International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES),(UGC APPROVED)
Impact Factor: 5.22 (SJIF-2017),e-ISSN:2455-2585
"International Conference on Modern Trends in Civil Engineering"(ICMTCE-2019)
(Towards Sustainable Development Goals)
Volume 5, Special Issue 02, Feb.-2019

APPROPRIATE TOILET TECHNOLOGIES FOR DIFFERENT TOPOGRAPHIES AND FAECAL SLUDGE MANAGEMENT IN NON SEWERED AREAS

Anurag Gupta

Programme Coordinator, WaterAid, Chattisgarh, India

Abstract- India has witnessed a massive sanitation drive in the recent years and 97% of the country's villages have attained Open Defecation Free (ODF) status. But the massive number of toilet construction now comes with its own set of challenges. To mention a few, the ODF drive in manyplaces led to construction of toilets not suitable according to the topographical characteristics of the region, for example leach pit toilets were built in high water table and flood prone areas. This in turn pose risk of contamination of water table and other sources of drinking water. There are also issues with the faulty design of the toilets. In many areas large number of people also resorted to the construction of septic tanks. Septic tanks have their own set of second generation problems like desludging, emptying and proper disposal of faecal matter. In the rural areas these are mainly done manually.

This papers presents the various models of toilets suitable for different kind of topographies- hard rock areas, high water table areas, flood prone areas. It also talks about the technical solutions for problem of septic tank based toilets- faecal sludge management. Papers explains details of interventions, relevance, scalability and challenges. It shares about models used by WaterAid India in their project areas.

Keywords: Appropriate toilet technologies, high water-table areas, hard-rock areas, flood prone areas, retrofitting of toilet, Faecal Sludge Management (FSM)

INTRODUCTION

The Swachh Bharat Mission has shown an overwhelming success, in terms of making toilets available at household level. In the last four years, about 4.5 lakh villages (close to 76 per cent of India's villages) have been declared Open Defecation Free (ODF); only 47,000 villages were ODF at the beginning of the mission. Around 83.8 million toilets have been built so far under the mission.Some 13 million households remained to be covered. If the rate at which toilets were constructed in 2017-18 (30 million toilets were built this year) is still maintained, India would become ODF by February 2019, at least in terms of building a toilet for each household.

This brings us to the next big challenge, how would India dispose the faecal sludge generated out of the new toilets? This is where use of right toilet technology comes into critical scrutiny. Usage of toilets may not be sustainable as people are using wrong technologies. The popular toilet technologies for managing the faecal matter from toilets areleach pit and septic tank. Without the right toilet this faecal matter would be dumped close to our habitation and would affect the soil and the sources of water. If the poorly-designed toilets are in ahigh water table or flood prone area, the stored faeces pose a major pollution and health hazard during the monsoons. Further, the high density of pit latrines and poorly made and maintained septic tanks can render the shallow aquifer water unfit for drinking because of microbial and chemical contamination.

A recent study by WaterAid India found that despite the promotion of twin-pit toilets by MDWS, there seemed to be high preference of septic tank toilets by the beneficiaries. Out of 1,000 households which were surveyed in the study 24 per cent preferred septic tanks. But the problem is that what people call septic tanks are not according to the Bureau of Indian Standards and thus this will surely lead to contamination of soil and water in the long run.

Areas with shallow ground water and areas prone to flooding present the greatest risks, because vertical separation is required between the base of latrine pits and the saturated zone.The ability to make informed decisions about water and sanitation options is largely inhibited by a scarcity of data, especially regarding the influence of environmental conditions on potential contamination. Although guidelines are available for site-specific assessment, and general procedures for siting latrines with respect to water points, however, generally these are not given attention during toilet construction drives.

Promotion of appropriate toilet technologies for solving sanitation related problems

This papers presents the various models of toilets,promoted by WaterAid India, suitable for different kind of topographies- hard rock areas and high water table areas in its project areas. It also talks about the technical solutions for second generation problem of septic tank based toilets- faecal sludge management and solution to flood prone areas. Papers explains details of interventions, relevance, scalability and challenges. Alternate toilet technologies and key interventions of WaterAid India has been as follows:

1. Promotion of EcoSan Toilet

About the technology-

EcoSan is a urine diversion dry composting toilet which uses less water and its manure and the collected urine can be used in the farms. It can provide sanitation in extreme areas like in desert and water scarce areas, where water scarcity necessitates frugal use of water; in rocky areas, where it is not possible to dig pits; in coastal/flood prone areas and areas with very high water tables; in earthquake prone zones, as there is danger of faecal matter leaking through cracked sewer lines or pits and contaminating ground water. Entire structure is constructed above the ground including faecal matter containment tanks.

Where-

Kanker and Korba districts in Chhattisgarh.

Relevance-

As an alternative to leach pit toilet in high water table areas and hard rock areas.

Challenges/ cautions-

- Conventional pour flush toilet is most preferred by people;
- Intensive follow-up is required for usage , which is very difficult for district administration due to limited human resource
- Cost of EcoSan toilet is higher as compared to twin leach pit toilet

Scalability-

WaterAid India promotedEcoSan toilets and have been successful in convincing the community and the district administration in adopting them. Demonstrations of EcoSan toilets, short films, pamphlets and wall murals on benefits and usage of EcoSan toilets were done for the purpose of Information Education Communication. Training of masons and engineers of Rural Development Department were carried out in Korba and Kanker.

Over 140 toilets have been constructed in 14 panchayats in Korba and Kanker district having high water table or hard rock terrain.In Kanker, District Administration had providedadditional incentive from District Mineral foundation (DMF) to cover the extra cost incurred on construction on EcoSan toilets.

EcoSan Toilets (#2) in Sonpur Village in Kanker

Squatting pan of a EcoSan Toilet

Wall Mural on community awareness on ecosan

Manure being taken out from one tank after 18 month

Urine collected from EcoSan toilets being used in Banana plantation as fertilizer

2. Promotion of Bio Toilet

About the technology

Bio-toilets are constructed with a multi-chambered bio-tank for the storage of waste (excreta). The waste is slowed down as it flows from one chamber to another by a special process in the bio-tank, such that the multi-strain bio-media present in the tank can digest the waste and convert it fully into non-toxic neutral water and methane gas.

Where-

In hard rock areas of Kanker and Raigarh district

Relevance-

- Alternative for septic tank. These are maintenance free, there is no need to de-sludge bio-digesters.
- Bio-toilets are suitable for hard rock, high water table and flood prone areas
- It is a good option for retrofitting of septic tank based toilets

Challenges/ cautions-

- availability of bio-media (bacteria inoculum) is difficult at local level
- Cost is higher than leach pit toilet
- technical cadre and masons are not oriented about the technology

Scalability-

- WaterAid India provided technical support to district administration in Kanker for construction of in-situ bio-digesters. 45 household bio toilets were constructed in 2 panchayats having hardrock terrain. Later Raigarh district also adopted bio-toilet for hard rock areas. More than 200 household bio toilets have been constructed in Raigarh under Swachh Bharat Mission. The additional cost for construction of bio-toilets had been provisioned from District Mineral Foundation.

Bio-Toilet (#4) in Pandaripani Village in Kanker

Bio-toilet under construction in Raigarh (note- it is constructed in hard rock terrain therefore entire tank is constructed above ground)

On site training of masons on construction of bio-toilet

Innner view of bio-digester tank

3. Promotion of Evapotranspiration Toilet

About the technology-

The Evapotranspiration toilet has been recently added in the list of appropriate toilet technologies by the Ministry of Drinking Water and Sanitation. The evapotranspiration toilet was developed and popularised more than two decades ago by permaculture practitioners in different countries, especially in US and Brazil. In India, it has been successfully tried in Raibareli district of Uttar Pradesh by an independent researcher, for

constructing household toilets. Old tyres are used as the main component for the faecal digester tank of this toilet. The toilet tank comprises of a layer of broken bricks, tyre, stones, sand and soil. The tyres are arranged in a trench forming a tunnel. On the top, broad leaf plants like Banana and Cana are planted. The toilet is based on the principle that Anaerobic digestion converts a portion of the human excreta into biogas, which leaves from the front and back-stand pipes. The digested waste travels up and out the substructure through capillary action. The nutrients leave the system by becoming part of the plants' biomass through mineralisation and absorption by the plants' roots. Evapotranspiration removes the liquid, either transpiring through the plants or evaporating at the surface from the soil.

Where-

WaterAid India has demonstrated this technology in Kanker, Kumhari (Chhattisgarh) and in Nashik (Maharashtra). WaterAid used this technology for retrofitting of septic tank based hostel toilets, community toilets and household toilets.

Relevance-

This technology has huge potential for retrofitting of septic tank based toilets. This is a self-maintaining, low cost technology in which desludging is required. Scrape tyres are also put into good use. It is very easy to install and it has added aesthetic value due to Banana and Cana plants.

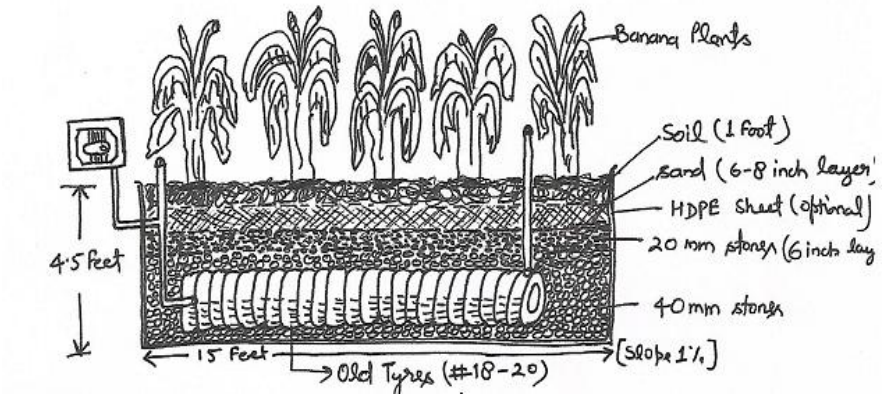
Challenges/ cautions-

The Evapotranspiration toilet technology is not suitable for flood prone and high water table areas.

Scalability-

It has huge potential for scaling up. In WaterAid projects, this technology is at the demonstration stage.

Stages of installation of Evapotranspiration faecal digester (Place- Sarona Ashramshala in Kanker)



Schematic diagram of Evapotranspiration Faecal digester (size suitable for upto 20 toilet users per day)

4. Design modification in flood prone areas*

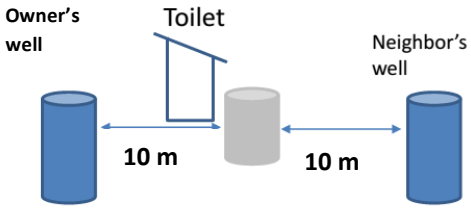
Place of toilet, flood level and groundwater levels are the key factors which must be taken into account while constructing toilet in flood prone areas. Awareness of the people on appropriate toilet design and technology is also important. Following steps are essential for constructing a toilet in such areas for protection of ground water source and for uninterrupted functionality of toilets:

STEP 1. CHOOSE THE BEST PLACE FOR THE TOILET

1) It is very important that the liquid from the pit does not move through the soil into any water sources.

2) Choose a location for the latrine that is at least 10 m (*in case of pour flush toilet and 20 m in case of flush toilet*) away from the family's well/bore well and the neighbours' wells/bore wells.

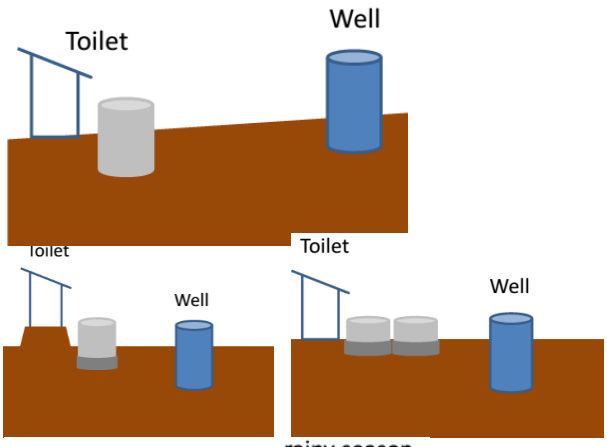
3) For uneven areas, build the toilet in an area lower than any wells



If there is not enough space to place the toilet 10 m away

1) Seal the pit above and below ground so that it does not leak into the soil; build a raised shelter, or make a series of pits. The pit will need to be emptied more often because it's sealed

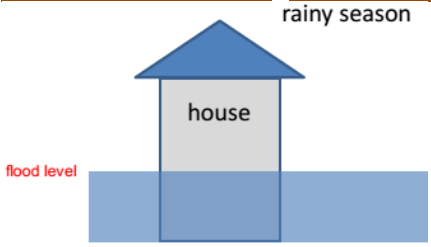
2) Remind the household to take extra precautions with well water; treat properly or find alternate sources

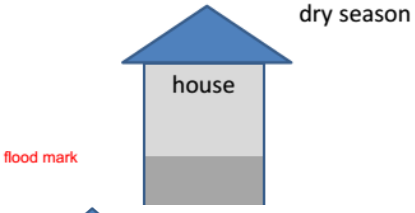


STEP 2: FLOOD LEVEL

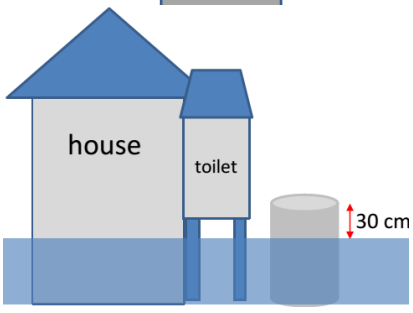
How high is the flood?

1. Ask the house owner about the typical flood level.
2. Check marks on buildings.





1. The cover of the pit must be at least 30 cm above flood mark
2. Suggest to the household that they attach the toilet to the house so that it is easy to get to during flooding



Based on flood level, how high does the toilet need to be?

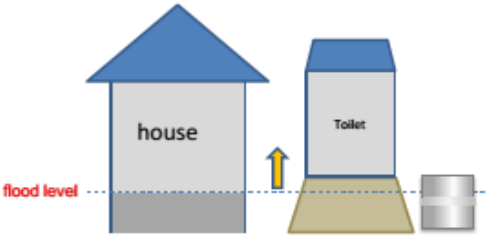
a. If less than 1 m, you can build up the soil to have the toilet above the flood level.

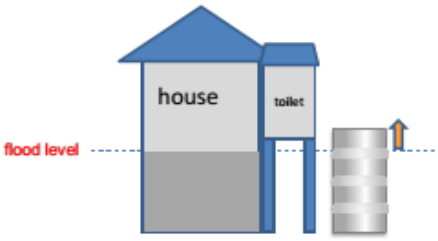
b. If higher than 1 m, you will need to put the toilet in the house or use stilts of concrete, bricks, or strong wood to raise the toilet.

Also important:

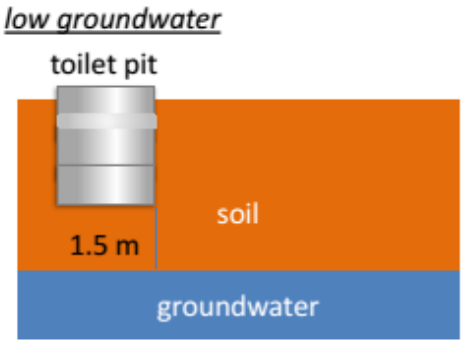
a. Seal the rings above ground very carefully

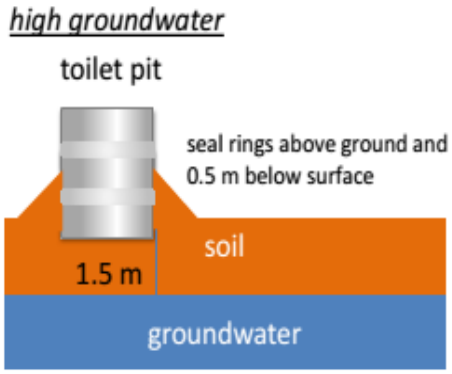
b. Having more than six rings on top of each other is not recommended

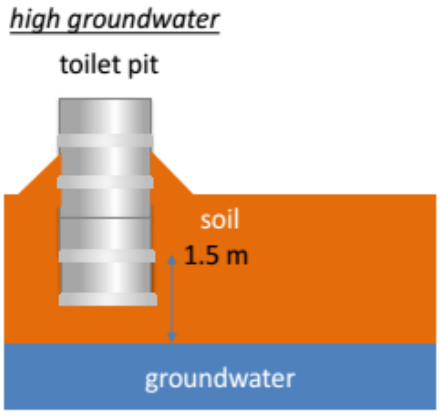




STEP 3: GROUNDWATER LEVEL
1. Ask the household how the water level changes in the rainy and dry season
2. Check the level of groundwater by looking in a well; if it is the dry season, remember the water will be higher when it rains
3. The bottom ring of the pit should be 1.5 m above the highest level of groundwater during rainy season to protect the water
4. All rings above ground must be sealed carefully





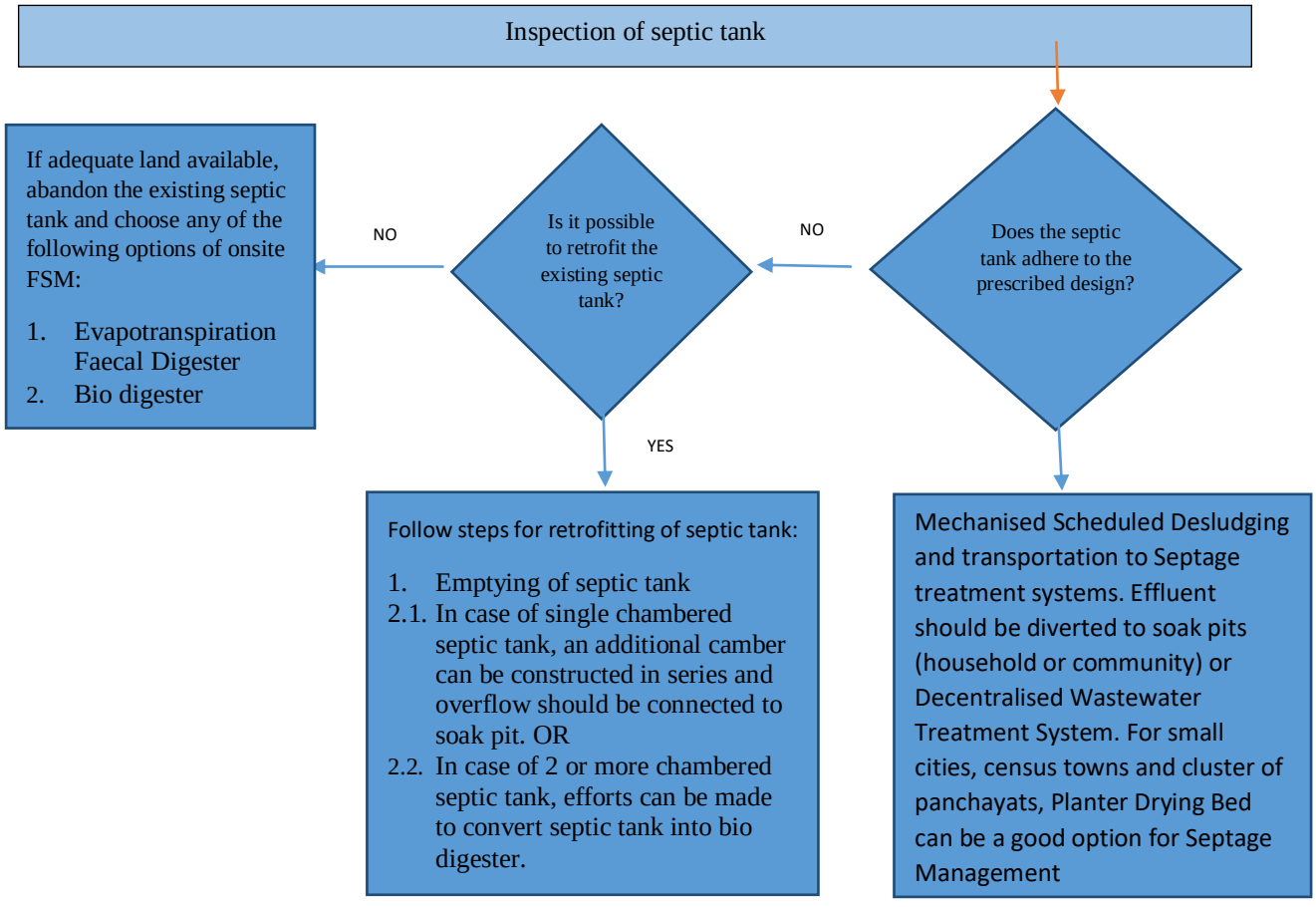


Source: Guide for Masons, EWB, https://www.ewb.org.au

5. Criteria for selection of appropriate toilet technology in different context

Options	Ground water table is shallow (less than 10 m)	Ground water table is deep (more than 10 m)	Soil strata-permeable (sandy, silty etc.)	Soil strata-low permeability (rock, clay etc.)	Preferred toilet technology
Option 1	√		√		Bio Toilet, EcoSan, Septic Tank
Option 2	√			√	Same as above
Option 3		√		√	Same as above
Option 4		√	√		Twin pit toilets (in case of pour flush), Evapotranspiration toilet,Bio toilet, Septic Tank, EcoSan

6. Flow chart for Faecal Sludge Management options for septic tank



RECOMMENDATIONS

There is a need of immediate modification of the single-pit and defective septic tanks. The single pit toilets can be retrofitted and converted to twin pits. On the basis of these intervention following are the recommendations:

1. In those areas where toilet construction is going on, toilets should be constructed strictly according to the topography of the area.
2. Technical survey of the toilets should be made mandatory where ODF have been either declared or in the process.
3. In the areas where toilets have been constructed but do not suit the topography of the area, there retrofitting of the toilets have to be according to the topography.
4. For retrofitting, it is more important to study the substructure of the existing toilet rather than the super structure.There will not be any universal approach for retrofitting of the toilets, each toilet has to be studied individually for this.
5. Since the process of retrofitting will require technical skilled persons and has to be done individually for each toilet, the process is going to be cost intensive and hence policy regarding this need to be formulated under national programme.

REFERENCES

1. Quality and sustainability of toilets, A rapid assessment of technologies under Swachh Bharat Mission - Gramin October 2017, WaterAid India
2. How to construct good latrines in areas with flooding and high ground water: guide for experienced and new masons; EWB 1010-2015-V1.1E; sceproject@ewb.org.au; STANDARDS EWB-A
3. Septage Management, A Practitioner's Guide, Centre for Science and Environment, 2017
4. How to Make an Evapotranspiration Toilet (with Pictures) – WikiHow; https://www.wikihow.com/Make-an-Evapotranspiration-Toilet