CASE STUDY 3

Coco peat filter and reuse production

Kushtia,
Bangladesh

Background

Treatment selection and purpose

The Faecal Sludge Treatment Plant (FSTP) in Kushtia, Bangladesh started operation in 2012. It is owned by the local municipality but is privately operated through a contractual agreement with the Environmental Resource Advancement Services (ERAS), a small-scale private enterprise. The FSTP includes unplanted drying beds to separate solid and liquid waste, a coco peat filter to treat the liquid effluent, and involves a co-composting process for treating dried sludge with organic waste for reuse purposes. These technologies were chosen for their low-cost and simple design for construction, operation and maintenance (O&M). A natural technology was chosen over mechanised options to avoid costly energy bills and the frequent O&M requirements of any mechanised system. However, some mechanised pumps are used as part of the system.

Design selection was done through a consultative process involving several public and private organisations including: (i) the Local Government Engineering Department (LGED) of Bangladesh as the FSTP's funders (through its Secondary Towns Integrated Flood Protection [STIFP] project); (ii) the local Kushtia municipality as the owners of the FSTP; and (iii) a number of international and national consultants as technical advisers. The site was initially developed for the composting of municipal waste, and the faecal sludge management component was added afterwards. It was the Kushtia municipality that made the final decision on the design after discussion and consultation with members of the STIFP project, the municipality, and the technical advisers.

Kushtia municipality-owned and operated vacutug

Description of the system

The Kushtia FSTP uses a linear treatment system to process faecal sludge, which arrives at the facility via municipality-owned and operated vacuum trucks (known as vacutugs in Bangladesh). Figure 1 shows the treatment process. The facility calculates the volume of sludge received according to vacutug size, as each vehicle is marked with its capacity (i.e., 1000L, 2000L and 4000L). Upon reception of the sludge, no screening occurs; rather, it is dumped in the facility's two primary dumping chambers for sludge settling (one chamber on each side of the two drying beds in operation).

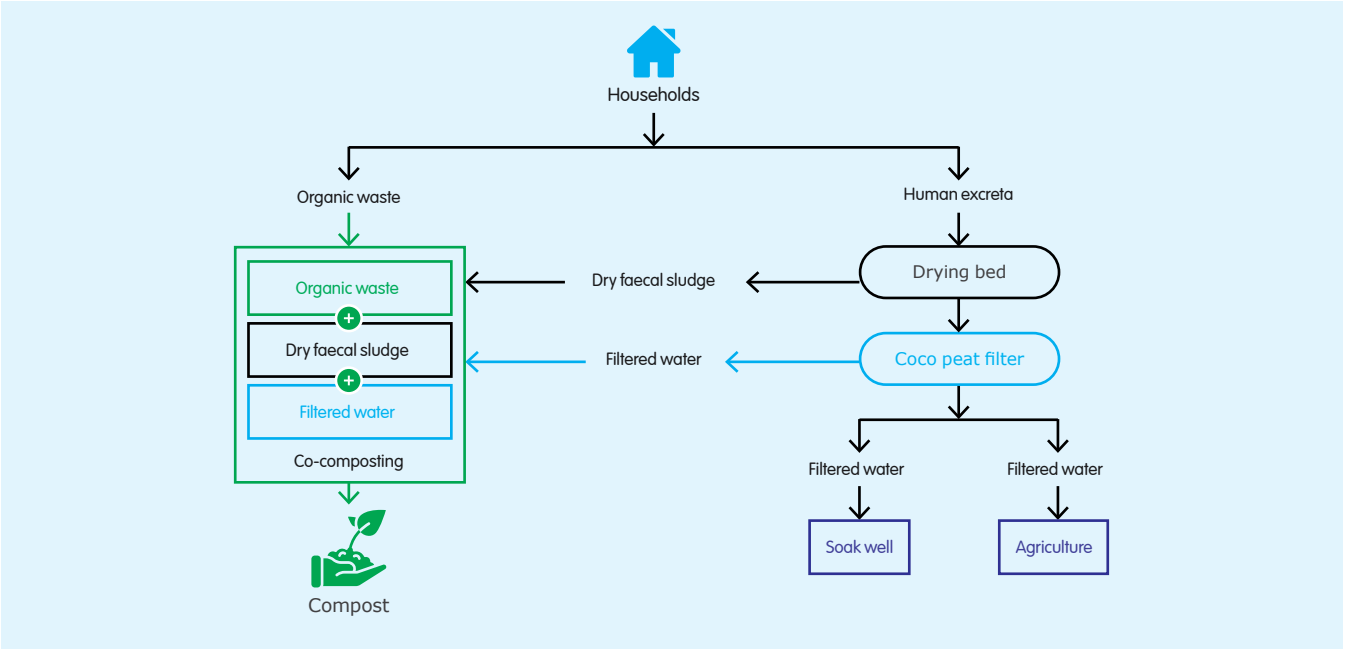
> *We have tried to adapt such a technology to reduce the cost of long-term operations, thinking about operational costing. Because, at the municipal level, capital or earning source is limited. That's why we chose this low-cost technology.*
>
> **ENGINEER, KUSHTIA MUNICIPALITY**

In the two primary dumping chambers, solid waste and other rubbish is sorted using a large perforated drum: the sludge moves through the holes, but the solid waste remains. The remaining sludge moves by gravity to the natural drying beds through the mouth of the chamber. In each drying bed there are three brick rows to distribute the faecal sludge uniformly. The liquid effluent is separated from the solid part in the drying beds through a filter material made up of bricks, sand, stones, and pipes.

Desludging household containment

Settled sludge moves to the natural drying bed via the filtering gate

Figure 1. Treatment flow diagram,[1] adapted by SNV



[1] I. Enayetullah, 'Co-composting of municipal solid waste and faecal sludge in Kushtia Bangladesh', *ISWA Congress 2015*, Dhaka, Waste Concern, 2015, https://www.unescap.org/sites/default/files/Waste%20Concern,%20Bangladesh.pdf (accessed 10 November 2020).

Filtering effluent in coconut dust and coir filtering bed

Discharging sludge into drying beds

Removing dried sludge from the drying beds

The liquid effluent is then accumulated in two reserve tanks and pumped to the coco peat filter. The coco peat filter is a vertical filtering system using coir from coconut processing plants. After filtration through the coco peat filter, filtered water is discharged into a reserve pond. This water is used for farming in the internal facility plant nursery or is discharged into a nearby canal.

The solid part of the treated sludge is combined with organic waste for co-composting in order to produce agricultural fertiliser, which is then sold.

> *The reason the coco peat filter seems good to me is that the water is being filtered twice. Once from the dry bed water goes into the tank. From the tank we upload the water to the coco peat. Water goes to the pond from there. The water has been tested and it has come up to the standard. This is the first time I saw the coco peat system in my life.*
>
> **PRODUCTION MANAGER, ERAS**

Table 1. Capacity and operating costs of coco peat filter and reuse production

	Sludge drying beds
Design capacity	8-9 m^3 of sludge/day
Operating capacity	8-9 m^3 of sludge/day
Operating costs	US$ 115,000 spent in capital expenditure US$ 900/month per staff for salary costs (seven staff at facility)

Regulatory environment and compliance

The Kushtia FSTP follows the environmental and compliance effluent quality standards set by the Government of Bangladesh's Ministry of Environment and Forests.[2] The facility reliably meets government-regulated water quality standards, which require that Biochemical Oxygen Demand (BOD) must be no more than 40 mg/L, and that faecal coliform bacteria must be less than 1,000 per 100 ml. The FSTP is currently meeting these effluent standards and has a laboratory at the facility site to test water quality on a regular basis. For the processed solid waste, no quality standards are followed except to ensure that the waste is safe to dispose of by conducting laboratory testing for pathogens at the facility.

[2] *S.R.O. No. 197-Law/97-Environment Conservation Rules* (1997) Ministry of Environment and Forest, Government of Bangladesh

Sludge drying beds at the Kushtia FSTP

Reserve tanks which drain water from the sludge drying beds

Operation and maintenance: realities, challenges, and opportunities

Realities of running the treatment plant

Costs, training, and support

The facility is leased to ERAS by the municipality, with each entity responsible for different O&M costs. ERAS pays a fee of US$ 590 per year to lease the facility, and the current lease runs until June 2021. As the lease holder, ERAS is responsible for small operational costs. This includes staff salary costs for seven people, which constitutes the largest operational costs. More significant infrastructure costs, such as major repairs and capital expenditure, are the responsibility of the municipality. To date the municipality has invested in connecting the facility to the electricity grid and ensuring proper road access. The municipality is also currently repairing some of the co-compost cells. The seven staff working at the plant have received on-the-job, and practical O&M training from SNV who provide regular technical support. Through the practical training received, staff are aware of and respond to the ongoing O&M needs of the facility.

> *There is no such [O&M] protocol. We take care of it on our own interest. If we understand with our bare eyes, it is dirty, we have to eliminate it or reduce the goods [sludge] if it is more than capacity. Then we make sure the maintenance [is assured].*
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> **PRODUCTION MANAGER, ERAS**

Cleaning and maintaining treatment units

Cleanliness and maintenance of the coco peat filter and sludge drying beds are the biggest tasks for staff as they require daily cleaning. Frequent operational tasks include lifting the effluent in the coco peat filter several times a week to ensure the filtration system is operating effectively. Desludging or removal of dry sludge occurs weekly to clean the beds and prepare them for new batches of sludge.

Electricity needs

Minimal electricity is needed to operate the FSTP, with the laboratory and pumps operated from the electricity grid, and a fuel-powered generator if power outages occur. The main electricity needs are to power a pump, which moves water from the reserve tanks to the coco peat filter, and to operate the laboratory for effluent quality testing. Additionally, the co-compost facility requires an energy source for the crashing and netting machines.

Lifespan of plant

The FSTP was designed at a small scale to assess the performance of the chosen system, and to gauge the need for future expansion. At the time of the plant's design in 2011, the total population of the city of Kushtia was 102,988. The facility services, including desludging, are available to all, and the lifespan of the facility will be for at least another 20-30 years. With the model treatment system deemed successful, current tendering processes are underway to expand the capacity of the plant to cope with larger volumes as emptying practices increase.

Challenges of construction, and operation and maintenance

Variability of waste input

The plant has experienced variable waste input in terms of quality and quantity, which has led to operational challenges. Poor quality sludge received from households (contaminated with rubbish, or dirt, or with a too high liquid percentage) affects production as it increases the human resources needed to process the sludge, thereby increasing costs.

When the waste input is too low, this affects the amount of fertiliser that can be produced. Equally, as described above, when the input is too high and the plant receives excess quantities of sludge, this excess sludge is discharged into trenches, creating environmental pollution concerns. The municipality agreed to a request by ERAS to expand the capacity of the facility through the addition of two drying beds, with funding from the municipality (80%) and a Bill & Melinda Gates Foundation-financed SNV project (20%). Through a tendering process, the municipality assigned a contractor to construct an additional two beds and a shed. The facility upgrade has been completed, and CCTV cameras for monitoring and security purposes are currently being installed.

> *Earlier, we said, we gave on-the-job training. Now, those who are involved in ERAS or composting look at health [and] safety issues. Gumboots for the legs, gloves for hands, masks for the face [are] provided to them… staff have to use these items.*
>
> **ENGINEER, KUSHTIA MUNICIPALITY**

Kushtia FSTP workers removing rubbish from solid organic waste for co-composting purposes

Clogging of filters

Clogging of the dumping chamber for the drying bed filters has resulted in overflow challenges and mechanism failure on occasion. The FSTP is in operation 24 hours per day, but the operators only work from 8 am until 4 pm, and so at times the vacutug operators dump sludge without monitoring from the plant staff. As vacutug operators do not know how much sludge the treatment system can receive at any given time, overflow challenges and occasional clogging of the filter media treatment mechanism has occurred twice to date. To deal with the current high input issues, vacutug operators have been instructed to offload sludge into the trenches while the additional drying beds are constructed. Large perforated drums have been installed in the dumping chamber to address the filter clogging challenge.

Co-composting of treated sludge and organic waste

Kushtia FSTP worker sealing the co-composted fertiliser into bags (left) and the final fertiliser product (right)

Rainy season

Flooding concerns and the rainy season presented challenges during construction, and affected ongoing O&M. During construction, it was a priority for the designers to raise the drying beds above the flood level, which required significant earthworks. Previously, O&M was put under pressure during the rainy season as there were no sheds or covers for the drying beds, which meant that sludge could not be dried, thereby disrupting the treatment process. Significantly more effort from operators was required to treat the sludge in the rainy season as the drying beds needed emptying and cleaning. In the middle of 2018, the production manager informed the municipality of this ongoing challenge and requested for the construction of a shed to protect the drying beds from the rains.

Occupational Health and Safety (OHS) challenges

Due to the manual sorting of organic matter from solid waste for co-composting processes, staff have frequently been cut by metal scraps. Despite OHS-mandated measures, including the use of gumboots, gloves, face masks, uniforms, and handwashing with anti-bacterial soap, the production manager explained that staff did not always use protective clothing due to the discomfort of these clothes in hot weather. However, at present, staff have become habituated to using protective clothing, which minimises these OHS challenges. The municipal authority is always encouraging the cleaners to wear Personal Protective Equipment (PPE).

Opportunities for reuse

Co-composting – the controlled aerobic degradation of organics using more than one feedstock (faecal sludge and organic solid waste)[3] – occurs at the FSTP for the retail production of agricultural fertiliser. At the Kushtia FSTP, open composting occurs where the mixed sludge and organic solid waste is piled in heaps and left to decompose for a period of 45 to 50 days. These piles are periodically turned to provide oxygen and to ensure that all parts of the pile are subjected to the same heat treatment.[4]

Plant operators sort the organic waste to be mixed with the treated sludge. The fertiliser that is produced is then sold for agricultural use at the local market and in other districts (Dinajpur, Bogura, Chittagong, Dhaka, Jashore). Since 2018, two years after private sector involvement in the co-composting operation, the facility has been realising a profit.

[3] E. Tilley, L. Ulrich, C. Lüthi, Ph. Reymond and C. Zurbrügg, *Compendium of Sanitation Systems and Technologies*, 2nd Revised Edition, Dübendorf, Swiss Federal Institute of Aquatic Science and Technology (eawag), 2014, https://sswm.info/sites/default/files/reference_attachments/TILLEY%20et%20al%202014%20Compendium%20of%20Sanitation%20Systems%20and%20Technologies%202nd%20Revised%20Edition.pdf (accessed 5 November 2020).
[4] As part of SNV's support, compost was sent to the Bangladesh Agriculture Research Institute for testing in different agriculture products, and the Fisheries & Marine Resource Technology Discipline of Khulna University to analyse compost impact on pisciculture. Findings of both research were used to improve the quality of compost production. Read more here: https://snv.org/cms/sites/default/files/explore/download/snv_-_co-composting_of_faecal_sludge.pdf and https://snv.org/cms/sites/default/files/explore/download/snv_-_impact_of_treated_faecal_sludge_on_fish_growth.pdf

Informed choice considerations	Coco peat filter and reuse production in Kushtia, Bangladesh
Operating & design capacity	Design capacity = 8-9 m^3/day Operating capacity = 8-9 m^3/day
Operating costs	US$ 10,800 per year (salaries) + US$ 950 per year for facility lease
Energy requirements	Low energy demand
Input characteristics	Variability in both quality and quantity
Output characteristics	BOD = < 40 mg/L (discharge limit: 40 mg/L)
Reuse	Co-composting for retail agriculture fertiliser
Skills & human resources requirements	Seven staff
Technology/material (local) availability	Natural technologies were chosen for their low-cost and simple design in terms of construction, operation and maintenance

References

Enayetullah, I., 'Co-composting of municipal solid waste and faecal sludge in Kushtia Bangladesh', *ISWA Congress 2015*, Dhaka, Waste Concern, 2015, p.9, https://www.unescap.org/sites/default/files/Co-Composting%20Kushtia_Waste%20Concern.pdf (accessed 5 November 2020).

S.R.O. No. 197-Law/97-Environment Conservation Rules (1997) Ministry of Environment and Forest, Government of Bangladesh

Tilley, E., Ulrich, L., Lüthi, C., Reymond, Ph. and Zurbrügg, C., *Compendium of Sanitation Systems and Technologies, 2nd Revised Edition*, Dübendorf, Swiss Federal Institute of Aquatic Science and Technology (eawag), 2014, https://sswm.info/sites/default/files/reference_attachments/TILLEY%20et%20al%202014%20Compendium%20of%20Sanitation%20Systems%20and%20Technologies%20-%202nd%20Revised%20Edition.pdf (accessed 5 November 2020).

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Photos: SNV