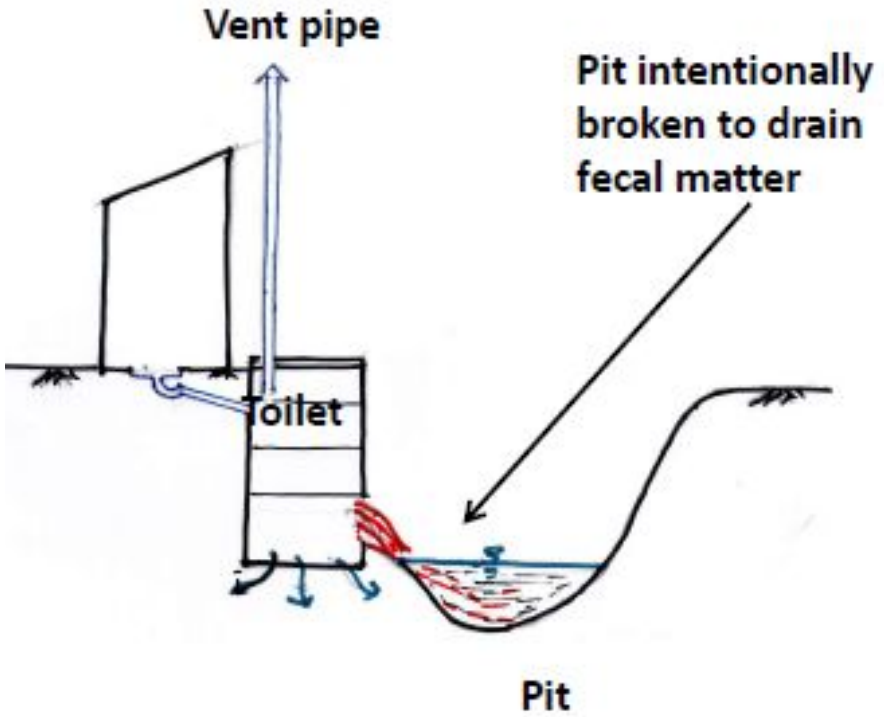
Fecal Sludge Management (FSM)

Fate of Fecal Sludge …….

- Pits are mostly emptied manually, **at great risk to the manual emptiers**, endangering public health. Media reported **31 deaths of sweepers while cleaning septic tanks in 2015.**
- In the absence of proper emptying services, the pit/septic tank-contents are often drained into the surrounding low-lying areas, or into storm drainage system.
- Even if the pits are emptied, the **emptied fecal matter are discharged into nearby drains/water bo**dies.

Fate of Fecal Sludge ……..





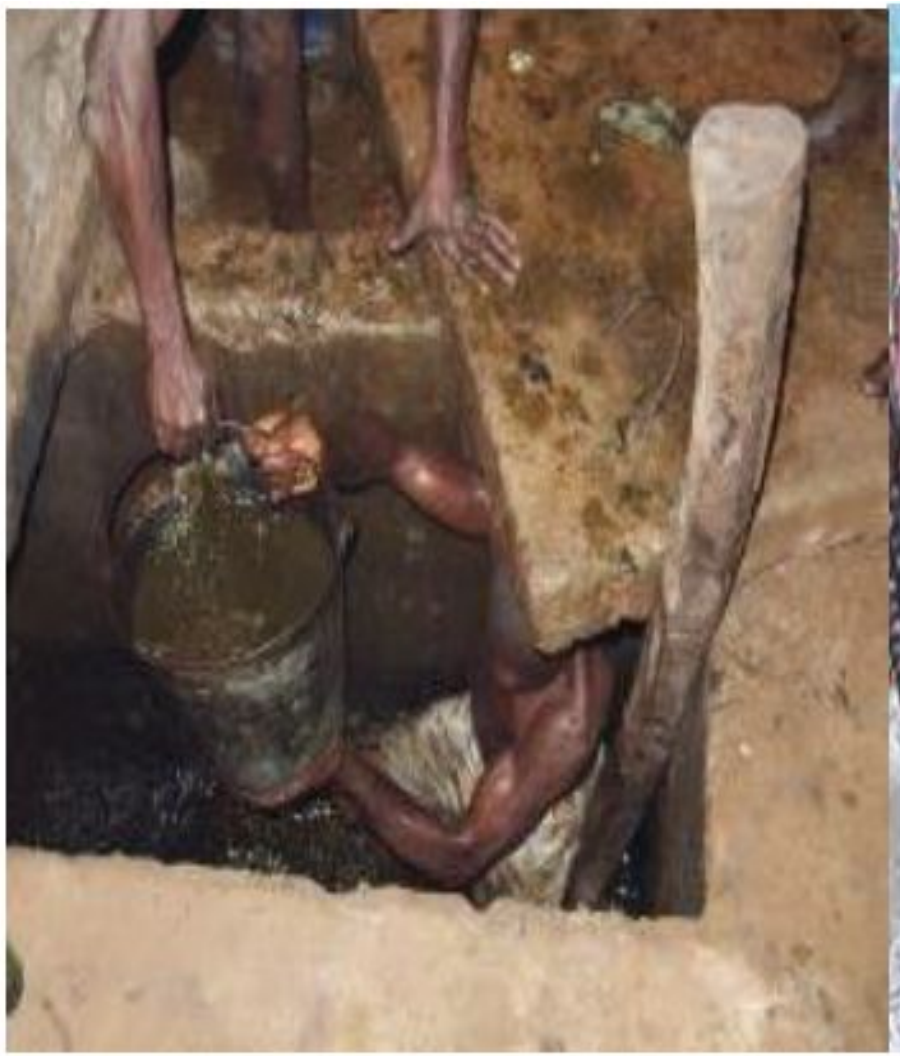
Fate of Fecal Sludge ……..



Fate of Fecal Sludge ……..



Fate of Fecal Sludge ……..





Fate of Fecal Sludge ……..





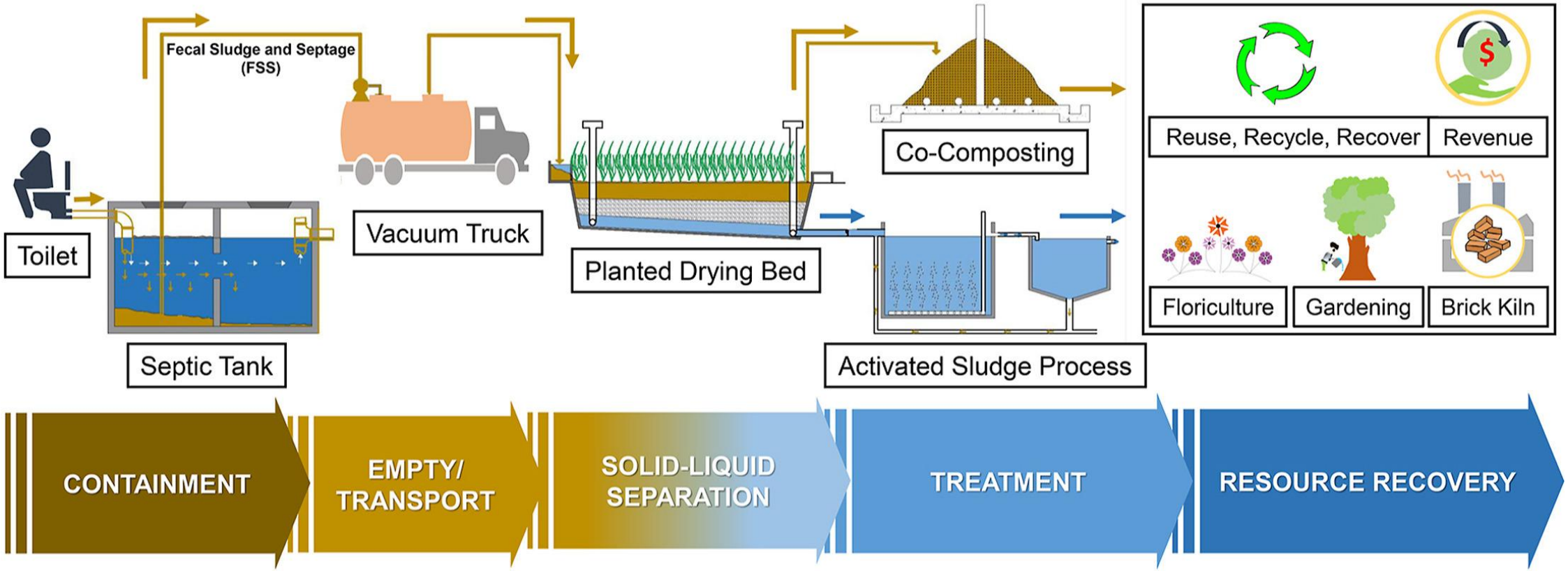




Fecal Sludge Management (FSM)

- Fecal Sludge Management (FSM) refers to a “systems approach” that includes technologies and mechanisms for containment, emptying, collection, transportation, treatment, disposal and/or enduse of sludge produced in onsite sanitation systems such as septic tanks and pit/pour-flush latrines.
- Conventional sewerage system is not included in a FSM system.

Fecal Sludge Management (FSM)



FSM System Elements: Important Issues

- **User**: Raise awareness of users regarding FSM
- **Containment**: Proper design for effective containment and easy emptying of fecal matter.
- **Emptying**: Sufficient access for mechanical desludging, particularly in slums and low income communities.
- **Collection**: Align collection vehicle size with available access to OSS facilities.
- **Transport**: Include transfer stations for cost-effective transport of fecal sludge up to treatment plants.
- **Treatment**: Ensure availability of land for establishment of fecal sludge treatment plants.
- **Disposal/ reuse**: Implement quality assurance of treatment and of treated FS for enduse.

Containment & on-site treatment

- The “containment” refers to small-scale treatment options for domestic wastewater treatment in which FS is contained for collection.
- Through good FS containment, the discharge of pathogens into the environment is significantly reduced.
- Within any technical containment option, wastewater is also automatically treated to some extent.
- The treatment process may consist of sedimentation, filtration (mechanical treatment), anaerobic and/or aerobic digestion (biological treatment) or a combination of mechanical and biological treatment processes.

Containment & on-site treatment

- Pit systems fall under the category of “basic sanitation” and do allow for an underground collection of feces.
- A conventional septic tank falls under the containment category of “improved sanitation” in which domestic wastewater from toilets is collected.



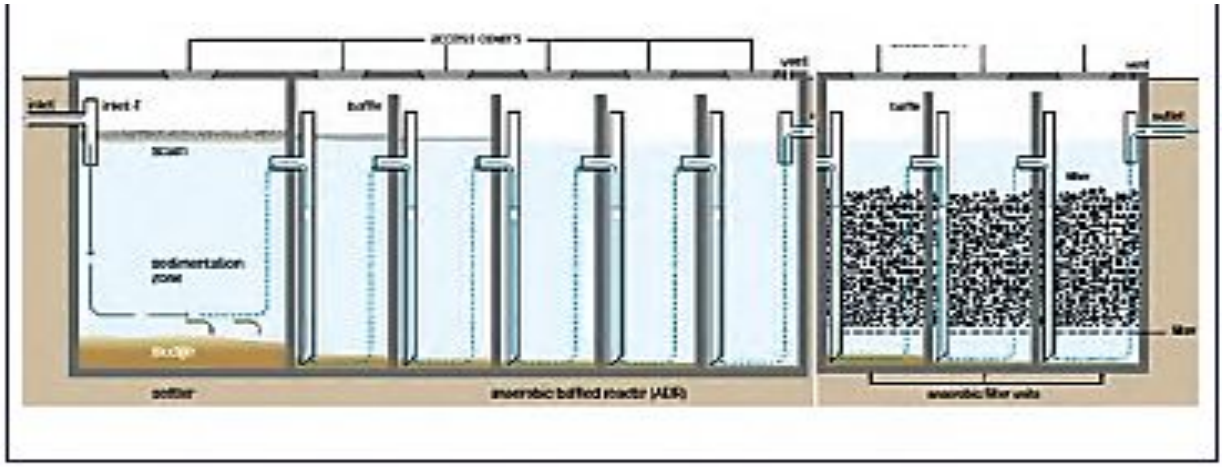
Pit System



Conventional Septic Tank



Prefabricated Septic Tank

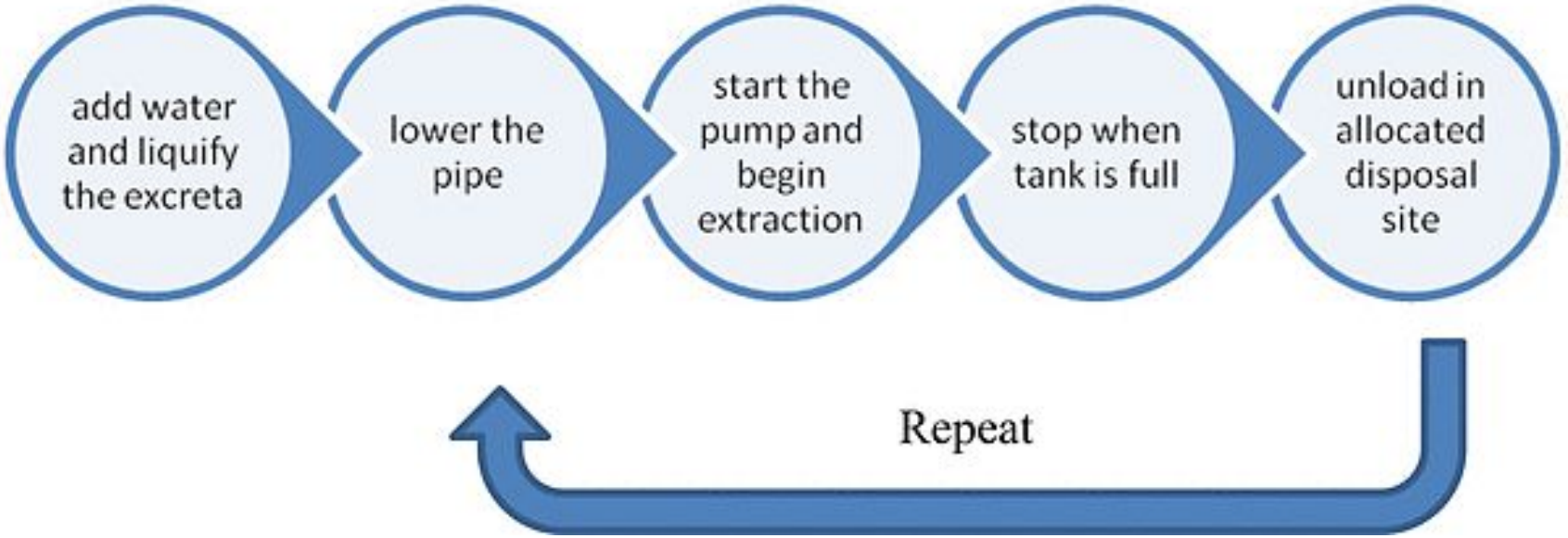


Anaerobic Baffled Reactor

Emptying

- The "emptying and collection" component within the FSM refers to different manual and mechanical means by which fecal sludge is collected from different types of containment structures for transport to fecal sludge treatment plants (FSTP).
- Human powered tools, Manually powered pumps, Wastewater Pumps, Vacuum tugs etc. are used for emptying fecal sludge from containment.

Mechanical Emptying Procedure



Emptying/Collection of Fecal Sludge in Bangladesh

- Mechanical emptying service was first introduced in Dhaka by **DSK** in the year 2000, with support from **DWASA** and **Water Aid,** using a vacuum tanker (**vacutugs**).
- This service is still continuing. Emptied sludge is discharged in DWASA sewer network.



Emptying and Collection of FS







Emptying/Collection of FS



Mechanized Gulper

Capacity: 60 Liters/min



Motorized Gulper

Capacity: 90 Liters/min



Vacutug Mark II

Capacity: 120 Liters/Min

Transport

- The transport process of fecal sludge is often directly linked to its prior collection.
- Manual emptying services may operate push-carts or wheel-barrows, mechanical pumps are mounted on different kinds of vehicles
- “Vacuum truck" is literally a combination of different pieces of technical equipment - a vacuum pump connected to a large vessel that is mounted on a truck.
- Major limitations of the transport component are the size of vehicles, the size and volume of mounted FS collection containers (smaller containers must be emptied more frequently which does consume valuable time) and the location of the fecal sludge treatment plant (FSTP).

Transportation of Fecal Sludge



Transport by manually driven vehicle



Mechanized Transporter (Mounted on Tri-Wheeler Diesel Engine Driven Vehicle); Capacity: 1000 Liters



Mechanized transport of fecal sludge

Transportation of Fecal Sludge



Vacutug Mounted on Pickup

Capacity: 250 Liters/Min



Vacutug with a capacity of 2000 Liters



Truck-mounted Vacutug

Characterization of Fecal Sludge

Parameter	Range of values (manual emptying)	Range of values (mechanical emptying)
Physical and Chemical characteristics		
Total solids (mg/L)	19,420 to 57,272	12,778 to 72,694
Suspended solids (mg/L)	17,868 to 55,484	10,852 to 70,896
COD (mg/L)	300 to 672	480 to 678
BOD (mg/L)	118 to 306	266 to 447
COD : BOD ratio	2.01 to 2.54	1.65 to 1.93
NH_4 – nitrogen (mg/L)	20 to 1,100	130 to 1,900
Total nitrogen (mg/L)	30 to 10,700	200 to 1,400
Total phosphorus (mg/L)	170 to 900	120 to 200
Microbiological characteristics		
E. coli (MFC media) (cfu/100ml)	1.6×10^4 to 6.4×10^4	6.1×10^3 to 8.0×10^3
E. coli (EMB media) (cfu/100ml)	1.4×10^4 to 4.2×10^4	1.8×10^4 to 5.4×10^4
Total helminth eggs (No/L)	267 to 781	408 to 562

Treatment

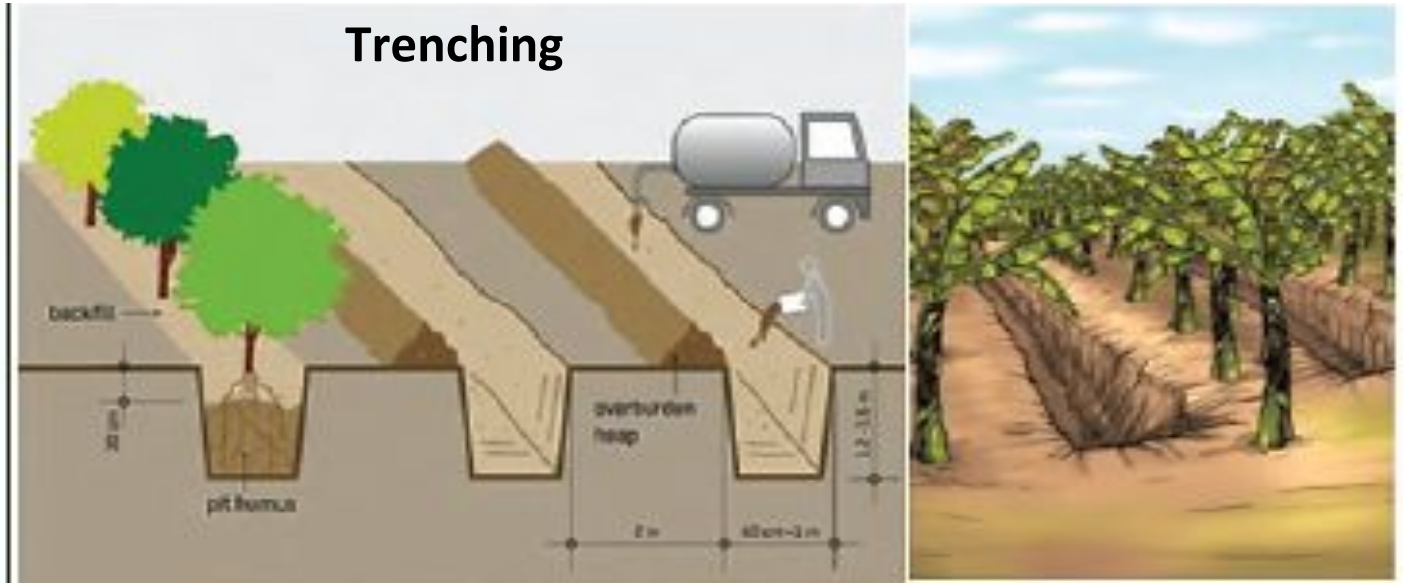
- Safe treatment of fecal sludge for disposal or reuse is the ultimate component within the FSM service chain.
- **Trenching** of FS is being promoted as (temporary) solution for safe disposal of fecal sludge.
- **Open lagoon**, pond or tank systems for fecal sludge treatment of various sizes are well known throughout the world.
- As part of an early liquid/solid separation during the treatment process of an FSTP, fecal sludge is discharged onto a **sand-bed**.
- **Geobags** or geotubes, which are made from engineered geotextiles, are an alternative technical option to sand-beds for dewatering of fecal sludge.

Treatment

- Technical processes of anaerobic **sub-surface FSTP**s are based on the principles an early liquid/solid separation, anaerobic sludge stabilization / digestion and flow of liquids by gravity.

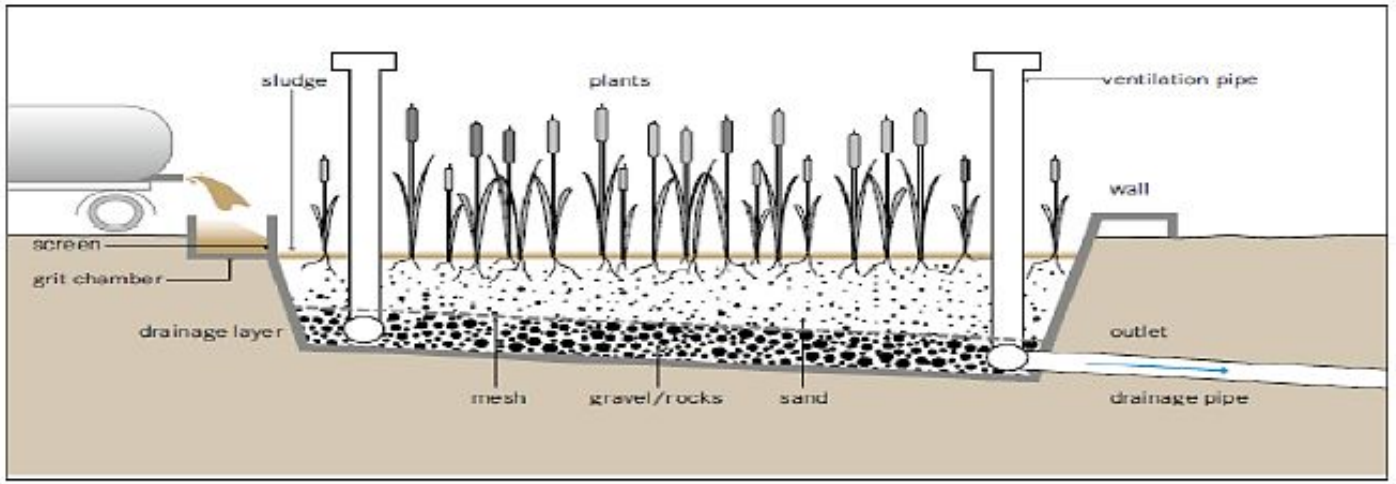
Treatment objectives

- Dewatering
- Pathogen inactivation
- Harnessing nutrients for beneficial use
- Stabilization–organic matter and nutrients
- Safe end-use or disposal



Advantage • Low-cost solution to dispose fecal sludge safely in sparsely populated rural areas with low ground water as well as in arid and semi-arid areas

Disadvantage • Unsuitable for densely populated urban regions • Risk of contamination of water resources during monsoon • Risk of public health hazards if open trenching is practiced



Planted Drying Bed

Advantage • Easy to operate (no experts, but trained community required) • Can be built and repaired with locally available materials • Relatively low capital costs; low operating costs • Fruit or forage growing in the beds can generate income •No electrical energy required

Disadvantage • Requires a large land area • Odors and flies may be noticeable • Requires expert design and construction supervision • Leachate requires further treatment



Large size lagoon system with splitter box, liquid /solid separation, facultative and aerobic ponds

Pond Systems

Advantages • Tested and robust sludge treatment systems • Low-operation and maintenance costs as no skilled personnel and equipment is needed • Long lifetime of 20+ years if properly constructed and maintained

Disadvantages • Large requirement of space especially for lagoon type plants • Compact tank/ pond plants are prone to hydraulic overloading • Potentially disturbing for nearby residents due to odors and overflow during rainy season



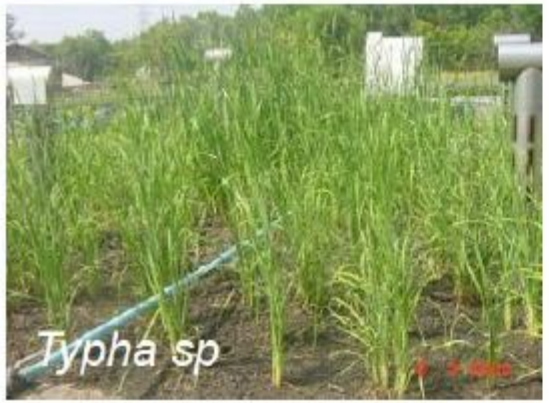
Geobags

Advantages • Less space requirement than sand drying-bed based FSTP • Less odor emissions than FS sand drying-bed based FSTP • No energy required for drying

Disadvantages • Continuous replacement of geobags required • Used geobags produce large amounts of solid waste • Short lifetime and subsequently high CO_2 footprint.


Echinochloa sp


Phragmites sp


Typha sp


Papyrus sp


HIGH COUNTRY
GARDENS



INNOVATION – Onsite dewatering systems



A mobile sludge dewatering truck is used to pump septic tanks, separate the faecal sludge from the liquids, and send the liquids back to the tank. High capital cost, but much more efficient in transferring solids than regular vacuum trucks.

Resource Recovery

- A reuse of treated fecal sludge as safe organic fertilizer and subsequent recovery of fertilizing nutrients in agriculture.
- Utilization of sludge as a source of renewable fuel.
- May require further refinements in addition to dewatering of sludge during its treatment.
- Solar drying and composting reduces the pathogen content for safe application in agriculture and will allow for easier packaging and efficient transport of sludge.
- Further processes such as sieving, nutrient enrichment and pelletizing are recommended for better sales and marketing of fecal sludge based organic fertilizers.

Resource Recovery

- In addition to produce fertilizer, the use of professional pelletizing equipment may also allow a combustion of sludge based organic materials as renewable source of fuel.

Resource Recovery

production of animal feed



soil conditioner



production of biogas





solid biofuel



component in building materials