contamination than microorganisms. One of the advantages of vermi-composting is the high nutrient content of the product.

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Silke Rothenberger

Pit composting (Pune, India)

Biodegradable waste is placed in shallow pits and left to decompose for several months. This method is very simple, often practiced in public parks or domestic gardens. In rainy conditions it is susceptible to water logging.

Jonathan Rouse

Manual windrow composting (Dhaka, Bangladesh)

A windrow is a convenient way of piling organic matter for composting in long rows with a triangular cross section. Windrows can make fairly efficient use of space, and turning compost relatively easy. In this case they are turned manually to allow sufficient air supply. The aerobic condition allow the compost to mature within three months.

Silke Rothenberger

Mechanical windrow composting (Luxor, Egypt)

This system is comparable to the manual windrow composting but is applied at larger scale as mechanical equipment is used. Mixed waste is sieved prior to composting. The organic waste is piled onto long windrows, which are frequently turned mechanically with a turning machine.

Silke Rothenberger

Compost chute (Kandy, Sri Lanka)

This chute composting plant is basically a long tube. Waste is fed in at the top. As more waste is added, over a period of a few months, mature compost emerges at the bottom. Gravity drives this process, which involves minimal mechanisation. Chimneys draw air up through the compost.

This chute was developed by a partnership between a university, NGO and municipality.

David Kuper

High-tech aerated static pile composting (Bali, Indonesia)

Instead of a manual or mechanical turning of the windrow, in this example the pile remains unturned. Air is pressed through the material through valves using a motor driven ventilator. In Europe, the piles are additionally covered by a geo-textile, reducing moisture losses.

Adapted from 'Marketing Compost', Sandec 2008

Key considerations for planning composting

Raw materials and quality

The most significant determinant of the quality compost is the raw organic waste used. If this is consistently uncontaminated, an appropriate composting process is likely to produce a high-quality product. However, if your raw waste is contaminated, even careful composting may not produce a safe and acceptable product. The following diagram summarises the implications of using more materials from different sources.

Source	Compost Quality and Risk of Contamination	Potential Contamination
Agricultural waste (manure, straw, fruit/ vegetable residues		Pesticide residue, seeds
Vegetable market waste	Quality	Pieces of packaging waste and street sweepings
Segregated kitchen waste from households		Depends on care taken in segregation (packaging, glass)
Mixed Household Waste	Risk	Difficult to control (Batteries, medicines, human waste)
Organic matter from landfill mining		No control of input material. All above plus healthcare and industrial waste. High proportion of sand or stones.

Adapted from 'Marketing Compost', Sandec 2008

There are a number of ways of ensuring high quality, including: carefully sourcing raw materials; periodically conducting spot checks on raw materials; and carefully managing the compost process. Community-engagement to ensure source-separation of waste can significantly improve the quality of organic waste collected from households. Separated waste lessens the risk of contamination from such items as batteries and means that the organic waste is easier and safer to sort and handle. There are many such examples of community recycling or resource recovery schemes in developing countries.

Quality is the most important factor for ensuring satisfied customers and continued sales. In some countries farmers have been injured by glass and needles in low-quality compost they apply to their land. Low-quality compost can also contain invisible contaminants such as toxic compounds or heavy metals, which may affect the farmers and consumers in the long run, and also pollute land and groundwater. Different markets will have different quality requirements. However, all compost sold must have safe levels of pathogens, toxic chemical and heavy metal contamination within national or international standards.

Human waste and organic waste management

Human waste (excreta or sewerage sludge) can be added to organic waste for composting. This is called co-composting. Beware that in some societies there is a taboo on the use of human waste and sewage as an agricultural input. This may limit the market for compost produced in this way. Additionally there is a risk of spreading disease by using untreated human excreta. In the UK there are examples of small-scale co-composting, but the product is applied to trees, not food crops.

Locating composting plants

Many factors affect the decision of where to locate your business, and the decision will often involve compromise. Factors include:

- availability of raw materials;
- labour supply;
- land rents;
- location of competition;
- acceptance by neighbours;
- transport distances and cost of transportation; and,
- location of customers

Locating compost businesses involves compromise because:

- most domestic waste is generated in cities, but the bulk markets for compost lie in rural areas;
- land prices in large cities are very high compared with rural areas; and,
- relative to its value, transport costs of waste or compost are often high.

Composting urban organic waste close to the source of raw waste usually puts you close to the household market which can be lucrative, but is often relatively low-volume. Bulk markets (e.g. farms) are often located far from where waste is produced, necessitating transportation of either waste or compost. Usually it is more efficient to transport compost, because it volume and weight are just 30% of the raw materials. It is also more hygienic to handle and transport compost compared with waste. In small towns, composting plants may be located at the edge of the town, near to sources of raw materials *and* markets.

Marketing

One of the most common reasons composting initiatives fail is because no market is identified for the compost produced. Indeed sometimes, it is impossible even to give it away, resulting in small mountains of compost accumulating and eventually causing sites to cease production. Compost does not have a ready-made market in many areas because of a lack of awareness of the benefits of compost, concerns about quality (e.g. presence of sharps or glass), competition with other agricultural impacts (some of which may be subsidised) and cultural concerns over the use of waste. Applying basic marketing principles can help producers identifying and stimulate markets for their compost, leading to improved sustainability and even profit.

There are a number of basic steps in the marketing approach, namely:

- Understanding the marketing environment, including competition, legislation and environment.
- Identifying and understanding your market, including 'segmenting' the market. Segments may include for example: local householders; and rural farmers.
- Considering the four Ps: Product (defining the type and quality of compost), Price (devising pricing which appeals to the market and which makes you profit), Place (locating your business) and Promotion (awareness raising, packaging etc.).

For further information see 'Marketing Compost' (Sandec).

Strategic partnerships

Many players have a stake in organic waste management and it can be beneficial to form partnerships as a producer. Composting reduces the amount of waste municipalities have to collect, transport and dispose of. In recognition of this, they are sometimes willing to provide incentives to NGOs and businesses, for example, provision of land for composting, or direct payment reflecting their cost savings.

There are other examples of partnerships, for example with universities to benefit from innovation. The following box describes the partnership between a compost producer in Bangladesh and two agricultural companies.

Strategic partnerships in Bangladesh
Waste Concern in Bangladesh produces many tonnes of compost each week in central Dhaka. The market, however, is mostly based in rural areas far from Dhaka. Waste concern does not have its own transport infrastructure, so it has formed a partnership with two agricultural companies. MAP Agro purchases around 300 tonnes of compost from the NGO every month. They blend some of it with chemical fertilisers, package it and sell it to Alpha Industries, an agricultural input distribution company. Alpha Industries uses its existing transport and sales network to sell the compost as far away as 600 km from Dhaka. These partnerships leave Waste Concern to pursue what is good at: composting.

See www.wasteconcern.org

Conclusion
Composting can provide a solution to dealing with the most significant component of waste. It reduces the weight and volume of waste, and produces an inoffensive, useful product. Compost can have beneficial impacts on soil, benefiting agriculture and biodiversity and even slowing soil erosion. Finally composting can be a profitable business activity and provide income and employment opportunities for the poor.

Further reading and references

- *Compost Toilets* Practical Action Technical Brief
- *Re-use of Excreta and Urine form Eco-san* Practical Action Technical Brief
- *Planning for Municipal Solid Waste Management* Technical Brief, Practical Action
- *Biogas* Technical Brief, Practical Action
- *Compost Bin Manufacture* Technical Brief, Practical Action
- *Ecological Sanitation: a concept* Technical Brief, Practical Action
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- *Simple Pit Latrine.* Chatterton, K. WEDC.
- *Latrine Buidling: A Handbook for Implementation of the SanPlat System* Brandberg, B. Practical Action Publishing 2002
- *Toilets that Make Compost* P Morgan Practical Action Publishing 2008
- *Shit Matters* Mehta and Movik Practical Action Publishing 2010

- *Sustainable Composting* Ali, S.M. (Editor) and Rouse, J.R. 2004. Water, Engineering and Development Centre - WEDC, Loughborough University, UK, 2004
- *Organic Waste – Options for Small-scale Resource Recovery,* Urban Solid Waste Series, Lardinois, I., and Klundert, A van de, TOOL / WASTE Consultants, 1993. The focus of this book is on the recovery of urban organic waste, in developing countries, through activities such as animal raising, composting, the production of biogas and briquetting.
- *A guide to the development of on-site sanitation.* Franceys, R., WHO 1992. Provides in-depth technical information about the design, construction, operation and maintenance of on-site sanitation facilities, with numerous practical design examples
- *Decentralised Composting for Cities of Low- and Middle-Income Countries. A Users' Manual.* Rothenberger, S., Zurbrugg, C., Enayettullah, I. and Sinha, M.A.H. 2006, SANDEC and Waste Concern, Bangladesh.
- *Marketing Compost. A guide for compost producers in low and middle-income countries.* Rouse, J.R., Rothenberger, S., and Zurbrugg, C. 2008. SANDEC, (EAWAG)

Useful Websites
- WASTE (a Dutch NGO) is doing a large amount of work on ecological sanitation. Information can be found at www.ecosan.nl
- A Swedish funded ecological sanitation research group provide a wide range of useful information at www.ecosanres.org
- The German international cooperation enterprise for sustainable development, GTZ, provide a wealth of technical information at www.gtz.de/ecosan

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