Co-composting of Municipal Solid Waste and Faecal Sludge in Kushtia Bangladesh

Iftekhar Enayetullah
Co-founder & Director
Waste Concern, Bangladesh
www.wasteconcern.org

ESCAP Session: Designing Effective Partnership for Waste to Resource Initiative

ISWA Congress 2015

Antwerp, Belgium, September 8, 2015

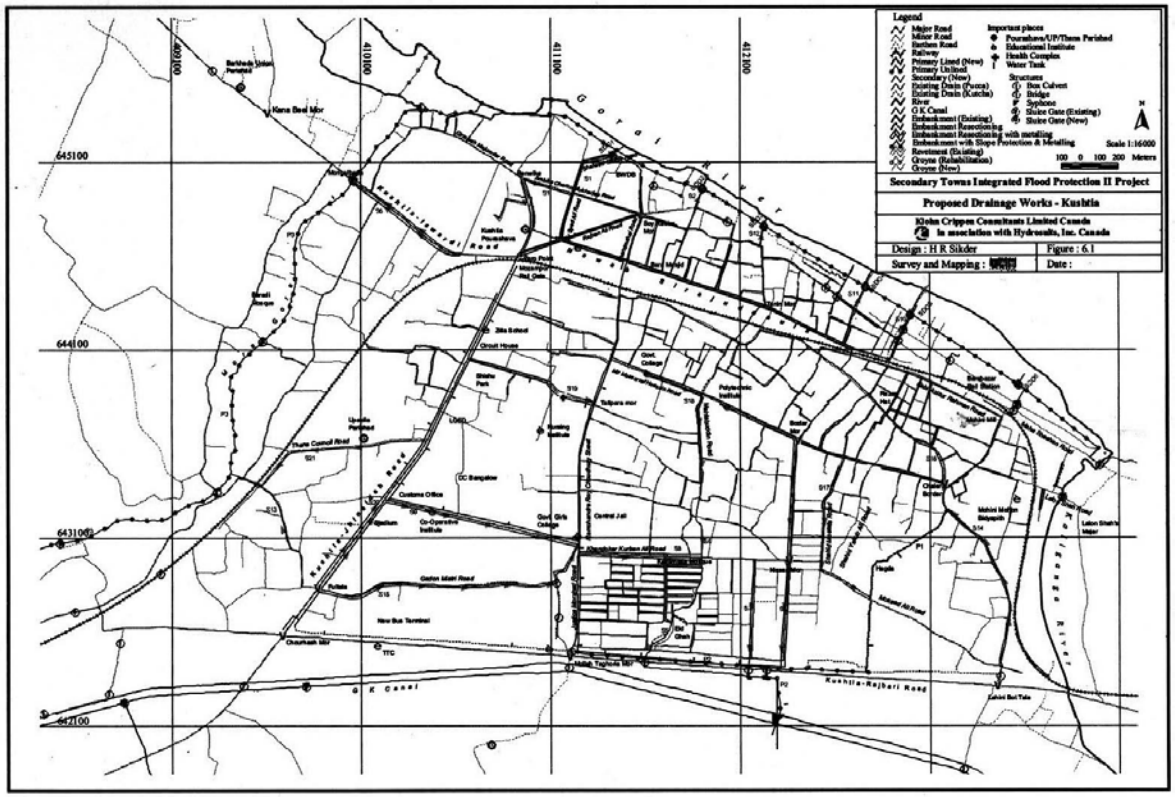





Overview of the Presentation

1. Background of Kushtia Municipality
2. Solid Waste Management in Bangladesh
3. Sanitation Situation in Bangladesh
4. Faecal Sludge Management Situation in Bangladesh
5. Problem of Solid and Faecal Sludge Waste Management
6. Pilot Intervention on Faecal Sludge Management in Kushtia
7. Key Findings

Background of Kushtia



Kushtia, Bangladesh

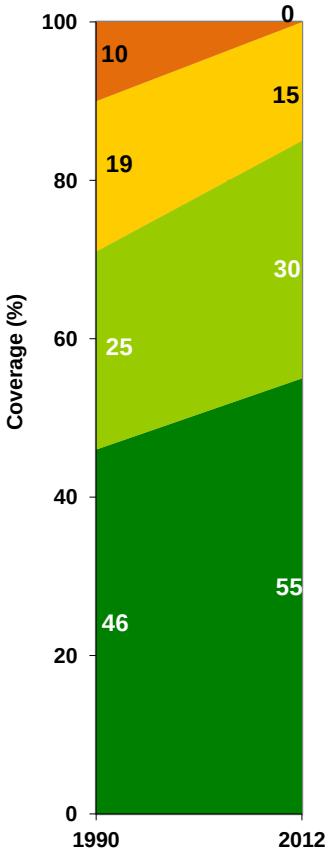
Total Area: 27.75 sq.m
Estimated Population: 102,988
Total Number of Holdings: 12,907
Total Number of Household: 23,037
Faecal Sludge Generated by the City: 180-270 M3/ month (estimated)
Solid Waste Collected by the City: 20-25 ton/ day (out of this 80% is organic)

Solid Waste Management in Bangladesh

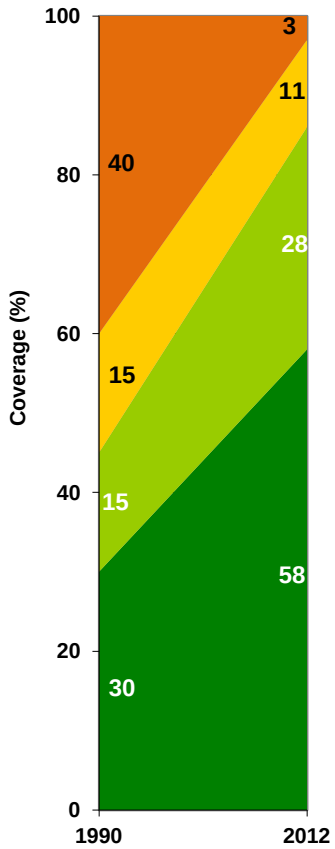
- Rapid urbanization in Bangladesh is creating an increasing strain on overburdened infrastructure, as well as more demand on limited public services.
- Solid Waste Generation in Urban Areas: **23,688 tons/day**
- Organic Waste: **70%**
- Collection Efficiency of Waste: **50-70-%**
- Crude dumping of waste in low-lying areas is the most common method of disposal of waste
- An enormous potential exists to improve existing municipal solid waste management operations with improved organic waste components and to provide positive economic and environmental benefits.
- Organic waste management, therefore, is a key sub-sector of municipal waste management which deserves more attention.

Trends of Sanitation Coverage in Bangladesh

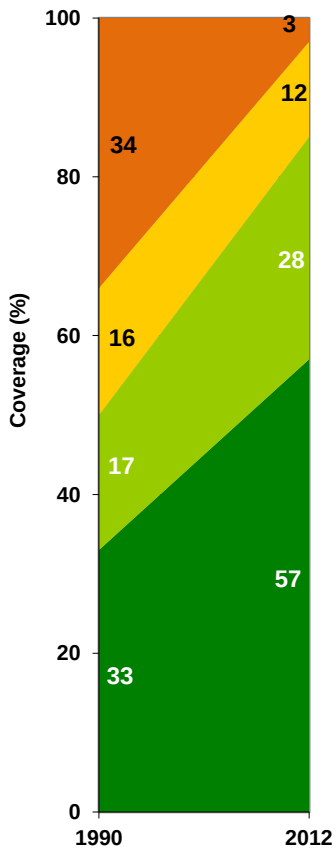
Urban Sanitation Trends



Rural Sanitation Trends



Total Sanitation Trends



With the increase in sanitation coverage in urban areas using septic tanks and pit latrines it is expected that faecal sludge volume will increase considerably within a few years and if collection and disposal systems are not developed serious environmental degradation and associated health risk will increase.

	Bangladesh	Sanitation coverage estimates					
		Urban (%)		Rural (%)		Total (%)	
		1990	2012	1990	2012	1990	2012
	Improved facilities	46	55	30	58	33	57
	Shared facilities	25	30	15	28	17	28
	Other unimproved	19	15	15	11	16	12
	Open defecation	10	0	40	3	34	3

Source: WHO/UNICEF JMP, 2014

Faecal Sludge Management in Bangladesh

- **Faecal sludge**: Sludges of variable consistency collected from so called on-site sanitation systems; such as . pit latrines, non sewered public toilets, septic tanks

- At present there is no formal or environmentally sound faecal sludge collection and disposal system in Bangladesh.

- Septic tanks and pits are not desludged regularly to keep them functional. These are occasionally emptied manually and dumped into the nearby drainage system, low lands, surface waters and into open environment.

- With the increase in sanitation coverage in urban areas using septic tanks and pit latrines it is expected that faecal sludge volume will increase considerably within a few years and if collection and disposal systems are not developed serious environmental degradation and associated health risk will increase.

- Municipal authorities and the people in general, are not aware of the seriousness of the problem and therefore of the needs for improvement. Financial and operational capacity of the municipalities for improved faecal sludge collection, treatment and safe disposal are also limited.

Recommendation by National Sanitation Strategy 2005 and 2014 (revised)

To overcome a number of technological challenges for achieving adequate sanitation coverage the following strategies are recommended in the National Sanitation Strategy 2005:

- Low cost technology options;
- **Sewage treatment technologies with greater emphasis on resource recovery and recycling must be given top priority in improving urban sanitation situation;**
- Appropriate de-sludging of septic tanks and pit latrines must be enforced and effluent disposed of in a proper manner. Sludge emptying services by city corporation and municipality must be in place; and
- Multiple technology options must be considered including decentralized wastewater management option.

The Solution: By Combining Faecal Sludge with Organic Waste

- **Faecal Sludge is a rich source of nutrients** such as nitrogen, phosphorus and potassium. In human excreta, most of the organic matter is contained in faeces, while most of the nitrogen (70-80%) and potassium are contained in urine.
- **Before using faecal sludge as a fertilizer, it must be made safe.** Co-composting is the controlled aerobic degradation of the organics using more than one material (faecal sludge and organic municipal solid waste). Faecal sludge has a high moisture and nitrogen content while bio-degradable solid waste is high in organic carbon and has good bulking properties (i.e. it allows air to flow and air to circulate).

By combining the two, the benefits of each can be used to optimize the process and the output product. Co-composting is a natural process allowing good hygienisation of sludge in a relatively short time. This is due to high temperature of 50 to 70ºC, which is reached during thermophilic degradation process. Co-composting of pre-treated and thickened faecal sludge with solid waste might be a good solution, even for large sludge volumes.

Combining the two

Faecal Sludge

+

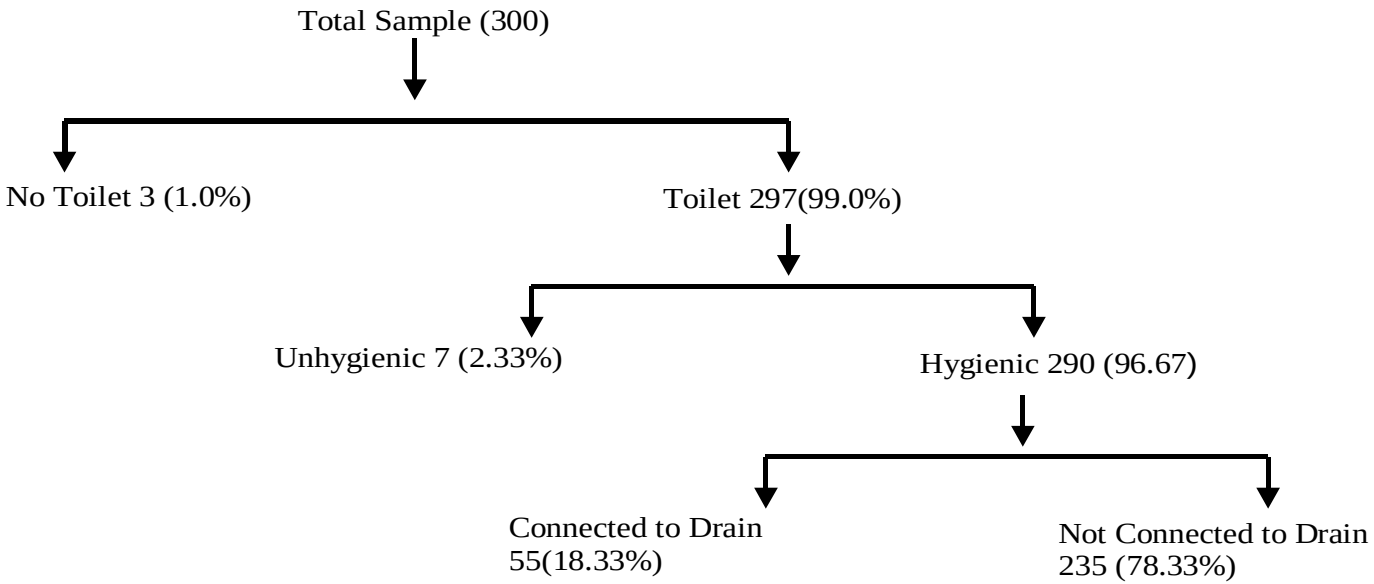
Organic Waste

Survival Time (in days) of Pathogen by Different Treatment Method

Types of Treatment	Bacteria	Virus	Protozoa	Helminths
Night soil, faeces at 20-30 C	90 days	175 days	10 days	Many months
Composting (anaerobic) septic tank/ pit latrine	60 days	60 days	30 days	Many months
Thermophilic Composting 50-60^{0}C	7 days	7 days	7 days	7 days
Waste Stabilization Pond Retention time >20days	20 days	20 days	20 days	20 days

Source: IDA (1990)

Sanitation Situation of the Kushtia Municipality

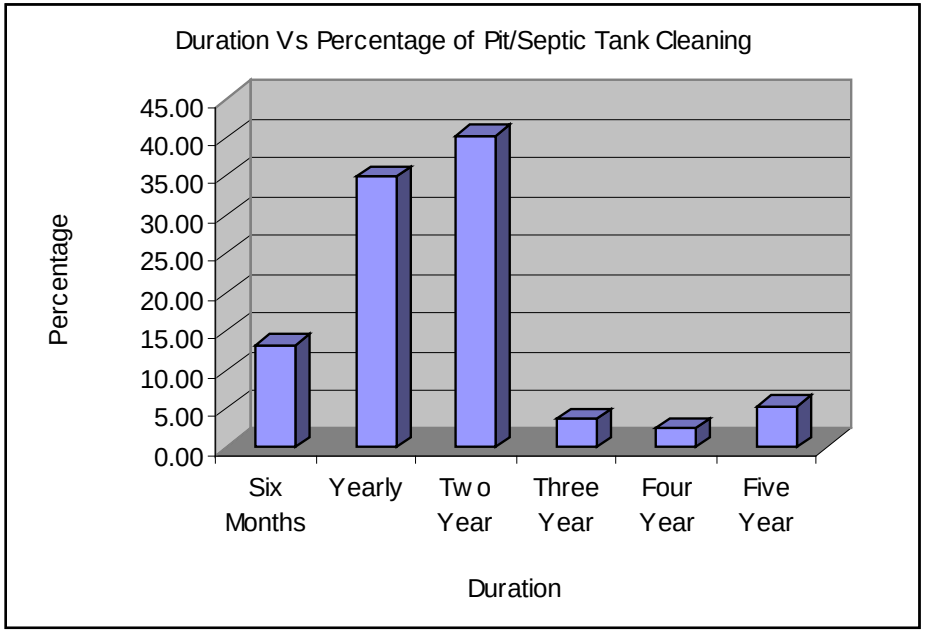


In order to assess sanitation condition of Kushtia Municipality, a sample survey was conducted amongst high, middle, lower-middle and low-income groups. Fig shows 96.67% (290 households out of 300) of the sample households of Kushtia Pourashava have hygienic toilets. However, 55 of them (18.33% of the total) have been found having connection with drains.




Collection and Disposal of Faecal Sludge

From the field survey, it was revealed that 50.33% households have septic tank toilets and 48.67% have ring slab or single pit or twin pit toilets. Although vacuum tug has been used for collection of faecal sludge from the filled up septic tanks or pits of Kushtia Town since a long time, there was no formal or environmentally sound faecal sludge disposal system. Figure shows the frequency of pit/septic tank cleaning in the Municipality.



Faecal sludge of less than three years is not fully decomposed and contains high pollution load, and hence, needs to be treated properly.

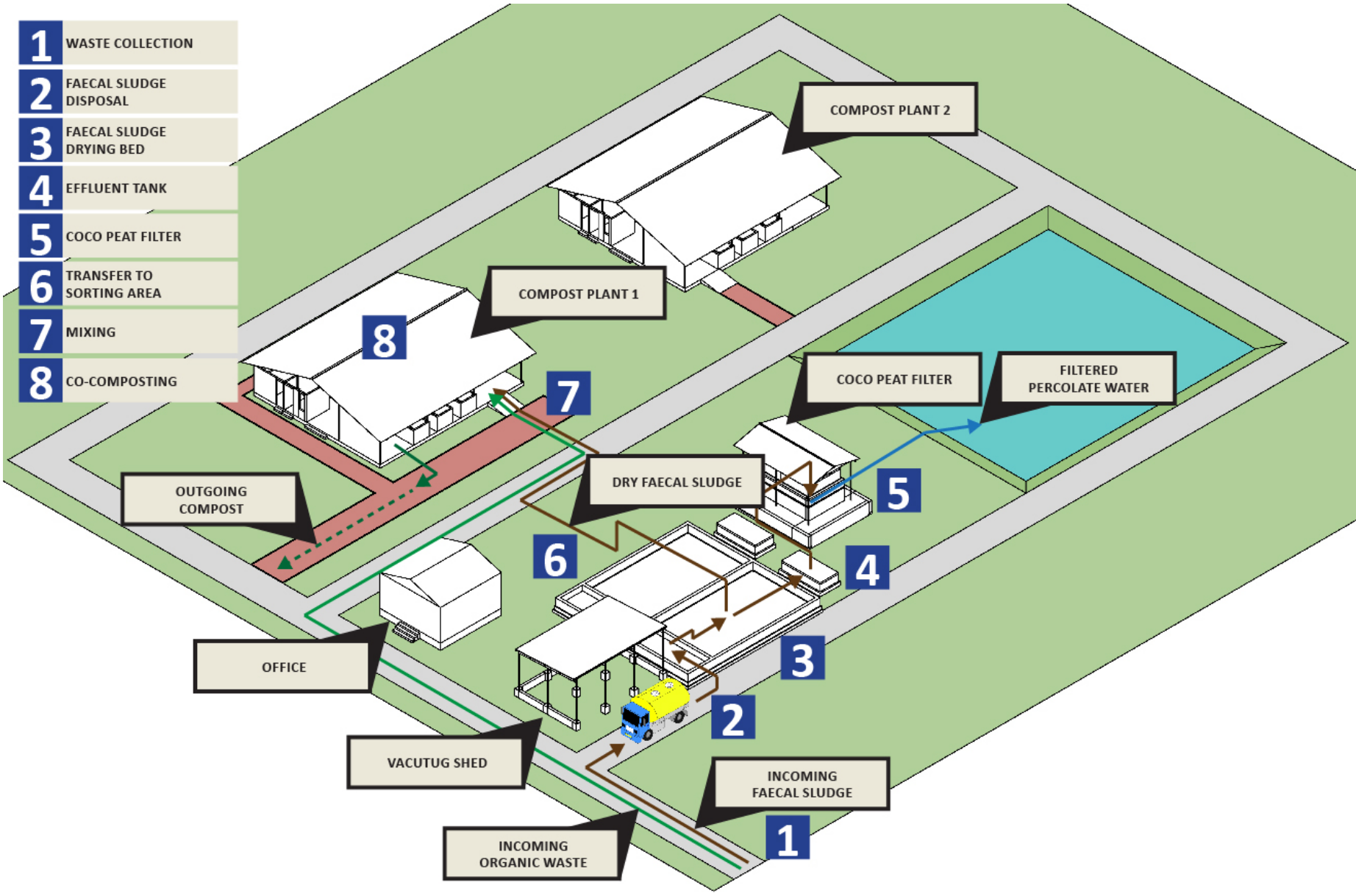
Pilot Intervention on Faecal Sludge Management in Kushtia

The main aim of the project is to develop a sustainable faecal sludge management system having full cost recovery and which can be replicated in secondary towns.

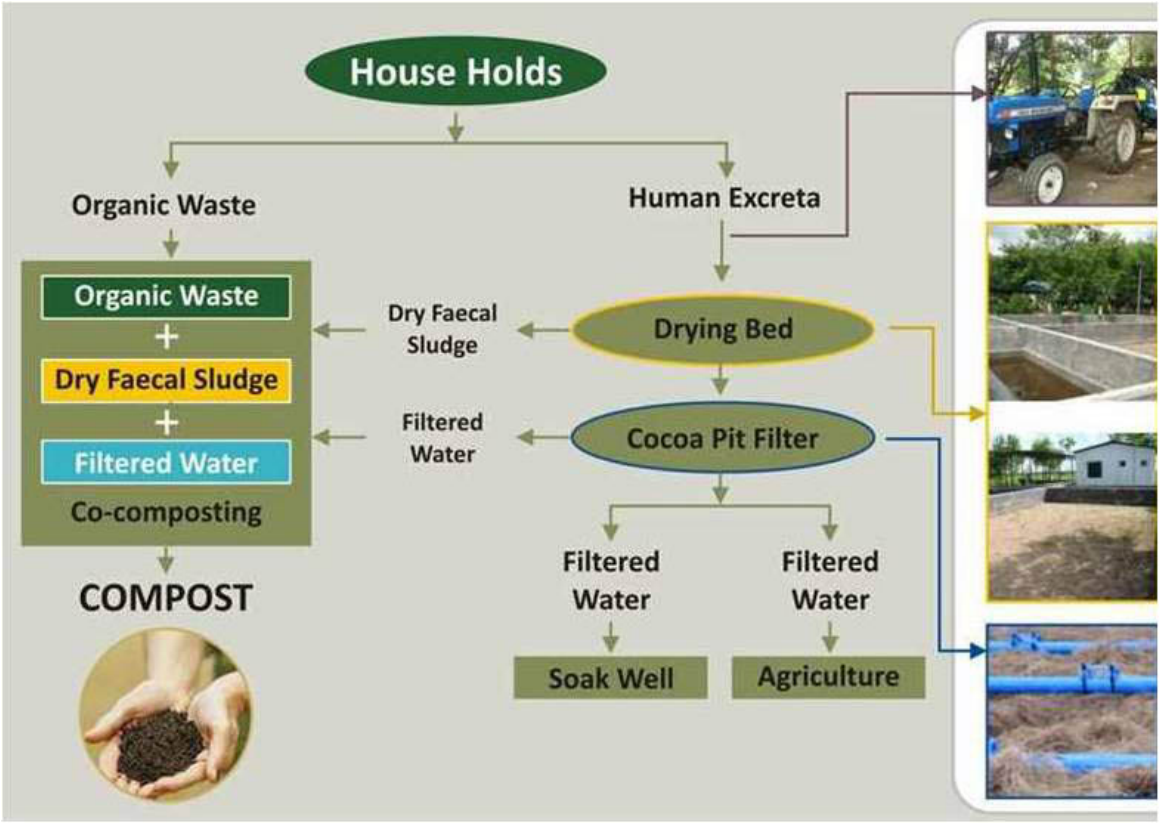
- In order to tackle **solid waste management** as well as **faecal sludge management** problems, a pilot project has been initiated in Kushtia Municipality, a secondary town in Bangladesh.
- **Project Initiated:** November 2012
- The pilot project has the following Features:

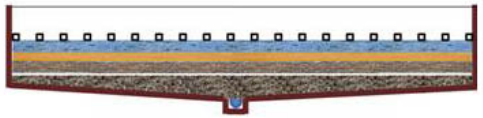
  1. **Compost plant Capacity** = **4 tons/ day**
  2. **Faecal sludge drying bed** (with a coco peat filter) to treat = **9 M3/day**
  3. **Land Area: 668 M2** (dedicated by the Kushtia Municipality)

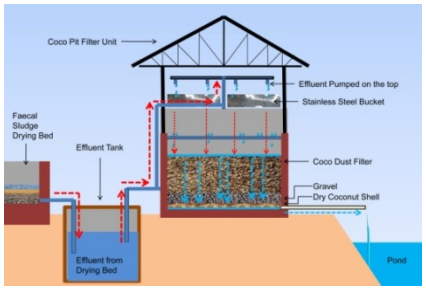
Pilot Intervention on Faecal Sludge Management in Kushtia



Pilot Intervention on Faecal Sludge Management in Kushtia

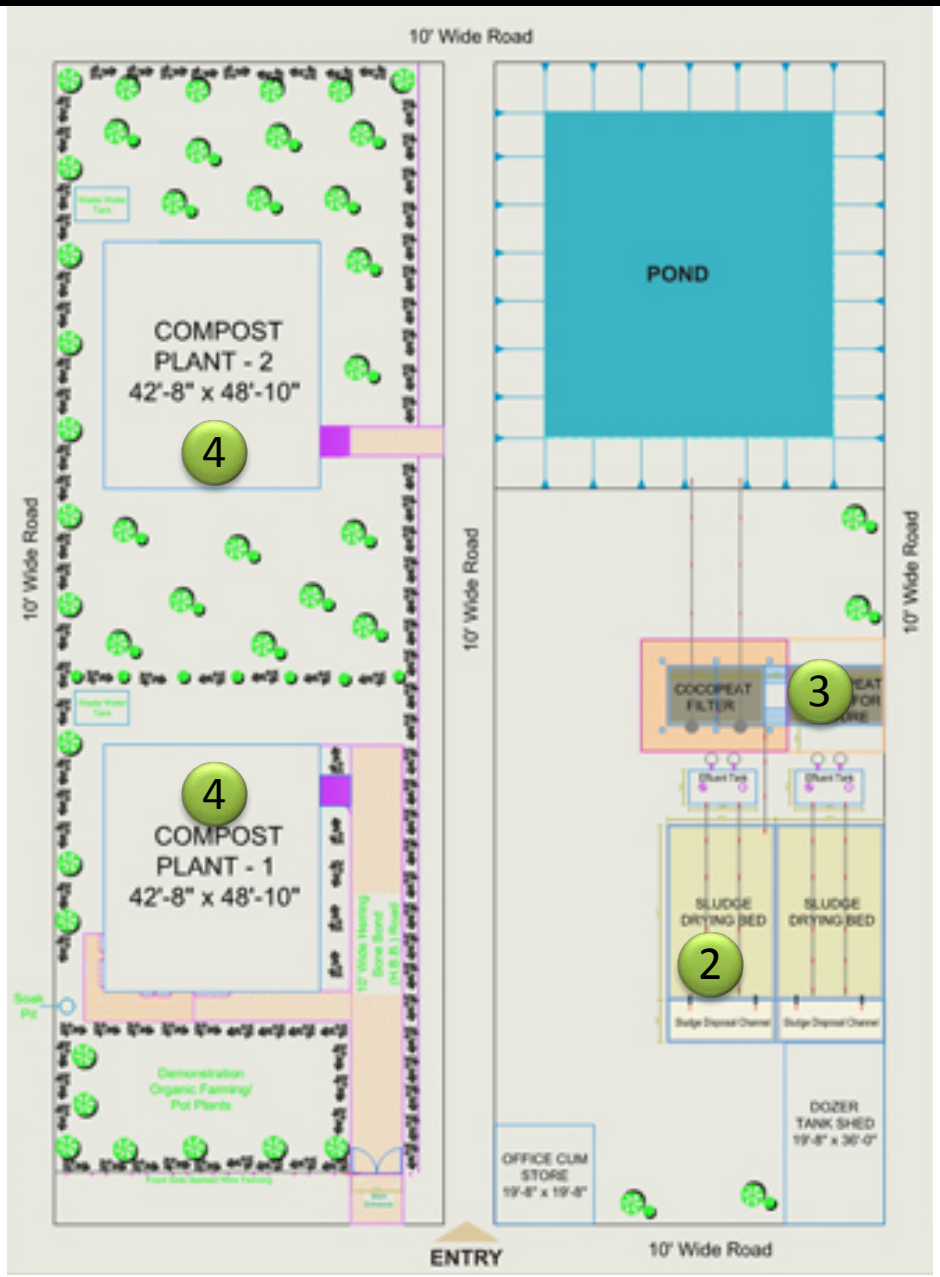






- The liquid sludge (faecal sludge) is poured into the sludge tank, from where it is passed into the sludge drying bed by natural gravity. When the drying bed becomes filled up, it is kept there for few days so that sludge gets dried and the percolate is transferred into the connected percolate tank.
- The percolate is pumped into the coco peat filtration unit for further treatment. The filtered water coming out from the coco peat has high nutrient, and can be safely released into agricultural land for irrigation purpose.
- On the other hand, dried layer of the fecal sludge is collected up from the drying bed and is mixed with the municipal organic solid waste in 1:3 ratios, and compost is produced in the co-composting plant using aerobic theomorphic composting method to be used as organic fertilizer.

Pilot Intervention on Faecal Sludge Management in Kushtia



Site Plan of the Co-composting Facility, Kushtia

WASTE CONCERN
www.wasteconcern.org

Problem & Solution

At present there is no formal or environmentally sound faecal sludge collection and disposal system.

Old practice

Properly managed faecal sludge management system

Current Practice

Co-composting of Faecal Sludge with Organic Waste at Baradi, Kushtia City

Faecal Sludge Collected by Vaccu-Tug and Discharged in the Drying Bed and later Co-composted with Organic Waste to Produce Compost

Project Partners

- Provided land
- operation of the project,
- collection of faecal sludge and
- collection of fee for the the service

Kushtia Municipality

- UNESCAP provided grant for construction of the coco peat filter.

UNESCAP

Waste Concern

- Technology Provider.
- Design of the co-composting facility
- Construction supervision.
- Monitoring & Evaluation of the facility of the plant.
- Preparation of Business Plan.
- Training of municipal staffs

- Cost for construction of the compost plant and faecal sludge drying bed along with the cost for the vacuum tugs

LGED

Test Results of the Co-Compost and Treated Waste Water

Physical Properties			
Sl. No.	**Parameters**	**Actual Concentration**	**Standard * Range**
1	pH	7.8	6.0 – 8.5
2	Organic Carbon	11.97%	10 – 25 %
3	Nitrogen (N)	3.08	0.5 – 4.0 %
4	Phosphorus (P)	0.97	0.5 – 1.5 %
5	Potassium (K)	1.08	1.0 – 3.0 %
6	Sulfur (S)	--	0.1 – 0.5 %
7	Zinc (Zn)		Maximum 0.1 %
8	Copper (Cu)	0.0064%	Maximum 0.05 %
9	Chromium (Cr)	27.6054 ppm	Maximum 50 ppm
10	Cadmium (Cd)	0.00 ppm	Maximum 5 ppm
11	Lead (Pb)	26.1172 ppm	Maximum 30 ppm
12	Nickel (Ni)	0.00 ppm	Maximum 30 ppm

* Compost Standards of Ministry of Agriculture, Government of Bangladesh for use in the agricultural purposes.

**All test performed according to procedure described in "Manual for Fertilizer Analysis", Ministry of Agriculture, Government of the People's Republic of Bangladesh

Test Results of the Co-Compost and Treated Waste Water

Physical Properties				
Sl. No.	**Parameters**	**Actual Condition**	**Standard Condition**	**Test Method**
1	Color	Dark gray	Dark gray to black	Visual
2	Physical condition	Non granular form	Non granular form	Do
3	Odor	Odorless	Absence of foul odor	Do
4	Moisture Content	29.33%	Maximum 15 %	Oven dry
5	Inert materials	-	Maximum 1 %	Sieving

Pilot Intervention on Faecal Sludge Management in Kushtia

Laboratory analysis of Compost Produced in the Kushtia Co-Compost Plant Carried Out by The Department of Soil, Water and Environment, University of Dhaka

Parameters	Results
Faecal Coliform, MPN/g	3.6
Salmonella spp/ 25g	Absent
Helminth/ g	Absent

* Compost Standards of Ministry of Agriculture, Government of Bangladesh for use in the agricultural purposes. **All test performed according to procedure described in "Manual for Fertilizer Analysis", Ministry of Agriculture, Government of the People's Republic of Bangladesh

Results of Waste Water from Sludge Drying Bed Before and After Treatment by Coco Peat Filter

Type of Waste Water	pH Standard (6.0-8.5)*	DO (mg/l) Standard (4.5-8)*	COD (mg/l) Standard 400 (mg/l)*
Before Treatment (First Tank)	7.34	1.3	576
After Treatment with Peat Filter (First Tank)	7.36	4.9	192
Before Treatment (Second Tank)	7.70	1.6	484
After Treatment with Peat Filter (Second Tank)	7.15	5.5	192

www.wasteconcern.org

* Compost Standards of Ministry of Agriculture, Government of Bangladesh for use in the agricultural purposes. **All test performed according to procedure described in "Manual for Fertilizer Analysis", Ministry of Agriculture, Government of the People's Republic of Bangladesh

Operational Cost of the Project Per Month

Description	Cost (USD)
Salary of Supervisor of Compost Plant	260
Salary of 2 Drivers of Vacuum Tug	467
Salary of 6 labors for faecal sludge collection	467
Salary of 6 labors for compost plant	467
Fuel cost for tractors	256
Fuel cost for vacuum tugs	807
Maintenance cost for vacuum tugs	80
Saw dust for composting	80
Personal Protection Equipment	30
Total Monthly Operational Cost	2914

Capital Cost of the Project (without land cost)

Description	Cost (USD)
Construction of Compost Plant	80,000
Construction of Sludge Drying Bed	15,000
Construction of Peat Filter	20,000
Purchase of Vacuum Tug	20,000
Total Capital Cost	**135,000**

❑ In order to sustain faecal sludge management services, it is essential to recover the operational costs and make profits.

❑ In order to sustain the operation, a profit of 15% to 20% should be charged on top of the expenditure.

Sanitation Fee or Rate per Household

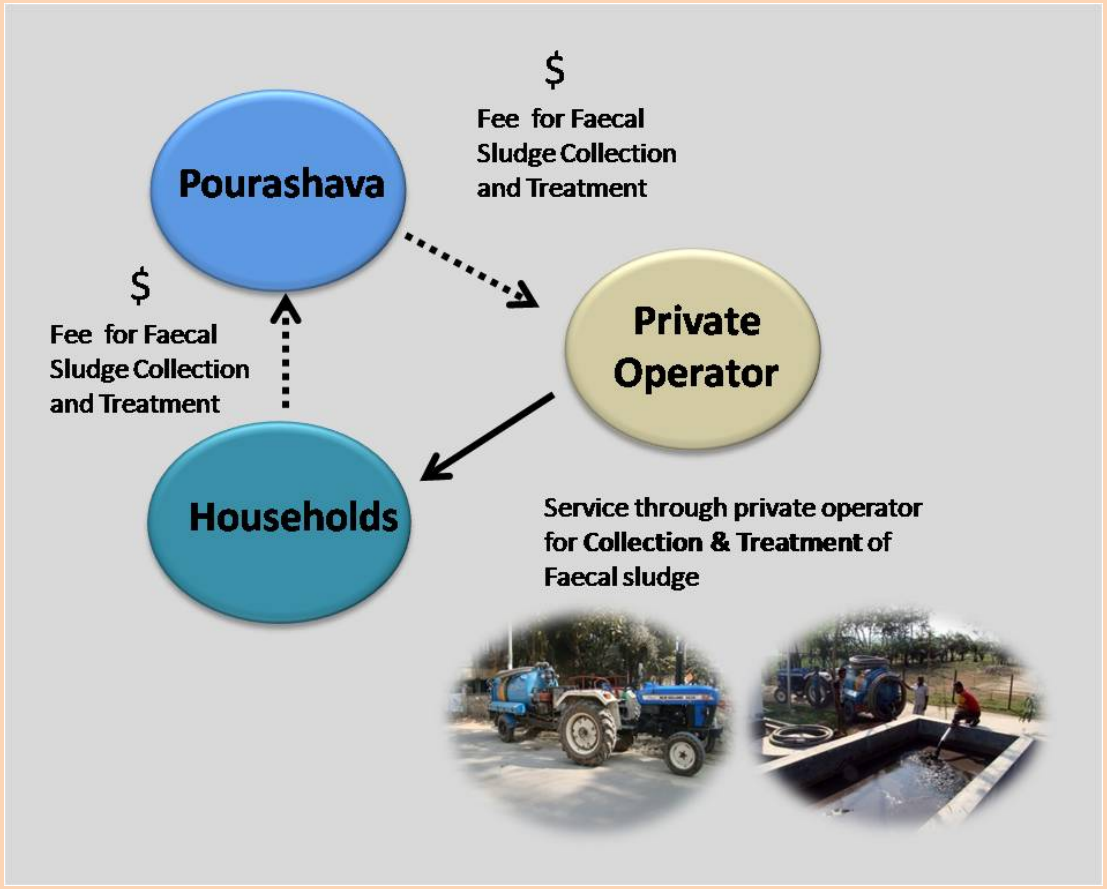
Total O & M including profit	Fee Per Year/HH with holding tax	Fee Per Year/HH with water charge
USD 53,713, with depreciation and 15% profit	USD 4.13	USD 8.7
USD 58,161 with depreciation and 20% profit	USD 4.5	USD 9.18

The cost for faecal sludge collection and treatment can be imposed with either conservancy tax or as a separate charge as sanitation fee linked with holding tax, subject to approval by the Ministry of Local Government. The other option is to link it with the water charge.

Based on the demonstration effect of this project Ministry of Local Government has allowed municipalities to charge FSM fee linked with holding tax from November 2014.

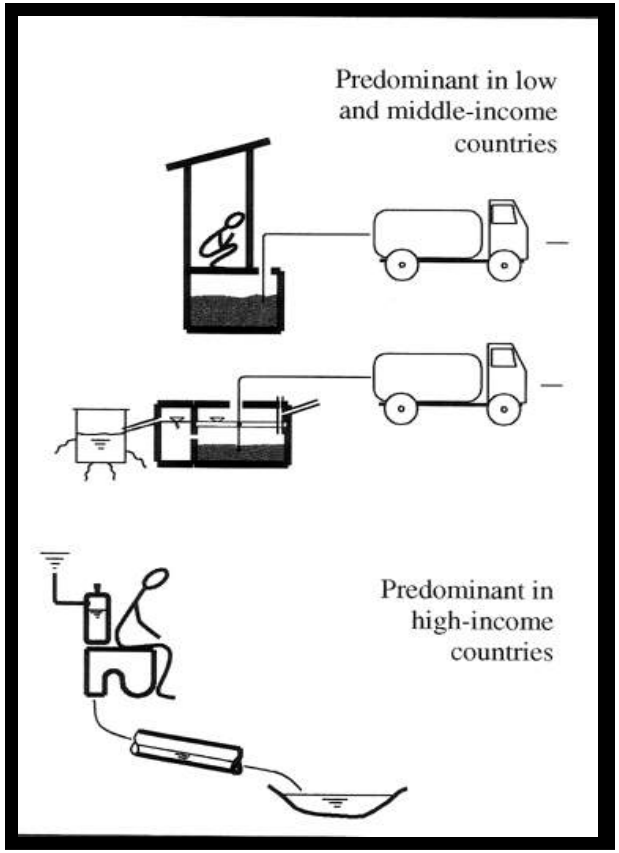
Different Management Options to Run the Facility

Option 1: Municipally Owned and Operated System
Option 2: Municipally Owned and Privately Operated System
Option 3: Privately Owned and Operated System

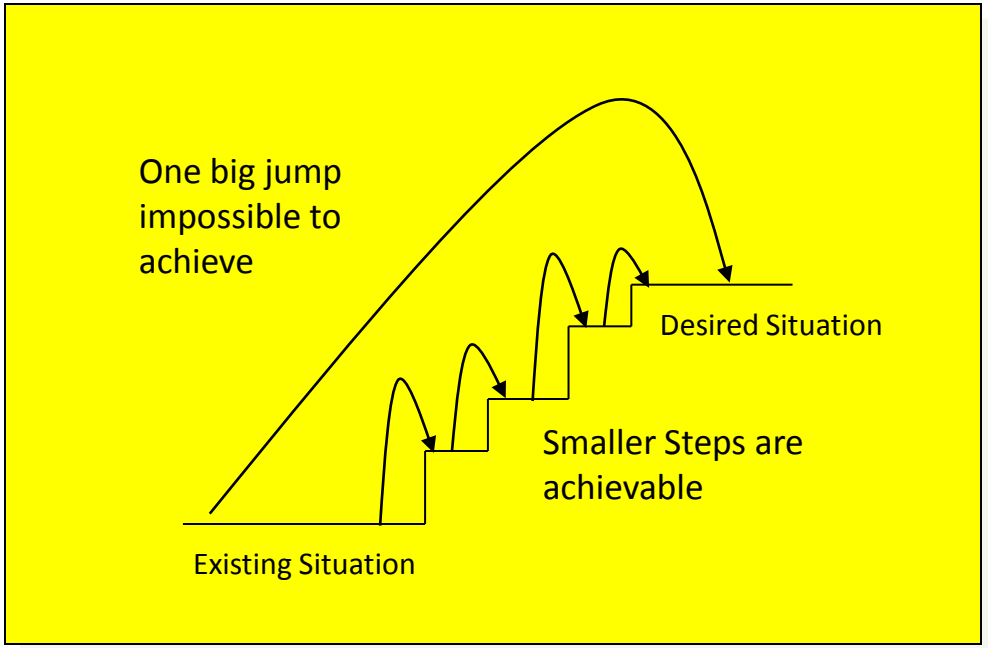


Financial Flow for Municipally Owned and Privately Operated Model

Pilot Intervention on Faecal Sludge Management in Kushtia



Excreta disposal systems predominant in urban areas of low and high-income countries



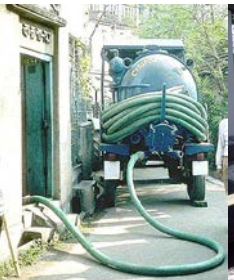
Several small steps are easier than one big jump

Investment Required

The Sector Development Plan (2005) estimates per capita investment costs of Conventional sewerage as varying from

USD 150 in medium municipal towns

USD 200 in large city corporations (GoB, 2005a).





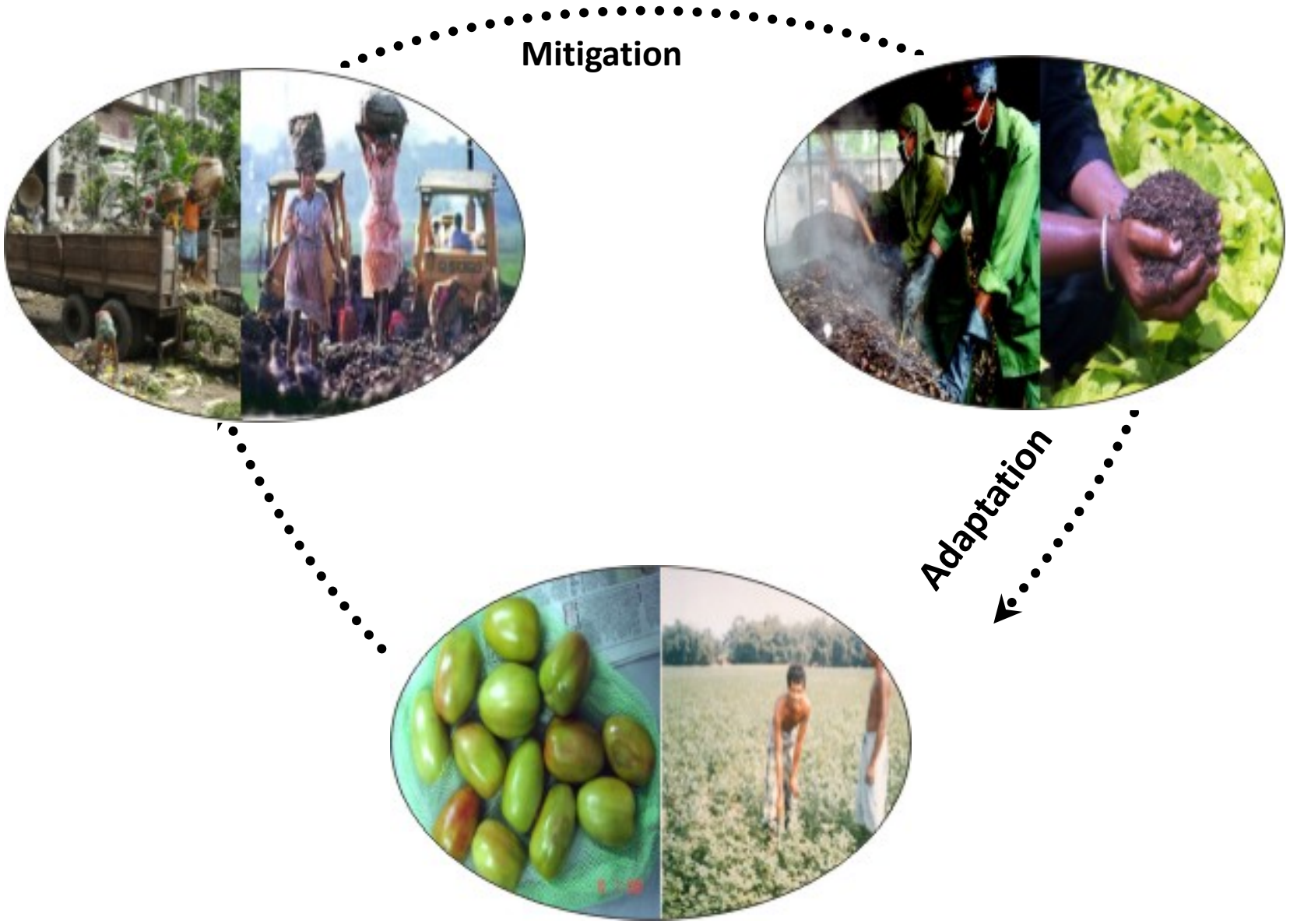

Recommended Options for Operation and Maintenance of Faecal Sludge Collection and Treatment System in Kushtia

- It is evident that there are three possible options for operation and maintenance (O&M) of the faecal sludge collection and treatment system. However, considering the present condition of Kushtia Pourashava in terms of availability of skilled manpower and experience in operation and maintenance of such project, municipally owned and operated system could not be recommended. Risks are high for lower quality of services.

- Fully privately owned and operated system is also not possible at the moment since there is no regulation or guideline for faecal sludge management currently in place. Since there are no incentives for private sector such as tax holiday for a certain period, nor low interest rates for financing such projects from banks, it is highly unlikely that private sector will be interested to invest capital cost which amounts to USD 135,000 for the Kushtia pourashava. Moreover, private sector would require a concession period of at least 20 years with a provision of land from the pourashava to initiate the project. Since all these issues are not clear at the moment, privately owned and operated system is currently not a viable option.

- Municipally owned and privately operated model seems to be a viable option. In this model, Kushtia municipality will invest and own all the infrastructure and they will lease it to the private sector to operate and manage it. Pourashava will pay the private sector a fee based on the number of pits/tanks cleaned per month.

Mitigation-Adaptation Loop



Thank You