Overview of Septage treatment Learning from Nepal, China and Bangladesh

Workshop on Septage Treatment Options, Pune

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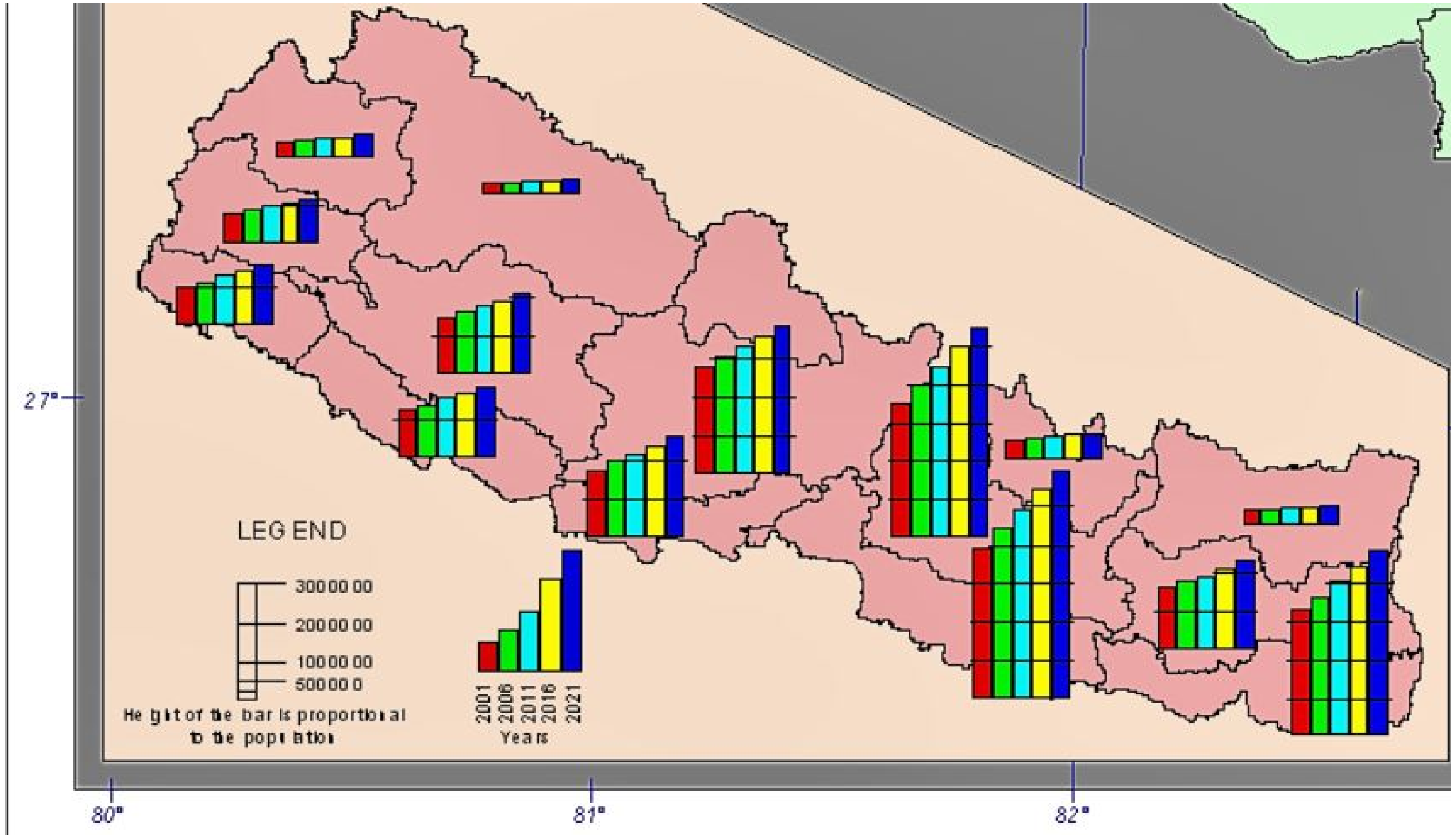
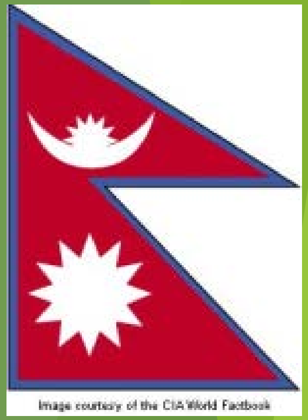
Prepared by : HP Mang, Christophar Kellner Humayun Kabir, PR Bjaracharya, KD Neupane, Sekun cheng

General Overview (Nepal)





Total Population: 26,494,504
Average growth rate : 1.35%
Population Distribution :

- **Rural : 83%**
- **Urban : 17%**

Source : CBS 2011

<u>Case : Kathmandu</u>
Population: 254764
Growth rate : 4.67%
Annual Septage Volume : 170000 cum
Per capita per year septage volume : 0.067 cum
Source: ENPHO, 2014

Sanitation Management Practices

1. Pit latrine
2. Pour flush latrine
3. Latrine connection with biogas
4. Latrine with septic tank
5. Sewerage connection
6. Open defecation

ODF STATUS OF NEPAL

Date:2073/2/5

DESCRIPTION	TOTAL NUMBER	ODF COUNT	REMARKS
VDC	3157	2127	
MUNICIPALITY	217	89	
DISTRICT	75	34	
ZONE	14	1	DHAULAGIRI

Problems of Urban Growth Centre

- Rapid & haphazard urbanization
- Very high population growth
- Poor waste management system

- Untreated wastewater disposal
- Sever environmental & social problems

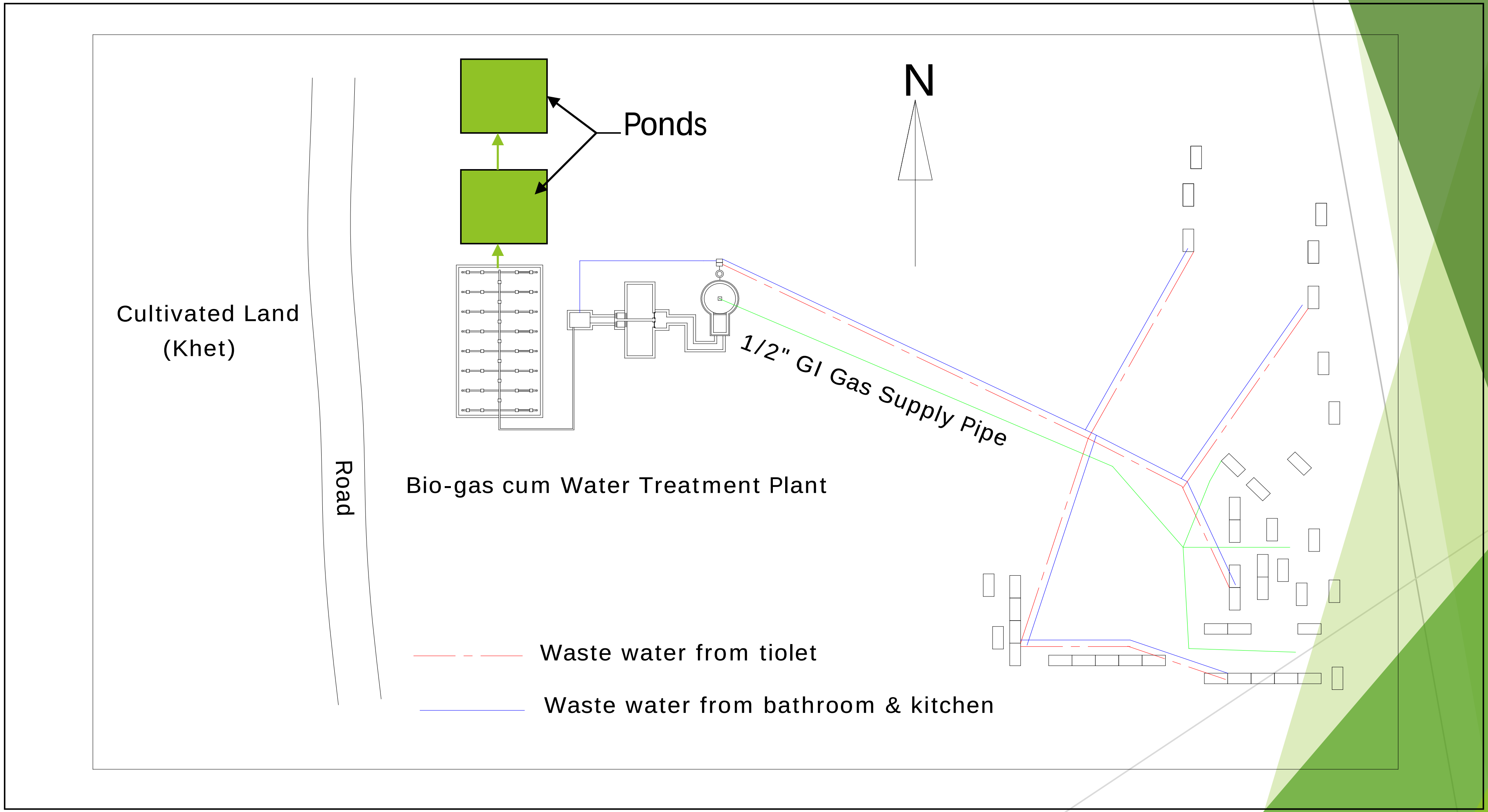
FSM management practices

- Drop and Buried (pit latrine)
- Dump into the water bodies/river (Sewerage system)
- Washed through the flood water
- Desludging with private /night soil workers (Usually this is used as manure)
- Desludging of septic tank with tanker when it is blocked
- Post treatment of sludge (only in pilot demonstration with some I/NGOS : ENPHO. LUMANTI, PRACTICAL ACTION….)
  - Practice through DEWATS – few community projects
  - Co composting
- Integration with biogas plant (limited to household level)

Case 1:
Household Waste to Energy and Environment: An Experience from 40HH -230population


आयोजनाको नाम: खोकना वातावरणीय सुधार पूर्वाधार विकास आयोजना
Programme Name:
Integrated Approach to Improve water and sanitation system and Increase Agricultural productivity in khokana.
बायो-ग्याँस तर्फको लागत विवरण:
(१) UN-HABITAT (लुमन्ति मार्फत) रू. 10,15,000/-
(२) समुदायको तर्फबाट रू. 16,45,000/-
पोखरी
ईनार
घरहरु
बायोग्याँस
सिंचित खेत
मन्दिर
UN-HABITAT
WaterAid
LUMANTI
SUPPORT GROUP FOR SHELTER

Project Description




Project Area
Community/Village

Slurry Chamber and *Reed Bed Treatment System* (RBTS)

Benefits

- Reduction of waste quantity solid waste produce from the households (~ 80 to 84 % of HH waste production)

- Reduced the GHG emission (by substituting the septic tanks)

- Reduce surface water pollution (by producing almost pollution free water which can also be reused)

As a by product;

- Saving Energy : Use biogas as a supplement for the imported cooking fuel like LPG, kerosene etc.

- Reduced stress of chemical fertilizer as the slurry used as a good organic manure

Challenges

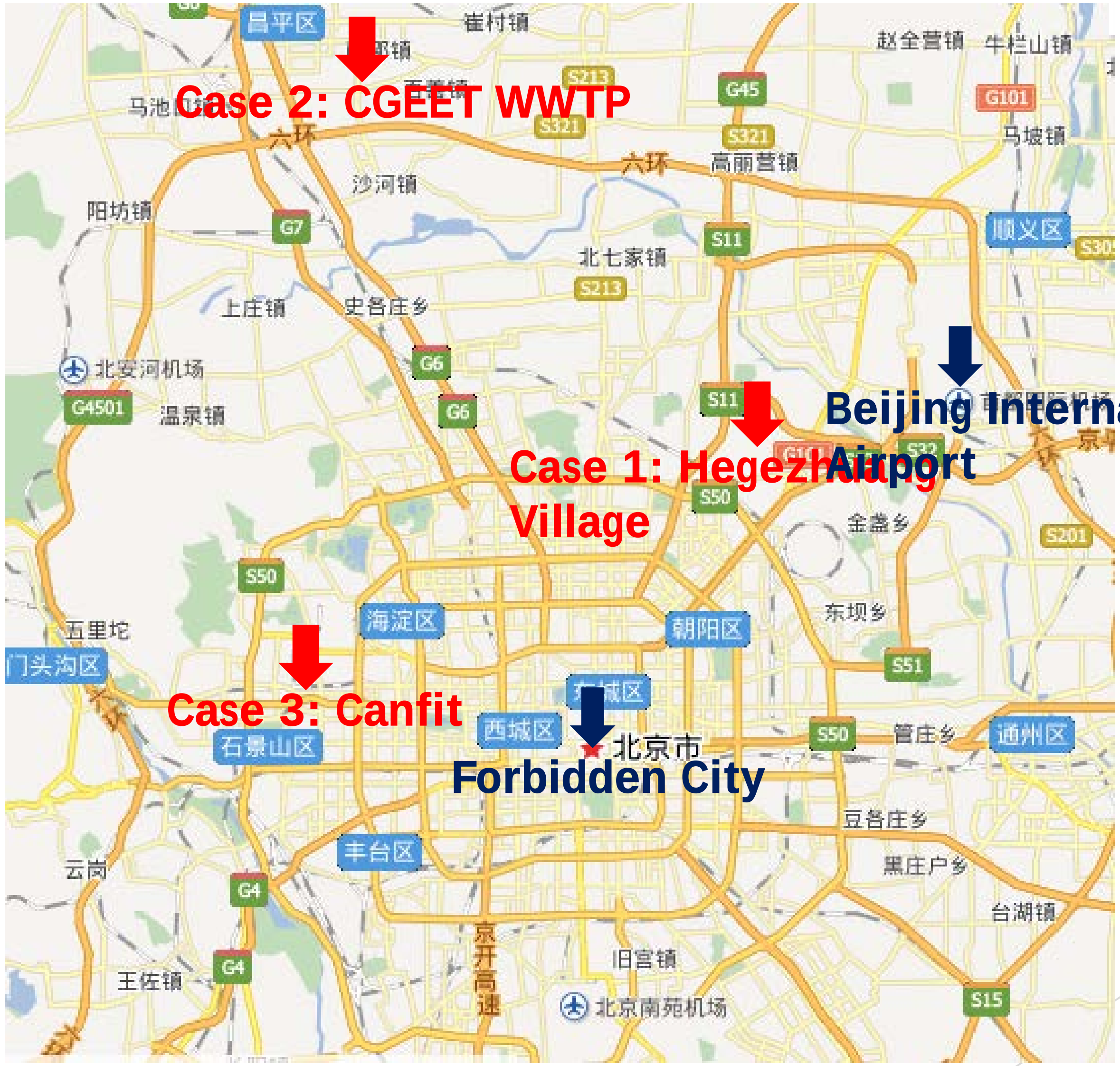
- Difficult to transfer knowledge to the users (may technology is complicated at users level)
- It has been applied in the community level instead of individual household
- People are used to for using antiseptic cleaner to clean the toilet
- Mixed household waste obtain at the station, however it was assumed to have screened biodegradable waste from household level
- Community use Grey water into the irrigation before it passes through the reed bed

Technological options for fecal sludge treatment in urban areas: case study in Beijing

Highlights

- **Case 2 – agricultural model, FS treatment for hygiene and bio-slurry reuse**
- **Case 3 – EPC model, FS and kitchen waste treatment for composting, biogas, biodiesel.**
- **Case 4 – R & D model, FS and kitchen waste treatment for by-products: bio-methane, struvite, bio-ethanol, biochar, compost, etc.**

Case studies



Case 1 .Hegezhuang biogas plant

Capacity: 20t FS/d

Process: 2 steps –

1st: thermophilic ,

19 days RT,

central vertical

stirrer

Manual screening of plastic waste, homogenization mixer

Homogenization (ca. 5%DM)

Heating water to more than 70℃ with 2-rings biogas burner Or with coal - when biogas is not enough or consumed in greenhouses

Pre-heating and pasteurization batch basin (70oC keeping for some hours), covered and insulated, slow mixing for sand separation – ammonium emissions (heavy smell)

Pre-heated water tank for circulation of heating water, solar paneles (tubes)

Gravity flow from CSTR to 2nd step

Gravity overflow – air blower for double membrane

Digestate storage tank with stirrer

Digestate pump and hose for filling distribution trucks

Biogas generator (25 KWel) as emergency stand-by to keep feeding pump and stirrer running

Biogas heater in greenhouse

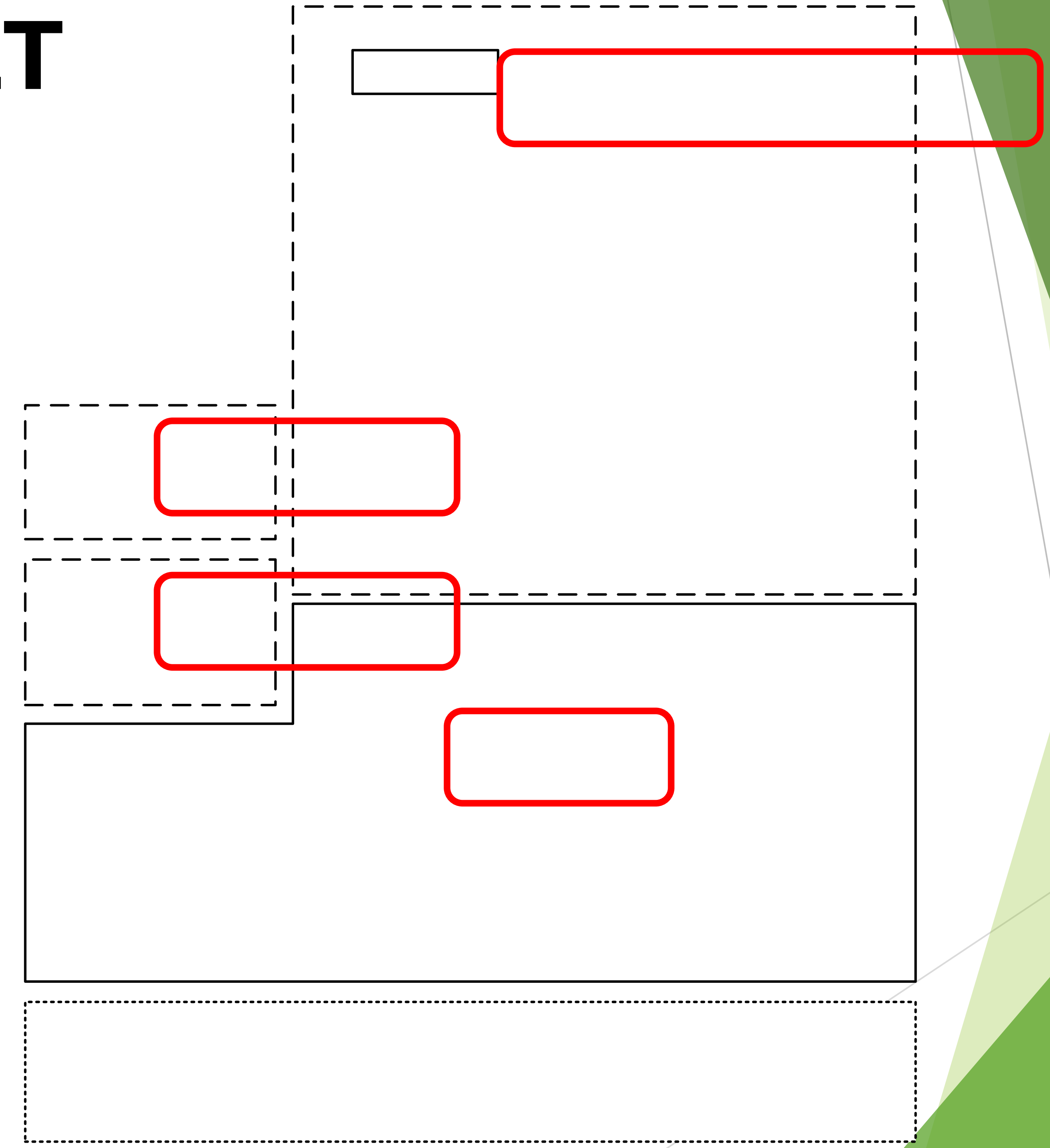
Biogas heaters distributed in greenhouse

Lessons learnt

- **Good agriculture model – combining biogas plant with vegetable plantations in greenhouses**
- **More environmental sanitation impact than energy output**
- **Ownership of biogas plant and nearby greenhouses is different – conflicts between biogas plant (village government) and greenhouses (recently privately owned)**
- **Corrosion issues after few years operation**

Case 3 - CGEET

- Start: 2009/2014
- Feedstock: 300 ton FS/d and 50 ton kitchen waste/d
- Organic fertilizer: 10-15 ton/d
- Biogas: 800-1500 m3/d



Pretreatment of Kitchen Waste

Receiver

Separation, sand removal, pyrolysis device

Pretreatment of Kitchen Waste

Bag-breaking and separation

Coarse material

Light material

Pulping

D ≤10mm

Sand removal

Cyclone Sand Remover

Oil & Fat Separator for biodiesel

120℃~170℃ steam

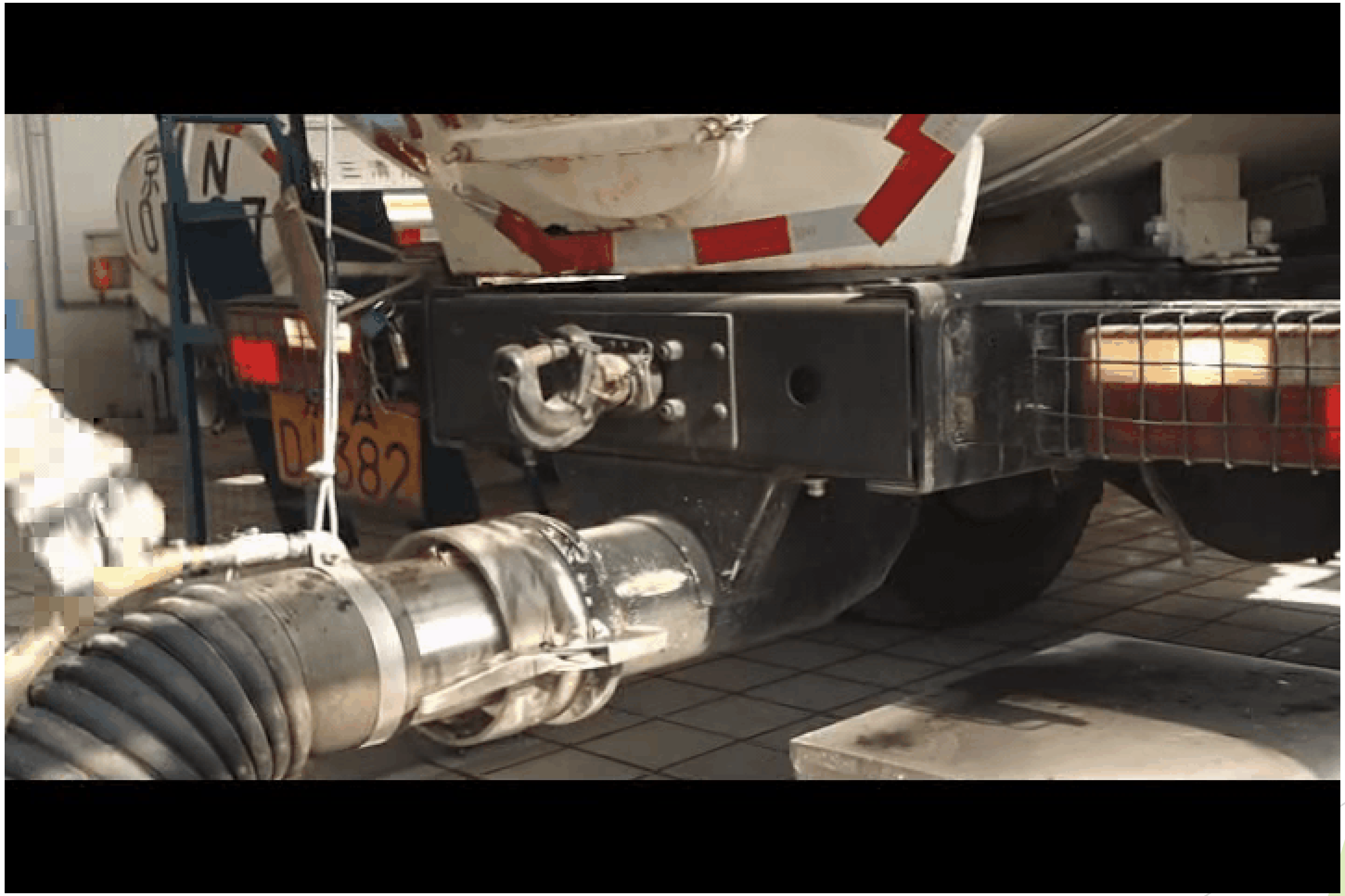
60~85℃ pulp

Three phase separator

Left to right:
oil, solid, organic wastewater

Clean Discharging of Fecal Sludge

Safe Discharging of Fecal Sludge



Solid-liquid separation

Anaerobic Digenstion

- CSTR
- Mesophilic
- Biogas boiler for producing steam, excess biogas is burned in torch
- Digestate goes to solid-liquid separation
- Liquid supernatant goes to WWTP

Biogas torch

Composting

- Aerobic composting
- One period: ca. 15 d
- Solid: applied in gardening / municipal greening

WWTP

AOM: Anaerobic +Oxic+ MBR

	COD	BOD	SS	NH_4^+-N	pH
	≤500 mg/L	≤350 mg/L	≤400 mg/L	≤45 mg/L	6.5-9.5

Online and real-time monitoring

Lessons learnt

- **Co-treatment with kitchen waste**
- **Located inside of WWTP, final wastewater goes to WWTP**
- **Output: Composting + biodiesel + biogas**
- **EPC (Engineering Procurement Construction) model**

Case 4- Canfit

Key facts

- 300-400t/d FS from public toilets in Xicheng district and Haidian District
- 50tons/d separated kitchen waste (KW)
- Treatment fee of 229 CNY/t KW.
- Liquid fecal sludge 56 CNY/t
- Capacity of one truck – 5 tons (most trucks)

Output- byproducts

1. Biogas, and a part of this up-graded to bio-methane (93% methane content) (water pressure scrubbing, compressed and bottled (17 bar) for own consumption)
2. Ethanol (experimental stage)
3. Biofuel (biodiesel from floating fat, gutter oil, grease trap fat and used restaurant oil)
4. Biochar (carbonization of solid digestate biogas in barrels)
5. Compost
6. Struvite (MAP experimental)

5 ton Kitchen Waste truck

Discharge of Kitchen Waste

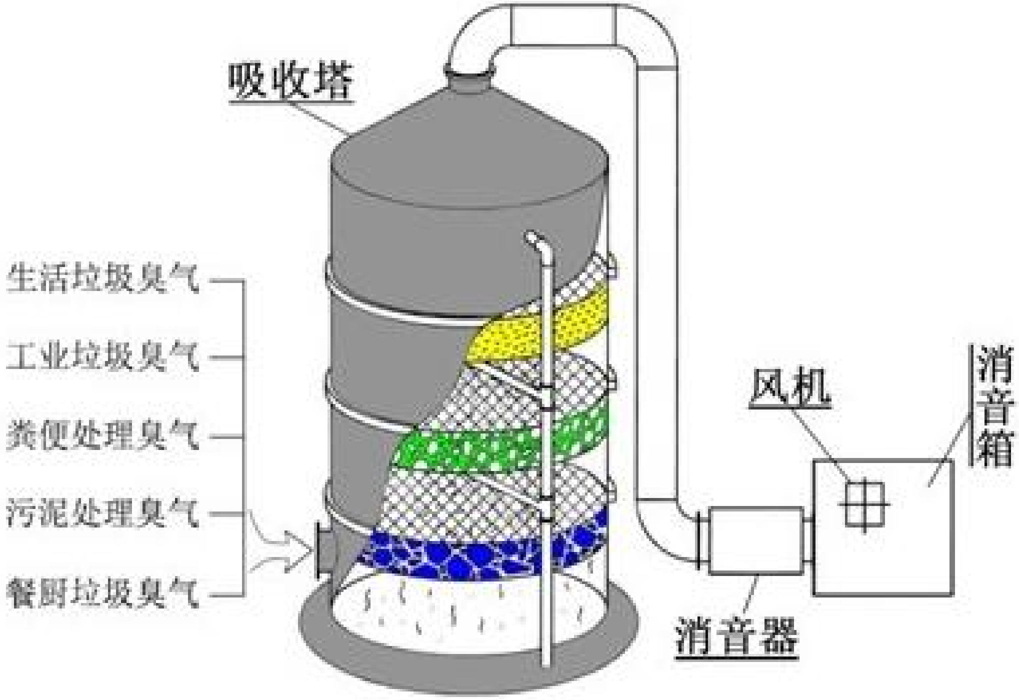
Biochar production

UASB

1200m^3 volume, biogas 1000-3000m^3/d. HRT is 40h.

Post-treatment of wastewater

Odor control



- Bio-filter
- Natural plant extracts

Odor concentration	H_2S (mg/m^3)	NH_3 (mg/m^3)
2000	0.33	4.9

Odor control

Smell removal facility

Samples

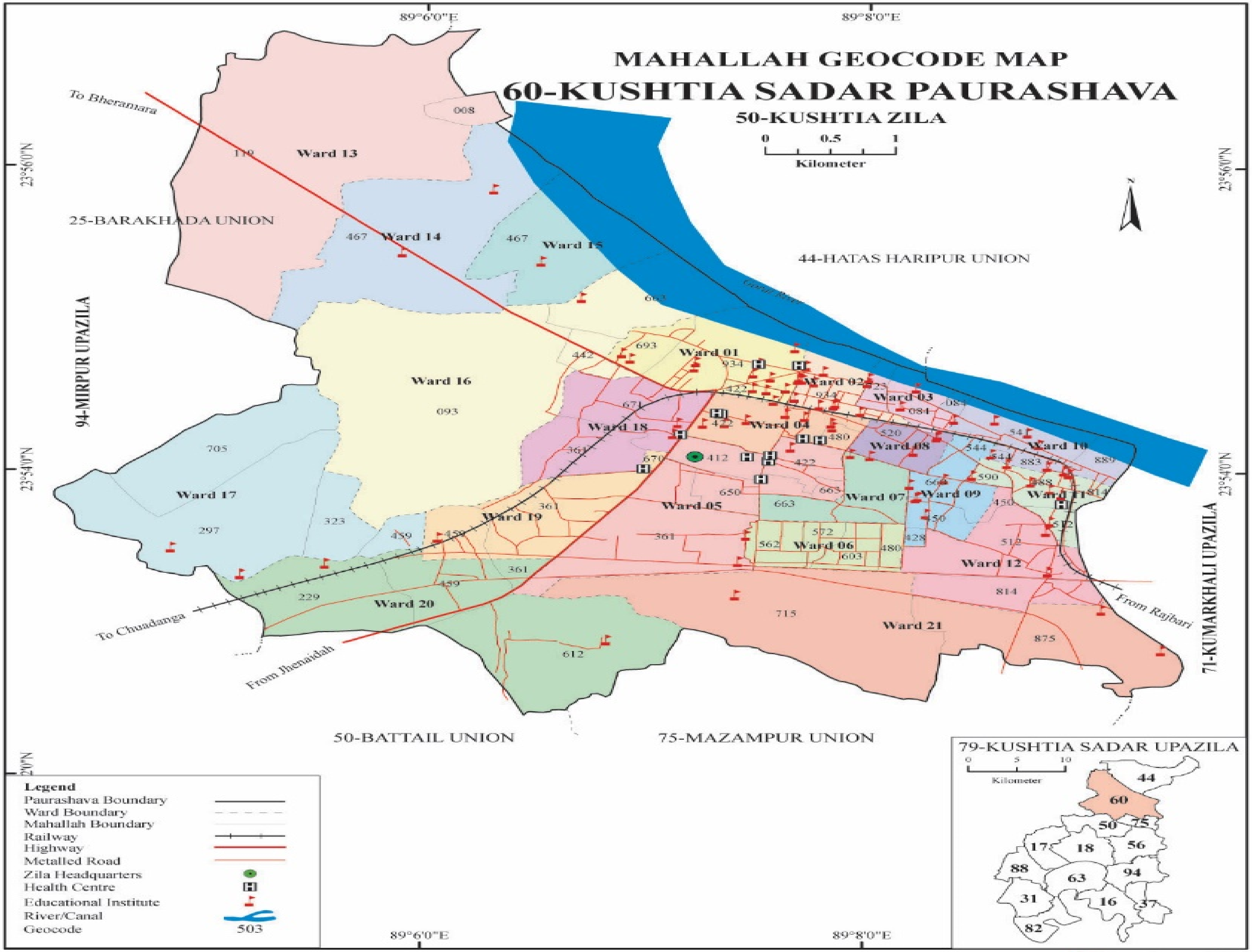
Laboratory for process control

Workshop for experiments

Lessons learnt

- **Own laboratory for experiments and process control**
- **R & D model: biogas to bio-methane, bio-ethanol, biochar, etc.**
- **Research model – many by-products, many problems need to be handled.**

FAECAL SLUDGE TREATMENT PLANT AND MANAGEMENT GUIDELINE FOR KUSHTIA PAURASHAVA (MUNICIPALITY) , BANGLADESH



GIS Project, BBS 2016

Content

1. Estimation of generated sludge volume
2. Sludge characterisation
3. Suitable treatment and management options

Estimation of generated sludge volume

- 42.79 km^2 of municipal area, divided in 21 Wards
- 375,149 people living in 75,000 households on 33,048 holdings
- 8 Public Toilets within the municipality jurisdiction
- Municipality is providing Septic-Tank/Pit Latrine emptying service through 4 Vacutugs (500, 1000, 2000, 4000 litre), **with 2 drivers**:
  - 50.33% households have septic tank toilets
  - 48.67% have ring slab, or single pit, or twin pit toilets,
  - 1% have no toilet (18.33% are with drains)
- 8-12 l of collectable sludge/household*day (600-900 tones/year)
- 65 tons of municipal solid waste/day

Sources: own observation & interviews

- IRC Wash, BRAC Wash, and BIOSOL ENERGY EUROPE B.V., Sourcing of Vacutug: Experiences from Faecal Sludge Management Programmes in Faridpur and Kushtia, 2015
- SNV, Baseline Study to Access Faecal Sludge Management of Residential Premises in Selected Southern Cities of Bangladesh, 2014
- Waste Concern, Technical Advisory Services for the Implementation of the Community based Composting Project in Bangladesh, 2008

Estimation of generated sludge volume cont..

- Study from Waste Concern presented in ISWA Congress 2015:
  - 7% household clean the septic tank once in 6 months,
  - 17% yearly,
  - 20% every two years, and
  - 6% after 3 years or more.
  - Service charge for pit tank is BDT 355 (new 500) + 15% VAT
  - Service charge for septic tank is BDT 930 (new 800-1200) +VAT
- Size of septic tank: 10 m^3 each (20’X5’X4’), with two chambers
- On average per cleaning 5 m^3 sludge is obtained (taking 50% volume)
- Total average quantity shall be **432 m^3/day at present** and **will be double when all Kushtia households use proper septic tanks**.

Sludge characterisation

- **Septic tanks or pits need to be de-sludged at regular intervals to keep them functional:**
  - Septic tank should be emptied when the solid component reaches one half or two-thirds of the tank.
    - FS from **pits** in Mirpur-Bogra, and Kamrangir Char–Dhaka (2015):
      93.7 - 94.6% water and 5.4 - 6.3% total solid
    - FS from **manual** emptying in five districts of Dhaka (2016):
      1.9–5.7% total solids, 1.7–5.5% suspended solids, BOD:COD ratio: 0.39 – 0.5 FS from **mechanical** emptying in five districts of Dhaka (2016):
      1.2-7.2 % total solid, 1-7 % suspended solids, BOD:COD ratio 0.51 - 0.6

If the BOD/COD ratio for untreated wastewater is 0.5 or greater, the waste is considered to be easily treatable by biological processes. If the ratio is below about 0.3, either the waste may have some toxic components or acclimatised microorganisms may be required for its stabilisation.

Sources:
- World Bank – WSP, Faecal Sludge Management Tools, Case Study in Dhaka, Bangladesh, 2016
- IRC Wash, BRAC Wash, and BIOSOL ENERGY EUROPE B.V., Sourcing of Vacutug: Experiences from Faecal Sludge Management Programmes in Faridpur and Kushtia, 2015

Sludge characterisation

- Always less sludge is collected than produced.
- As excreta decompose they are reduced in volume and mass due to:
  - evaporation of moisture;
  - production of gases which usually escape to the atmosphere;
  - leaching of soluble substances;
  - transport of insoluble material by the surrounding liquids;
  - consolidation (solidification) at the bottom of pits and tanks under the weight of superimposed solids and liquids.

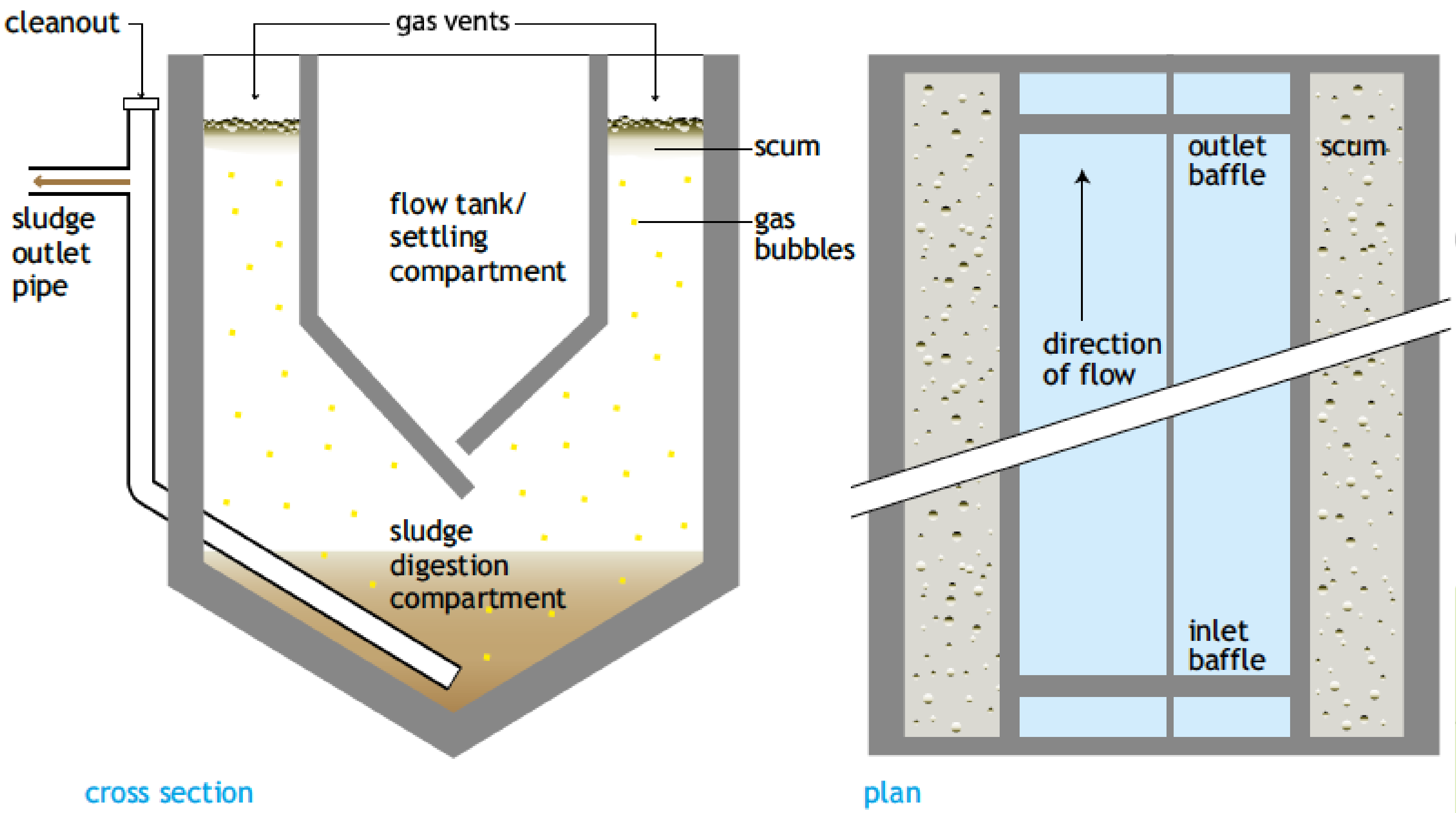
Source: WHO, A Guide to the Development of on-Site Sanitation, 1992

Suitable treatment options

- The major “low-cost” technologies for (I) Solid/liquid separation, (II) Dewatering, (III) Stabilization/further treatment, are:
  1. Settling tanks and sedimentation ponds
  2. Unplanted sludge drying beds
  3. Planted sludge drying beds
  4. (Non-aerated) waste stabilisation ponds (WSPs)
  5. Composting with organic solid waste (“co-composting”)
  6. Anaerobic digestion with biogas use
  7. Omni-processing

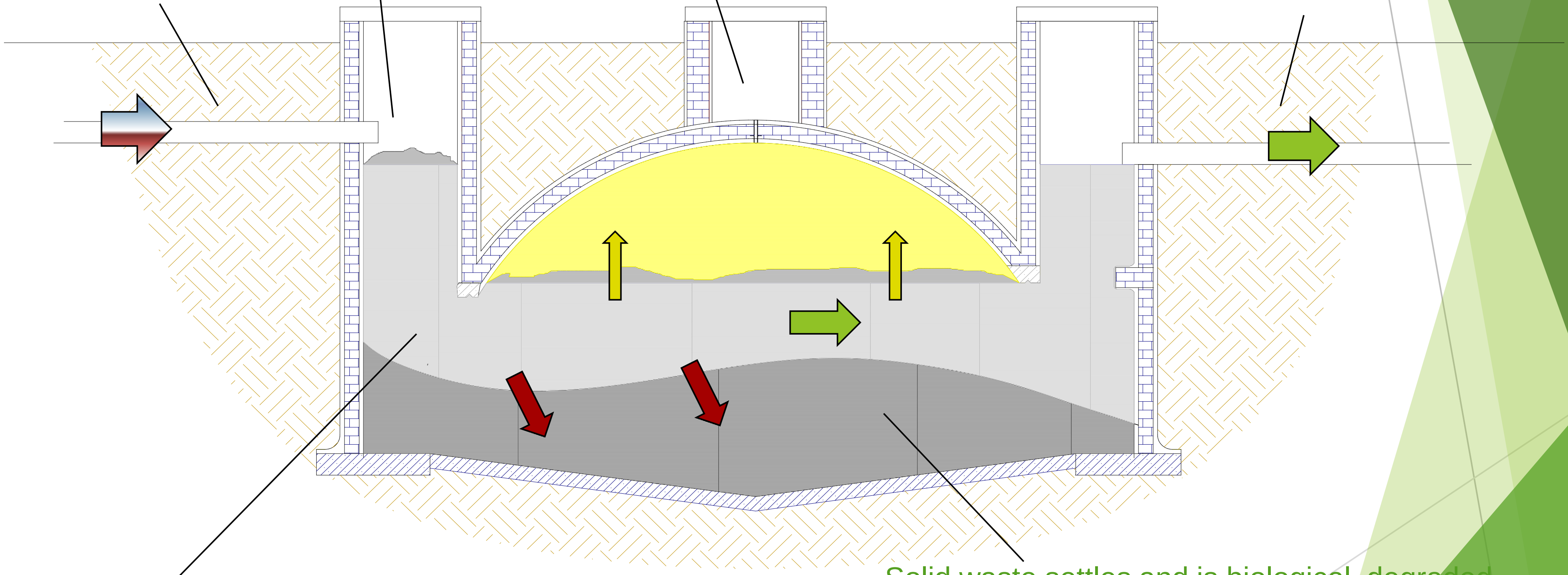
Source: EAWAG & IWA: Faecal Sludge Management Systems Approach for Implementation and Operation, 2014

1.a Imhoff sedimentation tank



Source: EAWAG & IWA: Faecal Sludge Management Systems Approach for Implementation and Operation, 2014

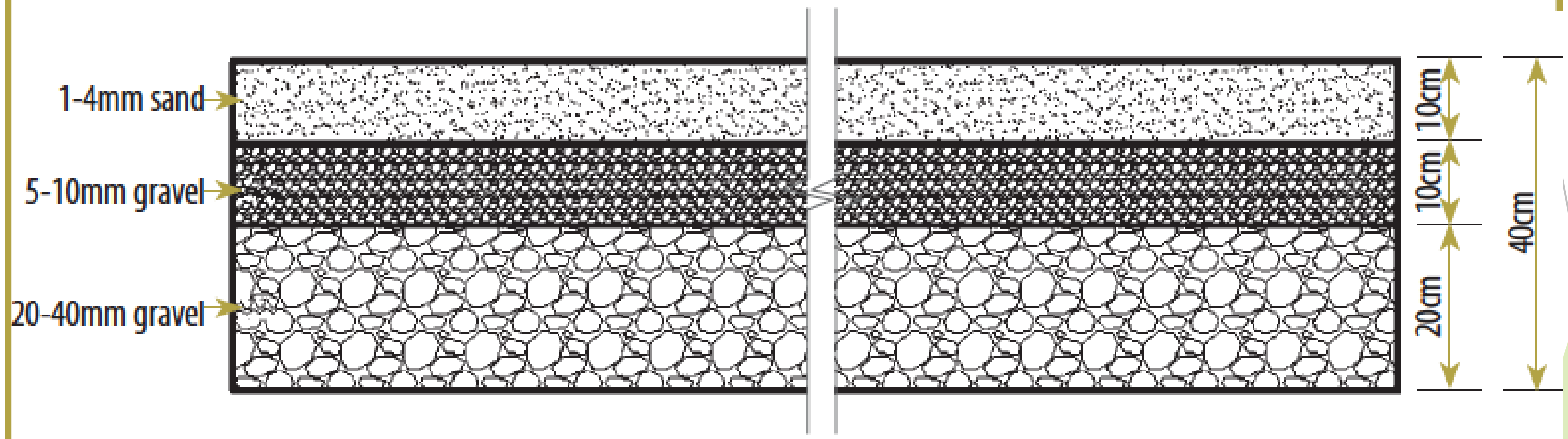
1.b Biogas settler



Findings

- The sludge contains sand, it has therefore to be expected that the settled sludge will be problematic to pump.
- For settling ponds the available land of approximately 12,500 m^2 is too small.

2. Unplanted sludge drying beds



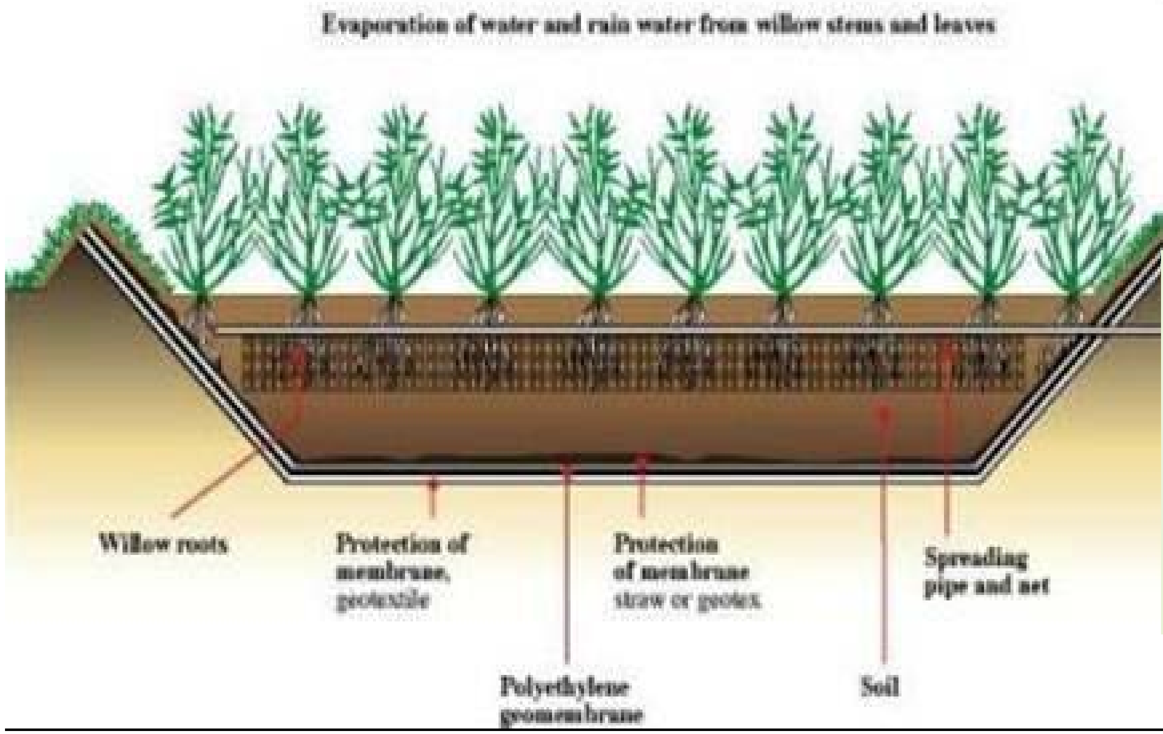
Substrate profile for sludge drying bed FIGURE 22

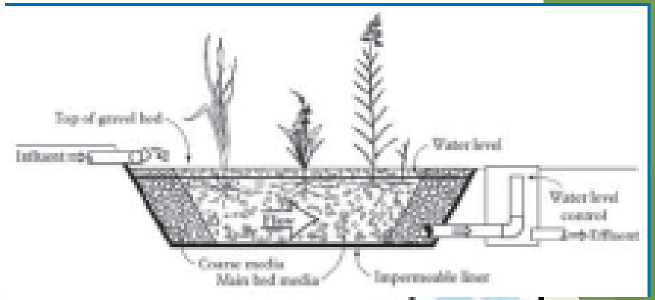
Source: UN-Habitat, CONSTRUCTED WETLANDS MANUAL, 2008

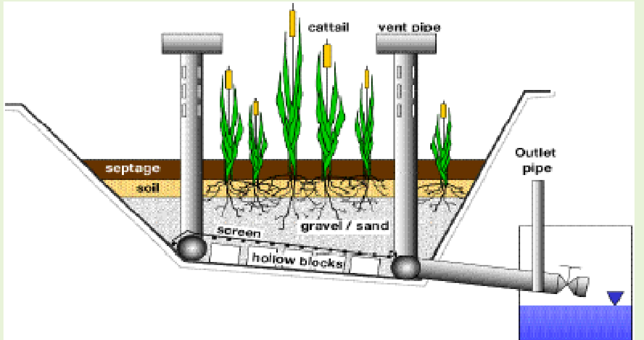
Findings

- It is important that the maintenance of the respective sand filter is made easy.
- Sand will be picked up by the dried slurry and gradually disappear as it could be observed in the pilot beds.
- Soon the gravel will be gone as well.
- The sand beds clog easily and need maintenance in order to cope with the capacity required.

3. Planted sludge drying beds







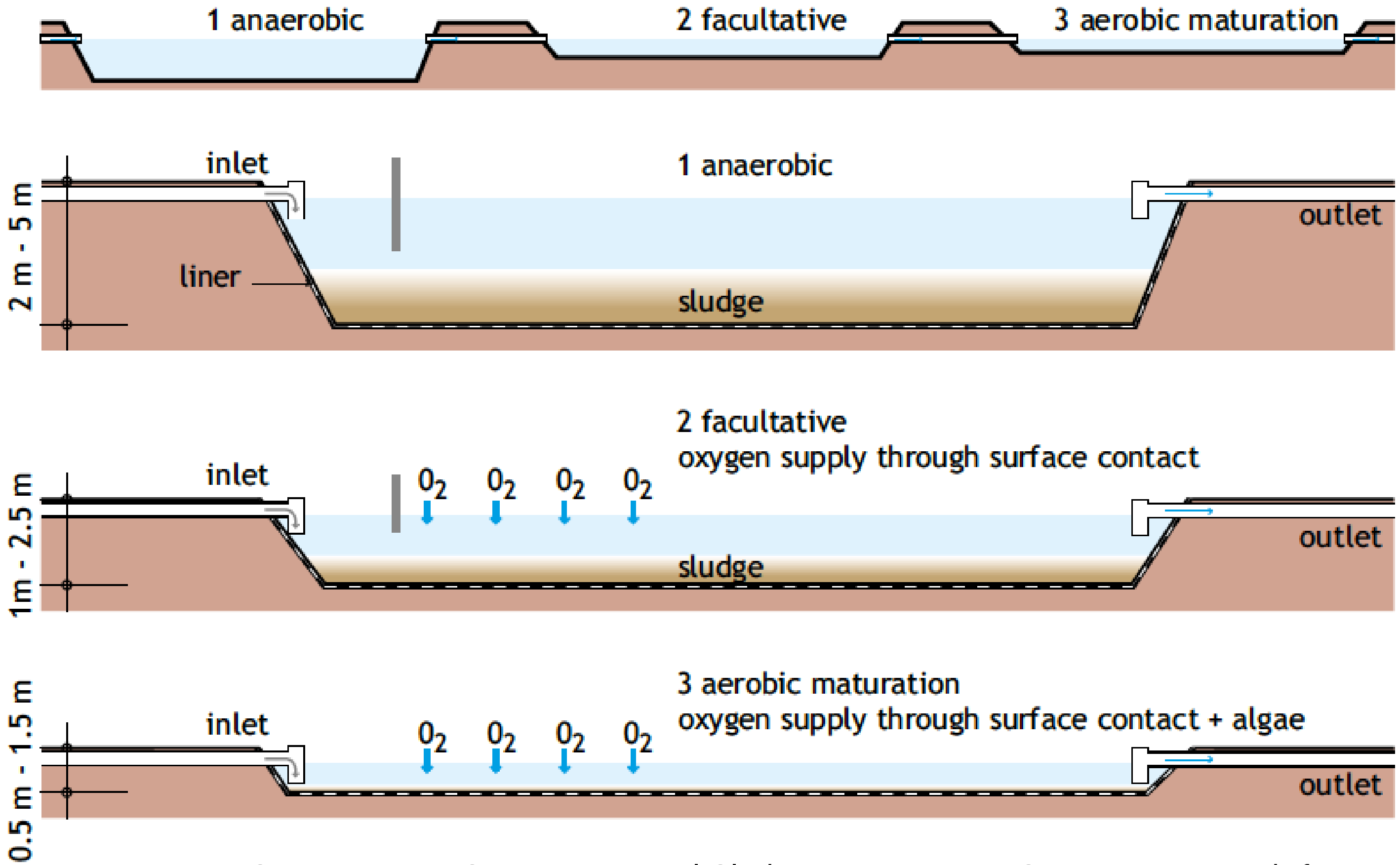
AIT Bangkok, 1997

Source: ACF & USTB-CSES, Suitability of different technology options for grey water and human excreta treatment / disposal units in Ger areas in Ulaanbaatar / Mongolia, 2010

Findings

- This is a method where the dried sludge acts as filter medium plants from gradually higher plant roots are forming the drainage capillary.

4. Design and principles of the three types of waste stabilisation ponds



Source: EAWAG & IWA: Faecal Sludge Management Systems Approach for Implementation and Operation, 2014

Findings

- The respective ponds are shallow so that naturally through wind and air movements the ponds are aerated and do not have much anaerobic zones.
- For the amounts of sludge expected, the area is too small for respective ponds.

5. Combining Faecal Sludge with Organic Waste

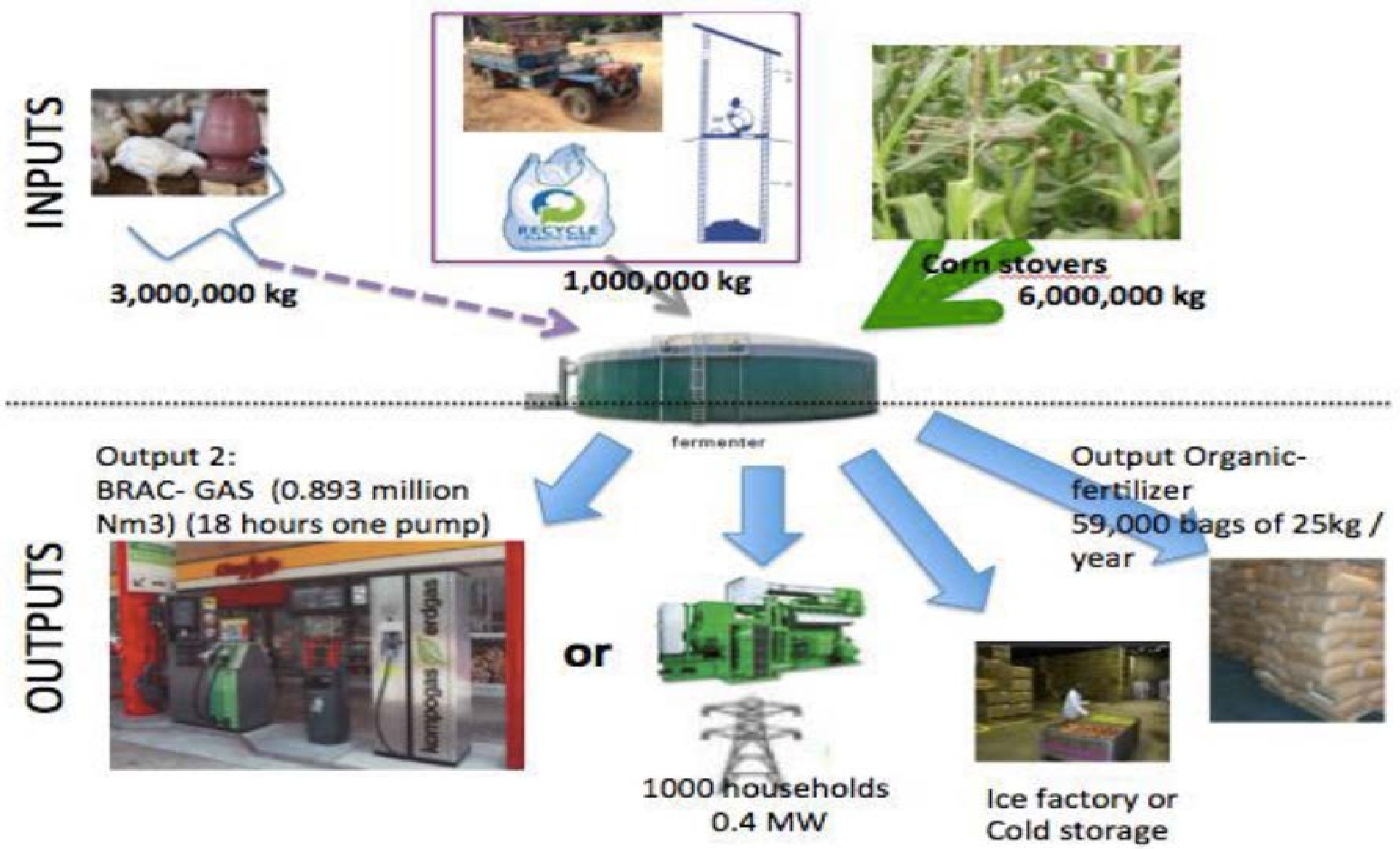
A balanced carbon - nitrogen ratio is relevant in aerobic and anaerobic digestion of faecal sludge. In composting, for example, organic waste from households can be added if the digestion process is hampered by a lack of carbon. Correct compost needs also humidity (between 30-75%), aeration, shredded organic material, temperature control.

Source: Waste Concern, Designing Effective Partnership for Waste to Resource Initiative, 2015

Findings

- This requires sludge drying on drying beds first.
- It is the method piloted at present
- Full capacity in the practical test are not shown, but should be tested with respective test runs.

6. Anaerobic digestion with biogas use



Source: IRC Wash, BRAC Wash, and BIOSOL ENERGY EUROPE B.V., Sourcing of Vacutug: Experiences from Faecal Sludge Management Programmes in Faridpur and Kushtia, 2015

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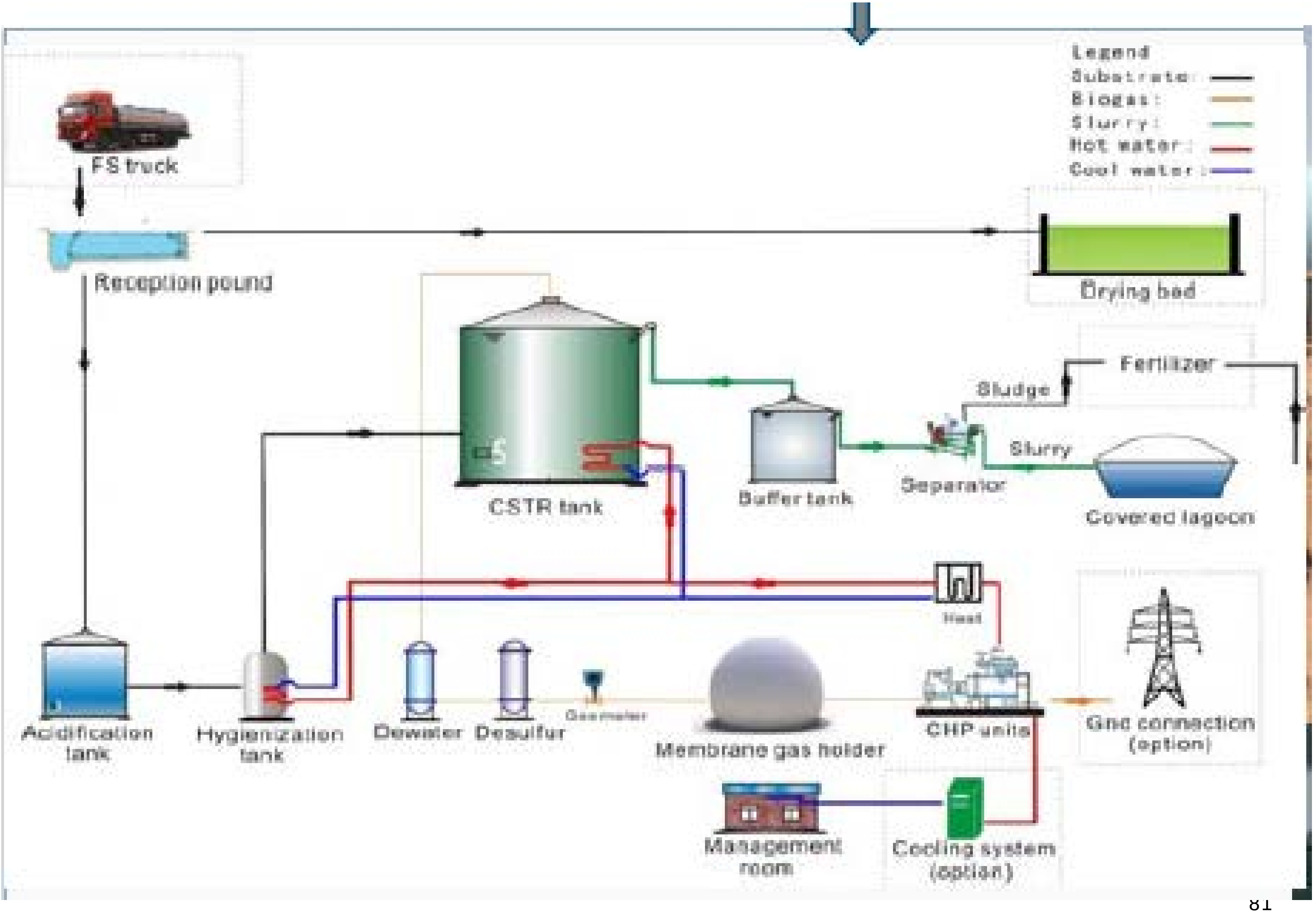
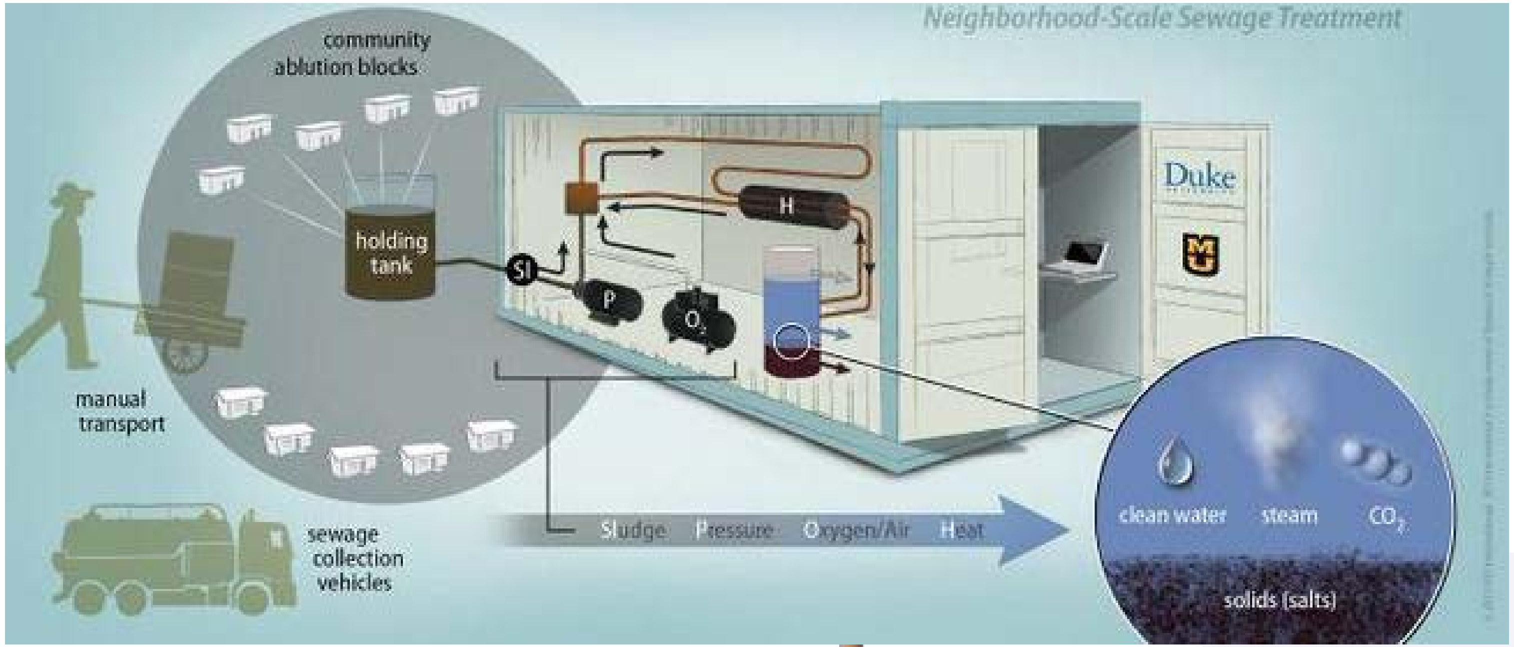


Findings

- The raw sewage would have to undergo through a sand trap first and pasteurization step second.
- After the digestion the solids are reduced by 30%, the digestion follows a liquid-solids separator whereby both fractions need further post treatment (composting).
- Other organic waste as co-ferment favourable.
- 400 t FS/day plus 80t of organic waste/day = result in 1 MW installed electrical capacity (Combined Heat and Power Production)

7. Omni-processing



Duke University

Janicki Industries

Findings

- The raw sewage sludge would have to go through a plastered drying beds, with rain protection roofs.
- 400 t FS/day = 100 kW installed electrical capacity
- Ash as phosphor and potassium fertilizer

THANK YOU VERY MUCH FOR YOUR ATTENTION!

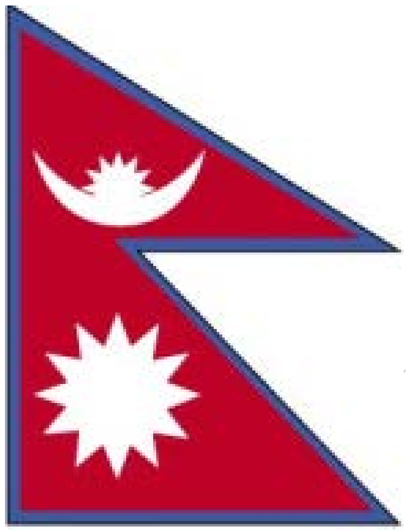


Image courtesy of the CIA World Factbook

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