Co-Composting of Municipal Solid Waste and Faecal Sludge for Agriculture in Kushtia

November 2014

WASTE CONCERN

UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific

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THE BANGLADESH CONTEXT

Image 1: Compost box at the co-composting plant in Kushtia, Bangladesh

1.1 Background

Bangladesh has a population of over 154 million people, making it the largest least developed country in the world, by population.[1] Since independence in 1971, Bangladesh has seen huge economic growth. From 1994 until 2013, Bangladesh's GDP growth rate has remained over 5%.[2] Poverty has decreased from 56.6% in 1991 to 31.5% in 2010. However an estimated 47 million people still live below the poverty line.[3] Bangladesh is ranked 142 out of 187 countries according to the United Nations Human Development Index (HDI), which measures health, education, and quality of life. As per the HDI, Bangladesh belongs to the medium human development group of countries. Bangladesh is one of the most rapidly growing and quickly progressing countries in the world; however, huge development hurdles remain. The Government of Bangladesh (GoB) adopted their Vision 2021 plan, which aims to achieve middle-income status by 2021.

Rapid urbanization in Bangladesh is creating an increasing strain on overburdened infrastructure, as well as more demand on limited public services. In Bangladesh, these trends are acutely noticeable as urban population growth rates exceed the national growth rate. According to the 2011 census, the population density of Dhaka is 8,111 inhabitants per square kilometer.[4] In particular, the projected urban population growth rate from 2010 - 2015 is 3%. If Bangladesh hopes to grow sustainably, there must be investment in sanitation infrastructure sooner rather than later.

Bangladesh is also one of the most at-risk countries for natural disasters. If global temperatures rise 2.5 degrees Celsius, this could increase the amount of flood areas by up to 29%, in a country that lies close to sea level and has over 260 rivers and streams that run through it. The direct annual cost of natural disasters (damage and lost production) to the national economy is estimated to be between 0.5% and

1 According to the United Nations Human Development Report classification
2 Asian Development Bank
3 "ON THE POST-2015 DEVELOPMENT AGENDA FOR BANGLADESH." United Nations in Bangladesh. 13 May, 2013.
4 BBS

1% of GDP over the past ten years.[5][6][7] Environmental threats not only have long-term, but also more immediate, consequences in Bangladesh.

1.2 Solid Waste Management and Sanitation Situation in Bangladesh

It is estimated that total solid waste generated in urban areas of Bangladesh is 20,000 tons per day (WEF, 2013), and up to 80% of this waste is organic waste with high moisture content. Urban local bodies are able to collect between 50-60% of the generated waste in Bangladesh (Waste Concern, 2005). Crude dumping of waste in low-lying areas is the most common method of disposal of waste. Left to itself, this waste is digested through an anaerobic process leading to emission of gases high in methane. This not only adds to the global warming process and associated climate change, but also to reduced quality of life due to odor and unhygienic living conditions. 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.

Urban sanitation also remains a major challenge in Bangladesh. Sanitation is the responsibility of the municipalities, who do not have necessary organizational and technical capacities to take up their role.

Conventional sewerage systems are absent in all urban areas except in parts of Dhaka city. Only 20% of the population of Dhaka is served by a highly expensive sewerage network; the rest use septic tanks, pit latrines, unhygienic latrines or none at all. Although it is claimed that the urban sanitation coverage is 88% as of March 2009, the overall sanitation situation in all urban areas is far from satisfactory (Rahman, M.M, 2009).

Most households do have standard toilet facilities within premises, but the sewage collected are discharged untreated directly into the river. Many buildings including high-rise ones are not connected to any kind of sanitation system and discharge their untreated effluent directly into lakes, canals and rivers causing pollution and health hazards in densely populated areas. This scenario of urban sanitation is prevalent in all urban centres including large cities and small to medium towns. Providing the urban households with sanitation by conventional sewerage system is very expensive as compared to other off-site sanitation options, such as modified sewerage and settled sewerage, which are particularly suitable for small to medium townships. The Sector Development Plan (2005) estimates per capita investment costs of conventional sewerage as varying from USD 150 in medium municipal towns to USD 200 in large city corporations (GoB, 2005a).

At present there is no formal or environmentally sound faecal sludge collection and disposal system in Bangladesh. Septic tanks and pits are not de-sludged regularly to keep them functional. These are occasionally emptied manually and dumped into nearby drainage systems, low lands, surface waters, and into open environments.

EWith 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; if collection and disposal systems are not developed, serious environmental degradation and associated health risks will increase. Municipal authorities and the public in general are not aware of the seriousness of the problem and therefore of the need for improvement. The municipalities' financial and operational capacity for improved faecal sludge collection, treatment, and safe disposal are also limited.

It is very unlikely that urban sanitation coverage in Bangladesh will see much application of costly conventional sewerage technology in the short and medium term programs, and will continue to depend on on-site technologies like septic tank and pit latrines. This is very common in other developing countries also. 98% of the urban households in the Philippines, 78% of Manila and 65% of Bangkok are served by on-site sanitation systems with faecal sludge collection and management in place (Rahman, M.M., 2009). Emphasis should therefore be placed on establishing and operating a sustainable fae-

5 BCAS

6 http://www.worldbank.org/en/news/press-release/2013/06/19/warming-climate-to-hit-bangladesh-hard-with-sea-level-rise-more-floods-and-cyclones-world-bank-report-says

7 http://pure.qub.ac.uk/portal/en/publications/rapid-rise-in-effective-sealevel-in-southwest-bangladesh-its-causes-and-contemporary-rates(792fcb3f-eb18-45fe-9837-7c7443b559e0).html

Image 2: Farmer applying organic compost to his crops

cal sludge management system that also promotes resource recovery, in order to attain 100% urban sanitation coverage as per the set national goal. Promoting private sector participation in faecal sludge collection and treatment as well as NGOs' participation in awareness raising is clearly a way forward.

National Sanitation Strategy 2005, prepared by the Local Government Division of the Ministry of Local Government, Rural Development & Cooperatives has set-up a national sanitation goal to achieve 100% sanitation coverage by 2013. In the Strategy, "Sanitation" means total sanitary conditions for healthy living which includes hygienic latrine facilities, proper management of solid waste, and proper disposal of household wastewater and storm water (GoB, 2005b).

The national sanitation strategy focuses on the following six major issues:

- Open defecation;
- Hardcore poor remaining un-served;
- Use of unhygienic latrines;
- Lack of hygiene practice;
- Urban sanitation; and
- Solid waste and household wastewater disposal not duly addressed

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 the 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 pourashava must be in place; and
- Multiple technology options must be considered including decentralized wastewater management option.

Image 3: Workers at the Kushtia co-composting plant sorting inorganic waste from organic waste

1.3 Pertinent Government Bodies

The Ministry of Local Government is responsible for the overall planning and monitoring of urban local bodies, but each body is responsible for its own activities. There are eleven city corporations throughout the country and 315 municipalities (pourashavas). City corporations are governed by Local Government Act, 2011, while the municipalities are governed by Local Government Pourashava Act, 2010. Pourashavas are solely responsible for water supply, sanitation, and solid waste management.

Department of Public Health Engineering (DPHE): Provides technical assistance regarding water supply, sanitation, and drainage services except in Dhaka and Chittagong. This is in accordance with the National Policy for Safe Water Supply and Sanitation 1998.

Local Government Engineering Department (LGED): Responsible for technical support to a number of development projects throughout the country covering physical interventions, service oriented interventions in water supply, sanitation, solid waste management, and socio-economic development.

Water and Sewerage Authorities (WASAs): Responsible for development, operation, and maintenance of sewage systems, treatment plants, storm drainage systems, and industrial waste but only in Dhaka, Chittagong, Rajshahi, and Khulna.

According to the Sanitation Strategy, municipalities are responsible for collecting faecal sludge; however, thus far municipalities have not been able to provide this service. Currently sludge is discharged in open drains, streams, or low-lying areas without any sort of treatment; this completely undermines any advances in terms of access to sanitation by polluting waterways and water sources.

The National Sanitation Strategy primarily falls under the purview of the pourashavas. The Ministry of Environment is responsible for drafting discharge standards, but faecal sludge management falls under the water sanitation strategy sub sector of the annual development programme. Under the public health section of the Pourashava Act, faecal sludge management is not explicitly mentioned. There is mention of infrastructure development, supply of water for use in residential, industrial and commercial purposes, storm water drainage and sewerage, as well as waste and health management. While

faecal management may easily fall under these categories, there is no specific mention of it. The section on waste management describes the collection process and disposal process of solid waste. However, the definition of waste in Pourashava Act includes human excreta as a part of waste. Under this Act, the Ministry of Local Government can make rules for faecal sludge collection and management.

According to Local Government Ordinance 2010;

"Although there is no mention in section 50(2) of the Pourashava Act 2009 about faecal sludge collection and treatment, however, this service can be provided as a part of waste management services (since the definition of waste mentioned in the Pourashava Act 2009 consists of human excreta also). Moreover, pourashava may provide faecal sludge collection and treatment service using section 50(2) (h) which says citizen's health and environmental protection as the responsibility of the pourashava."[8]

8 Asian Development Bank, 2014

PILOT INTERVENTION ON FAECAL SLUDGE MANAGEMENT IN KUSHTIA

Image 4: Faecal sludge drying bed at the Kushtia co-composting plant

2.1 Background

Kushtia is an important secondary town of Bangladesh. It has an area of 27.75 sq. km and has an estimated population of 102,988. The total number of holdings in the town are 12,907 comprising 23,037 households. According the municipality, the total number of holdings paying tax is 7,669, out of which 6,355 holdings are connected with piped water supply provided by the municipality. The city collects on average Taka 200 (USD 2.6) per month per holding as water bill and Taka 42 (USD 0.6) per month per holding as conservancy tax for secondary collection and disposal of waste. Total faecal sludge generated per month by the municipality is estimated at 180 cubic meters per day. Total amount of solid waste collected by the city varies between 20-25 tons per day of which 80% is organic in nature.

In order to demonstrate a faecal sludge collection and treatment model with emphasis on resource recovery and recycling as stipulated in the government's National Sanitation Strategy, a pilot project was initiated in Kushtia - a secondary town in Bangladesh – in order to treat the faecal sludge and solid waste together. The project is implemented by Waste Concern in partnership with the Kushtia Municipality. Local Government Engineering Department (LGED) provided the costs for construction of the compost plant, the faecal sludge drying bed, and the cost for the vacuum tugs. UNESCAP provided grant for construction of the coco peat filter.

2.2 Sanitation Situation of Kushtia

In order to assess sanitation condition of Kushtia Municipality, a sample survey was conducted amongst high, middle, lower-middle and low-income groups. Fig 1 below shows the overall sanitation situation of the town prevailing in November-December, 2012. 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.

Image 5: Coco Peat Filter Unit at Kushtia

Image 6: Map of Bangladesh and Map of Kushtia

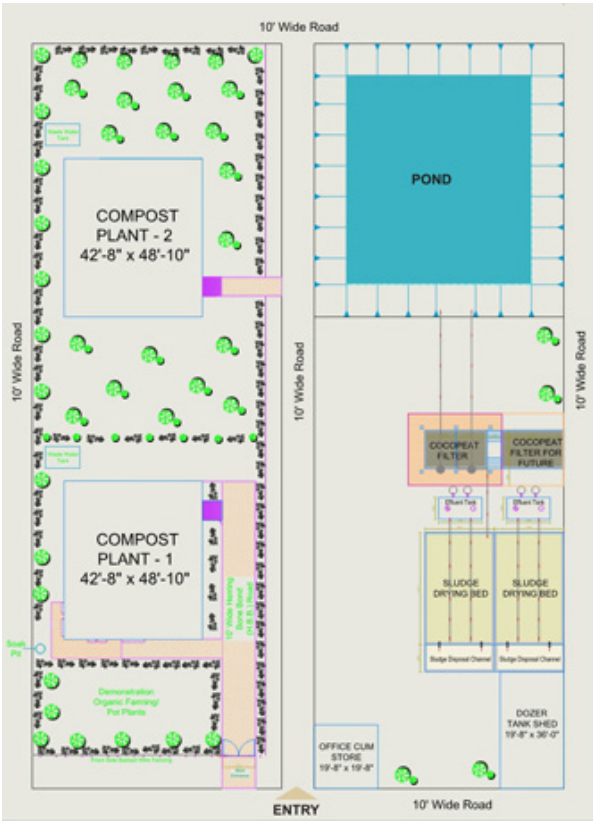

Image 7: Site plan of co-composting plant in Kushtia

Image 8: Vaccutug truck utilised for faecal sludge collection

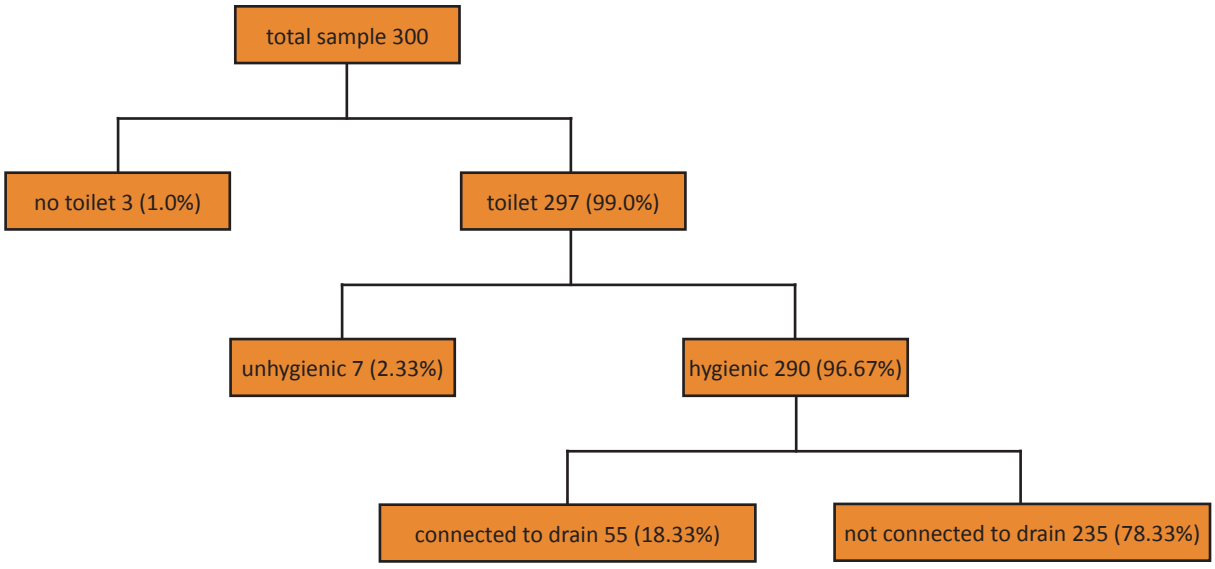

Figure 1: Sanitation Situation of the Kushtia Municipality

Table 1 below shows the different types of toilets used by different income groups. Septic tank is used by more than 50% of households, while the second largest type is twin pit latrine (31.67%). The majority of the septic tank latrines are owned by middle and high income groups, while twin pit latrine, single pit latrine and ring slab latrine are owned by low, lower middle and middle income groups. It is quite interesting to note that 40 households from the low and lower middle income groups have been found to have septic tank latrines.

Table 1: Type of Toilet by Income Group

	Income Group					
	Low Income Group	**Lower Middle Income Group**	**Middle Income Group**	**High Income Group**	**Total**	**%**
No Latrine	3	0	0	0	3	1.00
Unhygienic Latrine	5	2	0	0	7	2.33
Ring-slab Latrine	9	9	11	0	29	9.67
Single Pit Latrine	5	5	5	0	15	5.00
Twin Pit Latrine	33	38	24	0	95	31.67
Septic Tank	13	27	65	46	151	50.33
Total	68	81	105	46	300	100.00

Source: Field Survey, November-December 2012

2.3 Collection and Disposal of Faecal Sludge

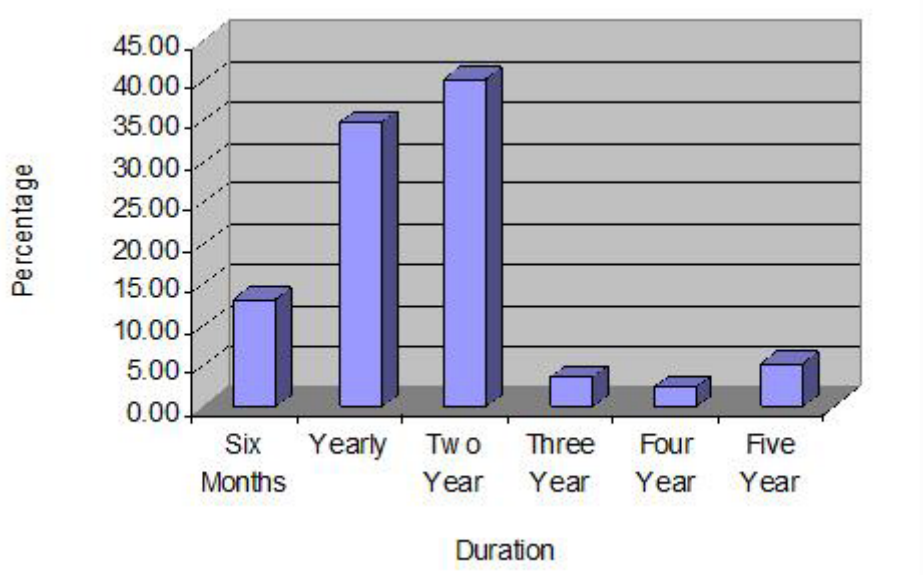

Figure 2: Sanitation Situation of Kushtia Municipality

It is evident from the above figure that about 35% of the households clean their pit/septic tank within one year, while about 40% do the same every two years. On average, 2.08 years is taken by each household for cleaning or removing the sludge from the filled up septic tank or pit latrine. Faecal sludge of less than three years is not fully decomposed and contains high pollution load and hence needs to be treated properly.

2.4 Estimation of Daily Demand for the Faecal Sludge Collection and Disposal

Total households in the municipality are 12, 907. Out of this 78% of the households are not connected to drain; as such, 10,067 households have hygienic toilet. From field survey it has been found 35% of the households clean their pit latrines or septic tanks annually. As such, the number of households cleaning their pits annually is 3,524. Out this, 64% of the households apply to municipality for collection and removal of faecal sludge. Therefore, monthly demand for removal of faecal sludge is from 188 households or 6.26 households per day (3 pit latrines and 3 septic tanks). The volume of septic tank is on average 2 cubic meters while pit latrine is 0.87 cubic meters. Total sludge generated per day for collection is calculated at 8.67 cubic meters per day. Based on this data, sludge accumulation rate is cal-

culated at 0.03 cubic meters/cap/year. The sludge accumulation rate will increase with the conversion of unhygienic toilet into hygienic toilet. Other studies have shown that sludge accumulation rate in pits and tanks varies between 0.04-0.07 cubic meters/cap/year considering upon storage and digestion for at least 1 year in pits or vaults in hot climate (EWAG, 2002).

2.5 Pilot Project

Human excreta are 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 human excreta 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.

In order to establish a comprehensive system of faecal sludge management (i.e. collection of faecal sludge from households, transportation, treatment and reuse), a pilot research project was initiated in December 2012. The project's duration is up to June 2015. Waste Concern is providing technical support to Kushtia Municipality in implementing the project. In this regard an agreement for technical support was signed between Kushtia Municipality and Waste Concern in October 2012. UN ESCAP is providing financial support to conduct this research. 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. The project focuses on the following aspects:

Phase -1: (December 2012- June 2014)

The activities under phase I

1. Capacity building and training of municipality staff regarding collection and treatment of faecal sludge from household and co-composting;

2. Conducting surveys to assess the demand for faecal sludge collection, current expenditure of the households for faecal sludge, and willingness to pay for improved faecal sludge management system;

3. Initiating faecal sludge collection from households using vaccu tugs through payment for the fuel cost for the faecal sludge collection services by the households as well as treatment of faecal sludge;

4. Testing of quality of faecal sludge pre and post treatment;

5. Testing of the co-compost in laboratory for compliance with the GoB's standard of compost/ co-compost as checking of yield of different crops using produced compost;

6. Testing of quality of percolate before and after treatment with coco peat filter to check compliance with DOE standards;

7. Assisting the municipality to obtain license from Department of Agriculture Extension (DAE) to market co-compost;

8. Estimation of emission reductions by avoiding landfilling and use of co-compost in agriculture.

Phase -II: (July 2014- September 2015)

The activities under phase II of this project are as follows:

1. Recommendation of a tariff for faecal sludge collection, transportation, and treatment which can be charged for 100% cost recovery by the municipality, subject to the approval of the tariff by the Ministry of Local Government.

2. Recommendation of a Public-Private Partnership model for scaling-up of the operation after approval of the faecal sludge management tariff by the Ministry of Local Government, as well as approval of the production and marketing license of co-compost by the Ministry of Agriculture and Department of Agriculture. Extension (DAE).

3. Dissemination of the results of the project for policy reform for faecal sludge management data.

2.6 Description of the Pilot Project

In the year 2008, Kushtia City Corporation with the support from the Institute for Global Environmental Strategies (IGES) and United Nations Centre for Regional Development (UNCRD) initially established a 1.5 tons/day compost plant. Later, at the same site, Local Government and Engineering Department LGED) of the Goverment of Bangladesh established a drying bed facility along with a 2.5 ton/day capacity composting plant to receive faecal sludge collected from the city. During this time Waste Concern provided all the necessary technical support to establish the compost plant and drying bed. Under the present pilot co-composting project, Waste Concern connected these stand alone facilities (compost plant and faecal sludge drying bed) in an innovative way with an additional coco peat filter to properly treat the faecal sludge with municipal organic waste.

This pilot project is established in a land of 668 m2, dedicated by Kushtia Municipality in a landfill site, out of which 165 m2 is used for faecal sludge drying bed as well as treatment of percolate using coco peat filter. Total quantity of municipal solid waste brought to the plant amounts to 2 to 3.5 tons per day. Under this project, faecal sludge is directly collected from the septic tanks or pit latrines of households using mechanical vacuum-tugs. Total quantity of faecal sludge collected per day is 2 to 6 cubic meters per day depending upon the demand. The municipality collects faecal sludge for 20-22 days in a month. The plant has a capacity to treat up to 9 cubic meters of faecal sludge per day. The collected sludge is directly sent to the treatment facility. 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 gets filled up, it is kept there for a few days (7-12 days depending upon season) 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 nutrients, and can be safely released into agricultural land for irrigation purposes. On the other hand, dried layer of the faecal sludge is collected from the drying bed and is mixed with the municipal organic solid waste in 1:3 ratios; compost is produced in the co-composting plant using aerobic theomorphic composting method to be used as organic fertilizer. Waste Concern is training municipal staff on collection and maintenance of all operational data as well as on operation and maintenance of the faecal sludge treatment plant.

At present Kushtia Municipality is charging Taka 350 as fuel cost of vaccu tug for de-sludging of pit latrine, and Taka 500 for de-sludging of septic tanks. Fuel cost for the tractor pulling the vaccu tug and staff salaries are borne by the municipality. In order to charge a fee or charge for collection of faecal sludge as per Municipal Ordinance 2010, approval of Ministry of Local Government is required. Without approval from the Government it is not possible for the local government to impose any fee or charge for collection of faecal sludge. Moreover, for marketing of compost, the approval of compost is required from the Ministry of Agriculture and Department of Agriculture Extension (DAE). The approval of compost is a two stage process; first the compost has to be tested in Government certified laboratory. If the compost complies with the Government Standard, the field trial is done for two seasons to check the yield of different crops using the compost.

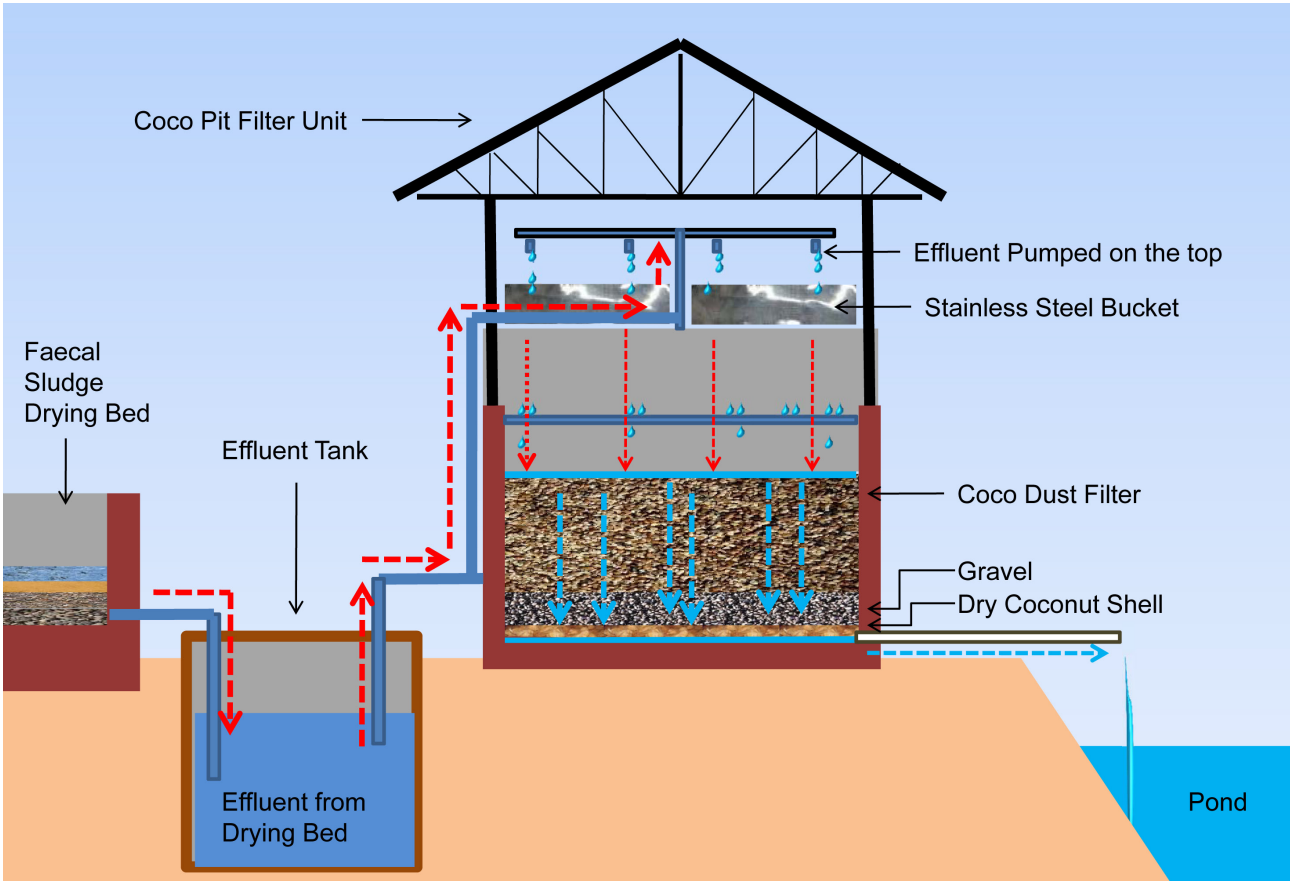

Image 9: Schematic section of coco peat filter at the Kushtia co-composting plant

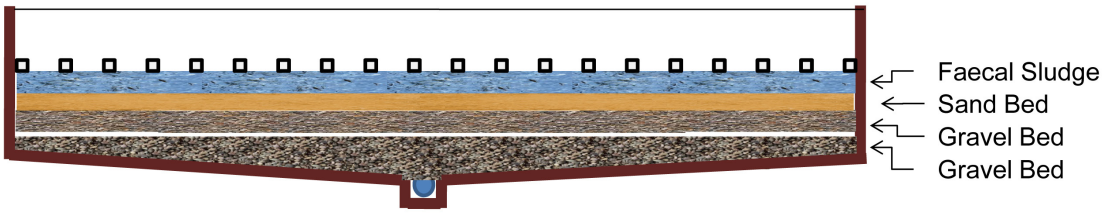

Image 10: Schematic section of faecal sludge drying bed at the Kushtia co-composting plant

Test results of the co-compost produced at Kushtia are complying with governmental standards and already cleared stage 1 of the licensing process. Now, the compost will be used for field trial process. It will take 9-12 months to obtain the license for commercial production and marketing of compost.

Since the inception of the project, Waste Concern has been carrying out a multi-year field trial on the impact of compost produced from the co-composting plant to validate the safety and agronomic value of compost on different types of crops. The main objectives of this field trial are the following:

- To assess the effects of the application of compost to arable land through replicated field trials over two years;
- To analyze compost use on soils and crops in each year;
- To assess the effects on soil microbiology;
- To carryout trials to assess the effects of composting on soil pathogens;
- To assess the economic benefits of using compost;

The method of co-composting has been graphically presented in Figure 3 on the following page (p.17).

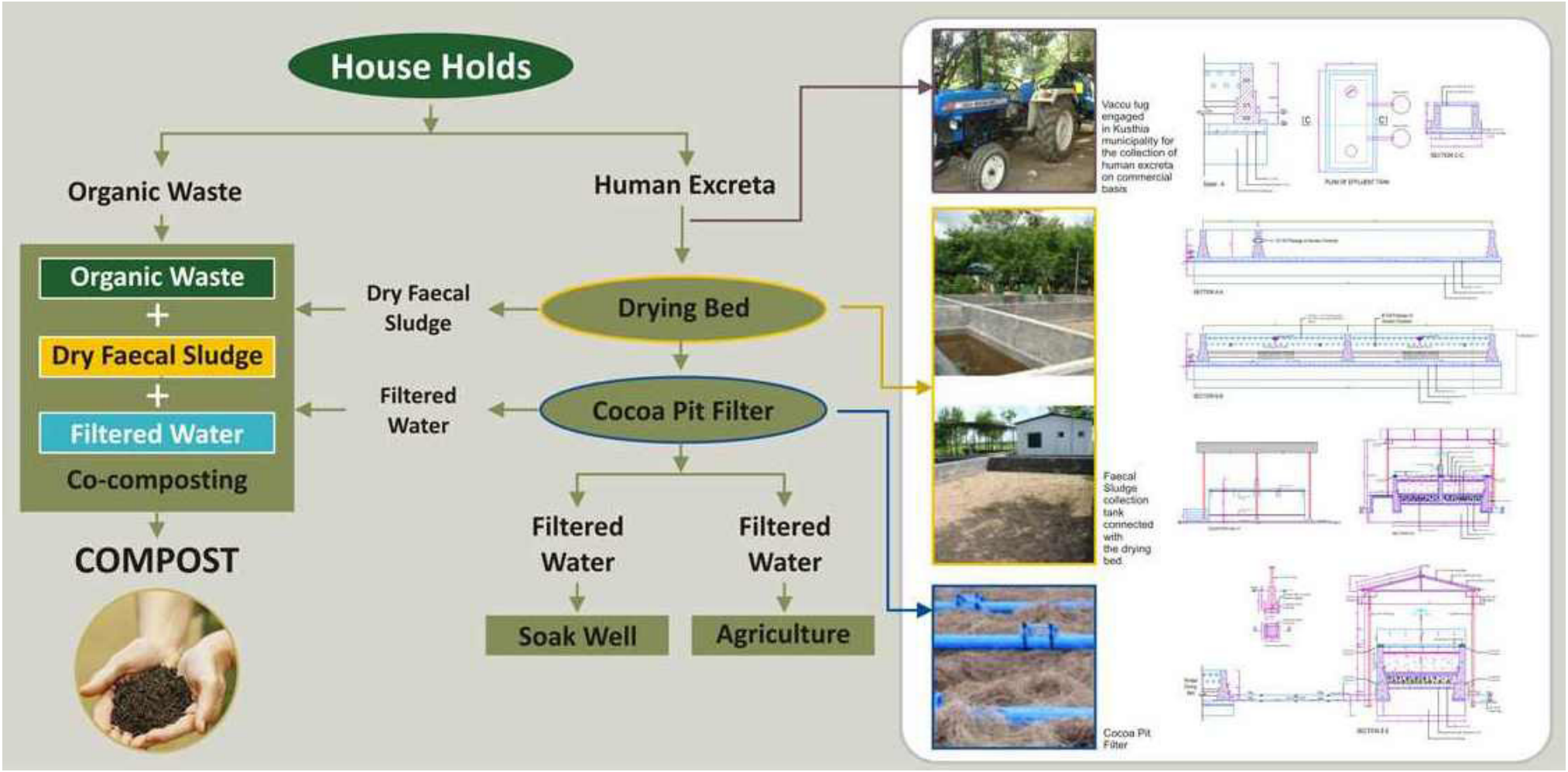

Figure 3: Method of co-composting

2.7 Test Results of the Co-Compost and Treated Waste Water

The analysis of compost produced in the co-compost plant as well as treated waste water using the coco peat filter has been conducted at the laboratory of Waste Concern. Both the compost and waste water are complying with the standards for use in agriculture and organic fertilizer and for irrigational purposes. Laboratory analysis of compost sample was also conducted at Dhaka University to check the pathogen level in the compost sample. It was found from the laboratory analysis that the sample has acceptable levels of helminthes and salmonella. Moreover, the compost has also been tested at SRDI laboratory of the Government which has also confirmed the compliance with the standards.

Table 2: Physical and Chemical Properties of Compost Produced in the Kushtia Co-Compost Plant

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
Chemical Properties				
Sl. No.	**Parameters**	**Actual Concentration**	**Standard* Range**	**Test Method****
1	pH	7.8	6.0 – 8.5	pH Meter
2	Organic Carbon	11.97%	10 – 25 %	Wet Oxidation
3	Nitrogen (N)	3.08	0.5 – 4.0 %	Micro-Kjeldahl
4	Phosphorus (P)	0.97	0.5 – 1.5 %	Spectrophotometric with HNO3 & HClO4 acid digestion
5	Potassium (K)	1.08	1.0 – 3.0 %	Flame Photometric with HNO3 & HClO4 acid digestion
6	Sulfur (S)	-	0.1 – 0.5 %	Spectrophotometric with HNO3 & HClO4 acid digestion
7	Zinc (Zn)		Maximum 0.1 %	Atomic Absorption Spectro-photometric with HCl acid dissolution
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

Table 3: 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 Coco Peat Filter (First Tank)	7.36	4.9	192
Before Treatment (Second Tank)	7.70	1.6	484
After Treatment with Coco Peat Filter (Second Tank)	7.15	5.4	192

* Department of Environment, Bangladesh Standards

2.8 Financial Analysis

In terms of capital cost, the compost plant accounts for 60% of the cost while faecal sludge treatment accounts for only 40%. However, in terms of operational cost, 71% of cost is incurred in connection with the collection of the faecal sludge while the rest (29%) is associated with the co-compost plant.

Table 4: 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 Coco Peat Filter	20,000
Purchase of Vacuum Tug	20,000
Total Capital Cost	135,000

Table 5: 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 laborers for faecal sludge collection	467
Salary of 6 laborers 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

2.9 Cost Recovery

In order to sustain faecal sludge management services, it is essential to recover the operational costs and make profits. Total estimated operational cost is estimated at USD 34,968. In order to sustain the operation, a profit of 15% should be charged on top of the expenditure. As such profit should be around USD 5,245 per year with 15% profit while with 20% profit it should be USD 6,994 per annum.

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. After getting approval from the Local Government Ministry, the pourashava would have to announce that it will provide services to all residents for removal of sludge from pits and septic tanks. The total holdings in the Kushtia Pourashava are 12,907 out of which 6,335 households have access to piped water supply. Following table shows sanitation fee or rate per household per year based on 15% and 20% profit margin on top of the operational cost.

Table 7: Sanitation Fee or Rate per Household

Total O & M including profit	Fee Per Year/HH with holding tax	Fee Per Month/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

2.10 Recommended Tariff for Cost Recovery

It has been found from review of the Pourashava Act that at present there is no provision to charge a fee for sanitation or faecal sludge management in case pourashava wants to provide such services. In order to levy a service charge or fee/rate for faecal sludge collection and management, pourashava has to get approval from the Ministry of Local Government. Alternatively, Ministry of Local Government can amend the Pourashava Act and include sanitation fee/rate or charge as a separate fee similar to water rate or conservancy charge as mentioned in the Act. Cost recovery is very important for sustainability of municipal services. The options for cost recovery are as follows:

- The first option is a fixed charge for all holdings under the poursahava. This will amount to Taka 351 per annum (USD 4.5 per household per annum) or Taka 29.25 (USD 0.38 per household per month). This flat rate can be charged with the conservancy charge or as a separate sanitation fee.

- The second option is to charge the feacal sludge collection with the water charge. At present, 6,335 households of the pourashava have access to piped water supply. In this option, Tk. 716 per household per annum (USD 9.18) or Taka 60 per month per household (USD 0.75 per household per month) can be charged with the water bill as faecal sludge management fee to the households having water connection. In this option, households with water connection will have to subsidize the households without piped water supply.

MOVING FORWARD

3.1 Moving Forward

Findings of the operation of the co-compost plant for the last two years show that treatment of faecal sludge along with segregated municipal organic waste is technically feasible and use of aerobic theomorphic composting is essential to make the compost pathogen free. Moreover, use of coco peat filter shows the improvement of the quality of waste water especially in terms of DO and COD and compliance with the standards for use in agriculture.
The capital cost of the project is much lower than the conventional sewerage system. This makes it very attractive for use as an intermediate solution for management of faecal sludge management in developing countries, especially for small and medium sized towns. However, to promote this concept there is a need for demonstration of such technology as well as support by national government.

In the future it is important to mechanize the faecal sludge collection system from the drying bed and subsequent transfer to the compost plant for co-treatment. At present, collection of faecal sludge from the drying bed is done manually by sweepers. Although sweepers use personal protective equipment while working with the faecal sludge it remains dirty work and the population of the sweeper community in Bangladesh has declined over the last forty years. In the long run it will be difficult to find people to work in the faecal sludge management plant and mechanization should be the primary path forward.

3.2 Lessons Learned from Operation of Co-composting Plant in Kushtia Municipality

Political Will is Crucial: The Mayor of the Kushtia is fully supporting the project. He is convinced about the benefits of the project and he regularly monitors the activity. Without political will it is difficult to implement such a project. Apart from Mayoral support, in order for full cost recovery of the project, support from National Government is very crucial for allowing municipalities to provide such services against a fee or a charge.

Awareness Raising and Capacity Building: It has been found that there is low level of awareness amongst the municipal staff regarding sanitation, conservancy, and engineering on different aspects of FSM. Waste Concern has been working with conservancy section staff and providing them on job training regarding different aspects of FSM. Waste Concern has developed a manual for O&M of the treatment plant.

People Are Willing to Participate and Pay for Faecal Sludge Collection: Waste Concern conducted a survey to get feedback from the residents regarding how they dispose faecal sludge and satisfaction with the services provided by the municipality. Following table shows the results of the survey:

Table 8: Process of cleaning the filled up pits/septic tanks in Kushtia Municipality

What is done when the septic tank/pit latrine gets filled up			How the faecal sludge is removed		
Description	**Frequency**	**Percentage**	**Description**	**Frequency**	**Percentage**
Apply to Municipality	200	66.7	Vaccu tug	192	64.0
			Manual labor	8	2.7
Don't Apply to Municipality	41	13.7	Manual labor	33	11.0
			Self	8	2.7
Never filled up	49	16.3	N/A	49	16.3
Unhygienic toilet	10	3.3	N/A	10	3.3
Total	300	100.0	Total	300	100.0

Above mentioned table illustrates the process of cleaning the filled up pits/septic tanks in Kushtia Municipality. 66.7% households apply to Municipal Authority for taking necessary actions to clean up their pits or septic tanks. At present the municipality collects between 2-6 cubic meters of faecal sludge for treatment which is equivalent to serving one to four households daily. Municipal Authority serves almost all of them with vacuum tug, except where the vacuum tug cannot move due to poor accessibility. Municipal Authority sends cleaners to those houses. The cleaners either carry the cleaned sludge to a nearby point where the vacuum tug is kept, or dump the sludge by digging a hole if the vacuum tug cannot come to a nearby point. It is to be noted that 13.7% households still do not apply to the Municipality Authority for cleaning the filled up pits/septic tanks. They either call in sweepers or clean the pits by themselves. Furthermore, 16.3% of septic tanks, latrines, or pit latrines of the Municipality never became filled up after being constructed. About 70% of the residents are happy with the services.
The reasons identified with them are as follows:

- Operators are well behaved;
- Service is quick and efficient;
- Tension free operation and does not break rings/slab in the process;
- Less problems between neighbors. Costs less and is risk free;
- Households do not have to stay awake at night;
- No mess in the home and less smells than traditional cleaning;
- Decreased the sufferings of women

Intermediary May Be Required to Start FSM System: Initial support (financial and technical) is required for the municipality to assist them with the operation and maintenance of the treatment plant. Proper operation is essential for compliance with environmental and agricultural standards of the government. Findings of the operation of the co-compost plant for the last fourteen months show that treatment of faecal sludge along with segregated municipal organic waste is technically feasible and use of aerobic theomorphic composting is essential to make the compost pathogen free. Moreover, use of coco peat filter shows the improvement of the quality of waste water especially in terms of DO and COD, compliance with ECR 97, and also with the standards for use in agriculture.

3.3 Operation and Maintenance (O&M) of Faecal Sludge Collection and Treatment System

There are three options for operation and maintenance of the faecal sludge collection and treatment systems namely:

Option 1: Municipally Owned and Operated System

This option considers faecal sludge collection and treatment as part of municipal services provided by the pourashava as a work to be done under the public health section of the Pourashava Act 2010.

Option 2: Municipally Owned and Privately Operated System

This option considers faecal sludge collection and treatment as part of the municipal services provided by the Pourashava, but operated by a private sector under lease and management contract. Such lease and management contract is admissible under section 96 Pourashava Act 2010.

Option 3: Privately Owned and Operated System

This option considers faecal sludge collection and treatment provided by private sector as a commercial activity. This type of service is allowed under build, own, operate and maintain (BOO) system or as a service provision agreement under section 96 of the Pourashava Act 2010.

Details of each option are given below in the following paragraphs:

3.3.1 Option 1: Municipally Owned and Operated System

This option focuses on faecal sludge collection and treatment as an integral part of the municipal services as mentioned in section 50 (responsibilities and function of pourashava) under the Pourashava Act 2010. Although there is no mention in section 50(2) of the Pourashava Act 2010 about faecal sludge collection and treatment, however, this service can be provided as a part of waste management services (since the definition of waste mentioned in the Pourashava Act 2010 consists of human excreta also). Moreover, pourashava may provide faecal sludge collection and treatment service using section 50(2) (h) which says citizen's health and environmental protection are the responsibilities of the pourashava. Since uncontrolled disposal of faecal sludge is an environmental and public health concern, therefore under this clause, pourashava can provide the aforementioned services

Driving Force

The main driving force for this option is to reduce illegal disposal of faecal sludge on land and water bodies and thereby improve overall public health and environmental situation of Pourashava.

Key Feature of this Option

The service provided under this option can be a non-commercial (no profit no loss) basis, but can be developed into a commercial operation with full cost recovery and marginal profit. However, to charge a fee/rate for faecal sludge collection and treatment, the approval of the Ministry of Local Government will be required.

Main Actor and Responsibility

The main actor for this option is the Pourashava. It will be also responsible for implementation as well as operation and maintenance of the services.

Mode of Implementation

Pourashava may start collection of faecal sludge from households using vaccu types and then further treatment of the collected faecal sludge using staff of conservancy unit under health section.

Households have to pay a fee or service charge for collection and treatment of faecal sludge at the time of pit/tank cleaning or it can be linked with conservancy tax. An estimated fee for pit and septic tank cleaning is shown in Table 7.

The capital cost for the establishment of the faecal sludge collection and treatment system can be provided by national government through a project. Alternatively, pourashava may take loan from Bangladesh Municipal Development Fund (BMDF) to implement such project. The other option is to raise the capital cost from CSR activity of large private sector companies or banks (since sanitation and waste management are part of approved CSR project list of National Board of Revenue, a tax rebate would be possible in this scenario).

Risks

The major risk involved with this option is that the operational efficiency may be low due to lack of trained manpower in the pourashava as well as experience in O& M. At present there is only one sanitation inspector for the sanitation activity of the Pourashava. There is a risk that faecal sludge collection service may not be reliable and there might be delay in providing services by the municipality which may discourage the use of service by the residents.

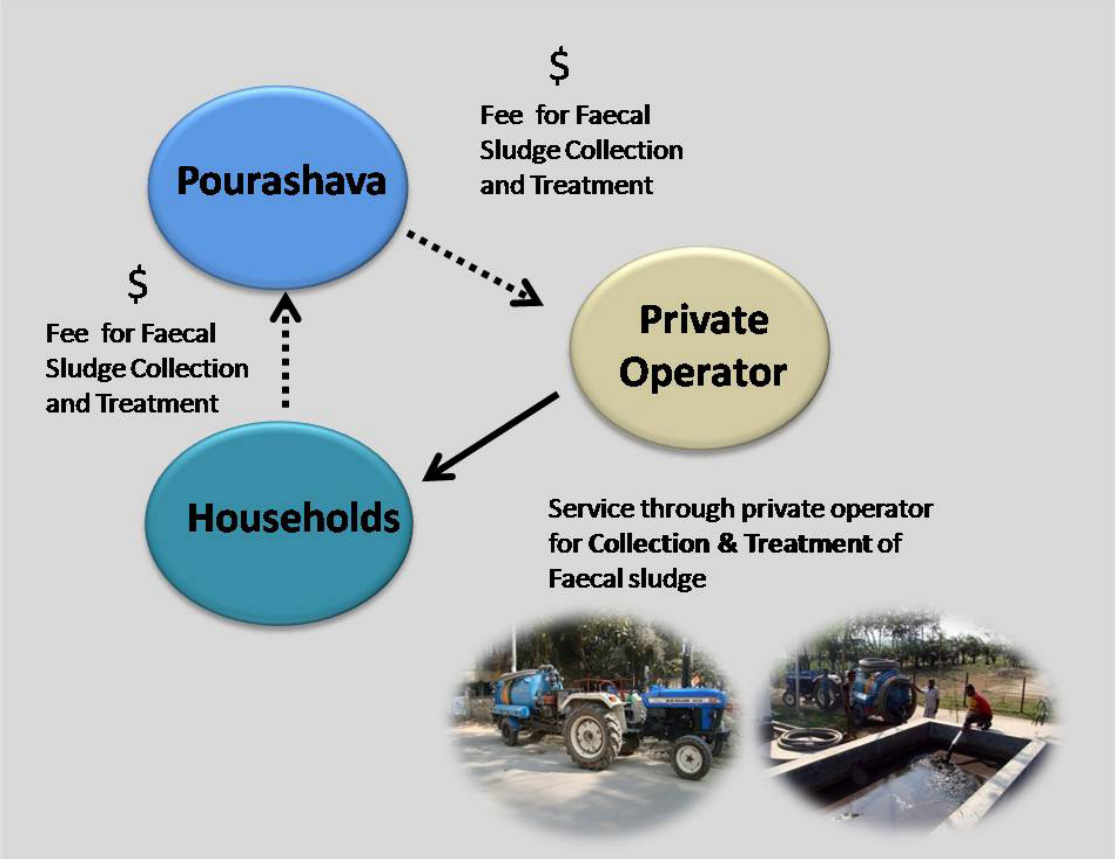

Image 11: Financial Flow for Municipally Owned and Privately Operated Model

3.3.2 Option 2: Municipally Owned and Privately Operated System

This option focuses on faecal sludge collection and treatment as an integral part of the municipal services as mentioned in section 50 (responsibilities and function of pourashava) of the Pourashava Act 2010. Although there is no mention in section 50(2) of the Pourashava Act 2010 about faecal sludge collection and treatment, however, this service can be provided as a part of waste management services (since the definition of waste mentioned in the Pourashava Act 2010 consists of human excreta also). Moreover, pourashava may provide faecal sludge collection and treatment service under section 50(2)(h) which says citizen's health and environmental protection are the responsibilities of the pourashava. Since uncontrolled disposal of faecal sludge is an environmental and public health concern, pourashava can provide the aforementioned services using this clause.

This option further focuses that the pourashava will finance and build all the necessary infrastructure, but the management and operation will be handed over to the private sector using section 96 (2)(h) of the Pourashava Act which is lease and management type of the service.

Driving Force

The main driving force for this option is to reduce illegal disposal of faecal sludge on land and water bodies and thereby improve overall public health and environmental situation of Pourashava.

Key Feature of this Option

The service provided under this option will be of a commercial nature with full cost recovery and with reasonable profit margin (15-20% over the operational cost). For cost recovery, service charge or collection fee has to be recovered from the users. However, to charge a fee/rate for faecal sludge collection and treatment, the approval of the Ministry of Local Government will be required.

Main Actor and Responsibility

The main actors for this option are the Pourashava and the private sector. Pourashava will also be

the lead agency and be responsible for financing of the capital cost as well as building the infrastructure. Private sectors can be involved in the collection of faecal sludge from the households and operation and maintenance of the treatment facility (such as co-compost plant along with the drying beds). Pourashava will monitor and supervise the activities of private sector operator.

Mode of Implementation

Private sector may start collection of faecal sludge from households using vaccutugs and then further treat the collected faecal sludge.

Households have to pay a fee or service charge for collection and treatment of faecal sludge to the pourashava. Pourashava will pay the private sector operator an operation and management fee based on the number of pits/tanks cleaned per month or volume of faecal sludge collected and transported to the treatment facility.

The capital cost for the establishment of the faecal sludge collection and treatment system can be provided by national government through a project. Alternatively, pourashava may take loan from Bangladesh Municipal Development Fund (BMDF) to implement such project. The other option is to raise capital cost from CSR activity of large private sector companies or banks; (since sanitation and waste management are part of approved CSR project list of National Board of Revenue, a tax rebate would be possible in this scenario).

Risks

There is a minimum risk in this approach for the pourashava. However, selection of right type of private sector/social enterprise with experience in urban service delivery especially sanitation is essential. For treatment of faecal sludge with co-composting approach, it is important to involve private sector which has the license to operate and market compost from the government. Moreover, it is also important to have the appropriate contract document which will make payment from the municipality to private sector based on the number of pits or tanks cleaned.

3.3.3 Option 3: Privately Owned and Privately Operated System

This option focuses on faecal sludge collection and treatment as an integral part of the municipal services as mentioned in section 50 (responsibilities and function of pourashava) of the Pourashava Act 2010. Although there is no mention in section 50(2) of the Pourashava Act 2010 about faecal sludge collection and treatment, however, this service can be provided as a part of waste management services (since the definition of waste mentioned in the Pourashava Act 2010 consists of human excreta also). Moreover, pourashava may provide faecal sludge collection and treatment service under section 50(2) (h) which says citizen's health and environmental protection are the responsibilities of the pourashava. Since uncontrolled disposal of faecal sludge is an environmental and public health concern, pourashava can provide the aforementioned services using this clause.

This option further focuses that the pourashava will give contract to private sector to build, operate, own, and maintain the faecal sludge collection and treatment for the municipality for a certain period under a concession agreement using section 96 (2) (a)(b) of the Pourashava Act .

Driving Force

The main driving force for this option is to reduce illegal disposal of faecal sludge on land and water bodies and thereby improve overall public health and environmental situation of Pourashava.

Key Feature of this Option

The service provided under this option will be of commercial nature with full cost recovery and with profit margin for the private sector. For cost recovery, the service charge or collection fee has to be recovered from the users by the private sector.

Main Actor and Responsibility

The main actor for this option is the private sector. Role of pourashava will be to prepare the guideline and regulation for collection and treatment of faecal sludge and providing long term contract to the private sector and arranging suitable site for the treatment facility.

Mode of Implementation

Private sector may start collection of faecal sludge from households using vaccutugs and then further treat the collected faecal sludge.

Private sector will invest the required money for purchase of vaccutugs and treatment facility and operation and maintenance.

Private sector will recover the costs by charging user fee directly to the households.

Risks

There is a minimum risk in this approach for the pourashava. However, selection of right type of private sector/social enterprise with experience in urban service delivery especially sanitation is essential. For treatment of faecal sludge with co-composting approach, it is important to involve private sector which has the license to operate and market compost from the government.

Since there are no regulations on faecal sludge management, no incentives for private sector (such as tax holidays for a certain period of time), lack of low interest rates for financing such projects from commercial banks, it is unlikely that the private sector will invest in this type of project in the beginning.

3.4 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.

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