COMPOSTING

Input materials	Pre-condition/Pre-treatment	Operation & maintenance needs	Objectives / Key features	Key technical parameters
Suitable organic waste: – Garden trimmings – Vegetables/fruit peels – Animal manure **Unsuitable waste:** – Big chunk of woody materials – Food-leftovers not preferred (risk of attracting pests and rodents)	Waste segregation at source Optional: shredding	Regular low operation and maintenance required.	Aerobic degradation of waste producing compost which can be used as soil-amendment.	Process time: 3-6 months Mass reduction: 35-40% Space: 180 - 300 m2/t*d

Outputs / products	Technical complexity	Maturity level	Educational aspect
Compost, soil amendment Compost is a stable dark-brown, soil-like material with earthy smell.	Limited infrastructure required (covered area) Low-level skill required for construction Medium-level skills required on composting process for appropriate operation and maintenance	Proven technology globally	**Topics:** Microbiology, Organic degradation, Nutrients recovery, Plant growth **Practical exercises:** Observing degradation process, Monitoring composting heap, Investigation on crops yield with compost

Composting involves the controlled aerobic decomposition of organic matter that results in a soil like material called compost. This process occurs as a result of microbial activity under aerobic conditions (in presence of oxygen). Use of compost improves soil structure and increases the nutrients availability in the soil.

Composting is an ancient and widespread practice worldwide. Composting of organic matter is driven by a diverse population of microorganisms and invertebrates who break down organic matter and produce carbon dioxide, water and heat.

Controlling the process implies that the predominant parameters such as organic material composition (carbon–nitrogen ratio), particle size, free air space, aeration, temperature, moisture, or pH are managed, controlled and adjusted to achieve fast degradation and good compost quality [1].

A typically feature of a well-functioning composting process is a high temperature phase (50-70°C). The high temperature contributes to the hygienization of the material by partially eliminating pathogens and weed seeds. The end of the composting process is reached when the inner temperature of the pile is similar to ambient temperature and the oxygen concentration in the air cavities within the pile remains (10–15%) for several days [2].

Under ideal operating conditions, compost can be produced within 3 months. When conditions are not optimal, the process may be slower or may be hindered [3].

The main output product from composting is compost, a stable dark-brown, soil-like material, with dark color and earthy smell. The quality of the input material and key biological and physical operating parameters have a major influence on the quality of the final compost.

Applicability: Composting can be conducted at different scale and with different use of technology mechanization. Small-scale home-composting is most frequently conducted in bins or open heaps and rely on passive aeration process, while medium and large-scale rely on mechanization with regular turnings or active aeration, either with open windrow, bins, or in-vessel composting reactor [3].

Design considerations: Key components in the design of a composting facility include space for waste separation and preparation, fo the composting heaps or units, for screening the compost and storage of produced compost as well as space for a buffer zone. Depending on the climate and available space, the facility (at least the area of the composting heaps or units) may need to be covered in order to better control moisture. The facility should be fenced to avoid animals entering and should be located close to organic waste sources to minimize transport efforts and costs. Robust grinders can be used for shredding large pieces of organic waste before composting [4].

Materials needed: Composting facilities can be constructed with locally available material. The compost pad can be made out of concrete or well-compressed clay. Cover/roof can be made from local materials such as bamboo, grass matting, wood, plastic or metal sheet. Prefabricated composting vessels of different sizes are available on the market.

Operation & maintenance: A good mixture of carbon and nitrogen in the waste is required to allow composting. This is expressed by the C/N ratio. Moisture is also highly relevant. Depending on the moisture content of the feedstock used in composting and the climate, the addition of water may be necessary at the beginning or during the process to ensure sufficient moisture for microbial activity. Periodic turning of the composting pile ensures sufficient aeration. This can be done by hand using a pitch fork or shovel.

Health and safety: While composting is not an inherently dangerous activity, precautions are necessary to protect against injury [5].

Costs: Costs of building a composting facility vary depending on the method chosen and the cost of local materials and if machinery is included or not in the design.

Social, legal, and environmental considerations: Composting can create leachate at the beginning of the composting process. Leachate should be collected and used to water the composting pile when the moisture content decreases. When composting is not performed in a controlled way, may attract rodents and flies. Furthermore, if too wet, anaerobic degradation may occur (i.e. organic waste starts to rot) generating bad smells and greenhouse gases (GHG). Bad smells from uncontrolled composting process can decrease social acceptance for composting. Ensuring that the compost product conforms to local guidelines/ standards is necessary prerequisites.

Strengths and weaknesses:

- ⊕ Proven, effective treatment method
- ⊕ Can be built and maintained with locally available materials
- ⊕ Low capital and operating costs
- ⊕ No electrical energy required
- ⊕ Easy to link with education purposes
- ⊖ Requires a large, well located land area
- ⊖ Long treatment time
- ⊖ Requires skills and knowledge on composting process and dedicated person to control the process

> References and further reading

1. Zabaleta, I., et al., Selecting Organic Waste Treatment Technologies. SOWATT, Eawag, Editor. 2020.
2. Cooperband, L., The Art and Science of Composting - A resource for farmers and compost producers, C.f.I.A. Systems, Editor. 2002.
3. Lohri, C.R., et al., Treatment technologies for urban solid biowaste to create value products: a review with focus on low- and middle-income settings. Reviews in Environmental Science and Bio-Technology, 2017. 16(1): p. 81-130.
4. Gensch, R., et al., Compendium of Sanitation Technologies in Emergencies. 2018.
5. Rynk, R., M. Van De Kamp, and G.B. Willson, On-farm Composting Handbook. 1992.

CCAC, ISWA. A handbook for schools on organic waste management. 2015

Rothenberger et al. Decentralized composting for cities in low- and middle-income countries. 2006

MOOC Youtube videos:

- *MOOC Mod.3.2 Science of composting*
- *MOOC Mod. 3.4 Operating the Composting Process*