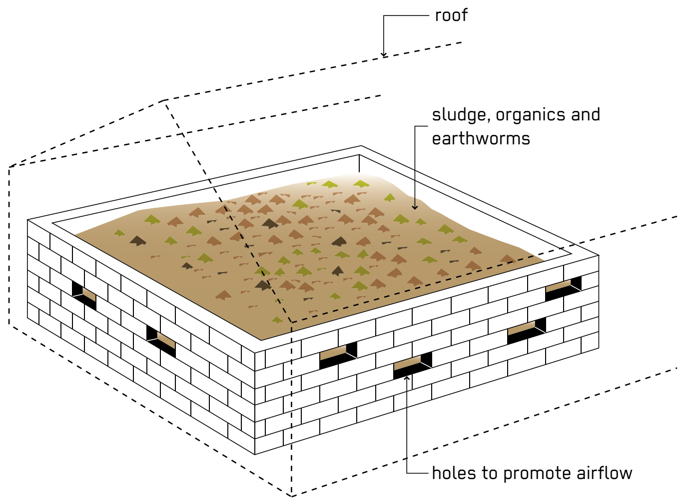
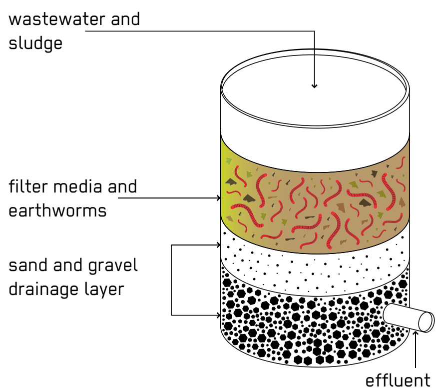
Vermicomposting and Vermifiltration (Emerging Technology)

Phase of Emergency	Application Level / Scale	Management Level	Objectives / Key Features
* Acute Response * Stabilisation ** Recovery	Household ** Neighbourhood ** City	Household * Shared ** Public	Compost production, Pathogen removal, Sludge reduction
Space Required	**Technical Complexity**	**Inputs**	**Outputs**
** Medium	** Medium	Urine, Faeces, Sludge, (Anal Cleansing Water), (Dry Cleansing Materials), (Flush Water)	(Vermi-)Compost, Effluent

vermicomposting



vermifiltration



Vermicomposting and Vermifiltration are two low cost, options for human waste treatment in which earthworms are used as biofilters. The end-product is worm cast or vermicompost which contains reduced levels of contaminants and depending on the processes chosen can reduce volume of faecal sludge by over 90 %. Vermicompost contains water-soluble nutrients and is an excellent, nutrient-rich organic fertiliser and soil conditioner.

Both Vermicomposting and Vermifiltration are aerobic treatment systems. Two parameters are particularly important: moisture content and the carbon to nitrogen (C:N) ratio. Faecal sludge has a high moisture and nitrogen content, while organic solid waste is high in organic carbon and has good bulking properties which promotes aeration. By combining the two, the benefits of each can be used to optimise process and product. The most commonly used method of Vermicomposting is the in-vessel method. Vermifiltration happens in a water-tight container and can receive more liquid inputs such as wastewater or watery sludge.

Design Considerations: The design of a Vermicomposting facility is similar to Co-Composting **(T.11)** using vessels and with the addition of earthworms. Vermifilters consist of enclosed reactors containing filter media and worms. These are used on a small scale in Worm-Based Toilets **(S.12)**. In Vermifiltration systems the solids (faecal sludge and toilet paper) are trapped on top of the filter where they are processed into humus by the worms and bacteria, while the liquid passes through the filter. In separating solid and liquid fractions the quality of the effluent is increased. Ventilation must be sufficient to ensure an aerobic environment for the worms and microorganisms, while also inhibiting entry of unwanted flies. The temperature within the reactor needs to be maintained within a range suitable for the species of compost worms used. The specific design of a vermifilter will depend on the characteristics and volume of sludge. Vermicomposting or vermifilters can be combined with other treatments - for example, the digestate from anaerobic digestion **(S.13–S.16)** could be vermifiltered to achieve solids reduction and increase pathogen elimination. Effluent produced during the vermifiltration process can be directly infiltrated into the soil, or further treated through evapotranspiration in a planted system.

Materials: Vermicomposting tanks can be made from local materials (bricks or concrete). Vermifilters require enclosed reactors made from durable materials that eliminate vermin entry, usually plastic or concrete. Filter material for the vermifilter can be sawdust, straw, coir, bark mulch or peat. Worms are required, and three species to date have been successfully used: Eisenia fetida, Eudrilus eugeniae and Eisenia andrei. It is possible to find worms in the local environment, buy them from vermicomposting or vermifilter businesses or import them. Prefabricated composting vessels of different sizes are available on the market.

Applicability: Vermifiltration can be applied in all emergency phases provided there is access to worms. Vermicomposting requires a high level of organisation and labour to sort organic waste, manage the facility and monitor treatment efficiency and is therefore unlikely to be practical in the acute response phase of emergency situations. However, it can be considered a viable option in the stabilisation and recovery phases where there is an available source of well-sorted organic solid waste and space. Experience has shown that vermicomposting facilities operate best when they are established as a business venture with compost as a marketable product that can generate revenue to support cost recovery. However, compost sales cannot be expected to cover the full cost of the service.

Operation and Maintenance: A Vermicomposting facility requires well-trained maintenance staff to carefully monitor quality and quantity of the input material and worm health as well as manage moisture and oxygen content. Organic waste must first be sorted so it is free from plastics and other non-organic materials. Turning must be periodically done with either a front-end loader or by hand using a pitch fork or shovel. A Vermifilter has low mechanical and manual maintenance requirements, and where gravity-operated requires no energy inputs. Recirculation, if required for improved effluent quality, would require a pump.

Health and Safety: Unlike Co-Composting **(T.11)**, pasteurising temperatures cannot be achieved as worms and bacteria are sensitive to extreme temperatures, thus for wastes containing high levels of pathogens (such as raw sewage or septic tank waste), further treatment may be required to produce a pathogen-free compost. Health risks can be minimised if adequate control measures are consistently practiced, and workers adopt basic precautions, hygiene practices and wear personal protective equipment. If material is found to be dusty, workers should wear masks. Vermicompost should be stored for at least a year before use. If resources exist, helminth egg inactivation should be monitored as a proxy measure of sterilisation. If reuse is not intended the compost can either be buried or brought to a final disposal site. The World Health Organization guidelines should be consulted for detailed information.

Costs: Costs of building a Vermicompost facility vary depending on the method chosen and the cost of local materials and if machinery such as aerators are included in the design. The main costs to consider are the overall operation requirements including transport and supply of faecal sludge and organic solid waste and disposal of compost. The cost of vermifilters depends on the scale and design of the system.

Social Considerations: Before considering a Vermicomposting system, the concept needs to be discussed with the affected community beforehand. If the community has experience with separating organic waste and composting this can be a facilitating factor. Identifying that compost made from human waste is an acceptable product for potential users (market survey) and ensuring that the compost product conforms to local guidelines/standards are necessary prerequisites. Without these, different treatment processes should be identified.

Strengths and Weaknesses:

- (+) Reduces quantity of organic waste
- (+) Simple robust technology
- (+) Can be built and maintained with locally available materials
- (+) Relatively low capital costs

- (−) Requires a large, well located land area (Vermicomposting)
- (−) Rodents can be attracted to the organic material (food waste etc.)

→ **References and further reading material for this technology can be found on page 194**