

Toilet Revolution: Solving India's sanitation problem

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UNICEF reports that close to 600 million people in India defecate in the open. "India leads the world in open defecation. This crisis contributes to disease, childhood malnutrition, loss of economic output and, as highlighted recently, violence against women," said Mr Vinoth Rayar, founder and president, Fresh rooms Lifesciences.

The government spends quite a huge amount on rectifying ailments resulting from improper sanitation. With PM's "Swachh Bharat Abhiyan" and "Reinvent the Toilet Challenge (RTTC)" jointly conducted by DBT, BIRAC, and Bill & Melinda Gates foundation, India is addressing its neglected public sanitation problem.

We take a look at the innovative approaches and technologies that can lead to radical and sustainable improvement in sanitation in India.

The Challenges

Creating sanitary infrastructure and public services that work and keep waste out of the environment is a major challenge. Lack of awareness about the importance of a household toilet is also a roadblock. The absence of a toilet necessitates open defecation in rural areas and in outlying and neglected urban areas.

Unclean and deserted toilets pose another risk. "Our key learnings and findings based on our 6 plus years' of experience in this sector, reveal the underlying challenges associated with poor, unclean and improperly maintained toilets in the country. Toilets are sufficient in numbers but the number found to be in proper, hygienic and functioning conditions are scarce,

subsequently scaling up the demand for constructing new toilets," said Mr Anvar Sadath, CEO, Eram Scientific Solutions (ESS).

"One of the major problems and associated costs involved with sanitation or toilet technology is the safe disposal of human waste. In a majority of cases, waste is discharged into large water bodies which subsequently results in the spread of enteric infections, which cause diarrhea, cholera and others resulting causing a huge health burden in developing countries. Although convenient physicochemical methods of disinfection can be applied, these technologies are not in the affordable range for developing or poorer nations," said Dr Sanjay Pal, assistant professor at the School of Biotechnology, Amrita University.

Solving the sanitation challenge in the developing world requires radical new innovations that are deployable on a large scale. "The most critical issue that the sanitation sector faces is the lack of systems-based thinking. We need to go beyond simply providing a toilet," opined Mr Rayar.

Solving the sanitation problem

1. Empowered Septic Tank (EST)

Sustainable Biosolutions LLP, a BITS Goa incubated startup has proposed an Empowered Septic Tank (EST). "The objective is to construct an EST. The system is based on Bio-electrolysis of wastewater which will exhibit an activated biogas (H₂+CH₄) production combined with a higher retention of ammonium which could be potential fertilizer. The effluent of the EST thus will have a lower load in COD and a lower odor. The prototype will be available within the next two years," said Dr Srikanth Mutnuri, associate professor, BITS Goa campus and technical collaborator for Sustainable Biosolutions.

The project which is funded by DBT, BIRAC and Bill & Mellinda Gates foundation is in collaboration with Ghent University, Belgium and BITS, Goa campus.

2. Black Soldier Fly Larvae (BSFL)

Indian Institute of Technology Roorkee (IIT-R) in collaboration with Fresh rooms Life Sciences are working on developing a single household container that will cultivate Black Soldier Fly larvae, using human faeces, which can be processed into valuable products. The project will also demonstrate the market potential for these products. This is a proof of concept grant.

Mr Rayar elaborated, "Fresh rooms lifesciences in association with IIT-R is developing an eco-friendly sanitation solution that exploits the natural capabilities of the Black Soldier Fly Larvae (BSFL), to efficiently process organic waste and ends, ideally, with safe usable commercial byproducts such as animal feed, biodiesel, and fertilizer. Our fundamental principle in the technology is that we visualize human excreta and wastewaters as not waste, but a valuable commercial resource that can be reused and recycled."

He further added, "Our vision is to make human excreta a profitable nutrient-rich raw material from which we are able to industrially collect waste and produce a high protein BSFL meal (a fish meal alternative) on a larger scale."

3. Bacteriophage therapy

Bacteriophage therapy against bacterial infections is a technology that has been applied and adopted by Russia and Eastern Europe over the past several decades. "This is now being explored with a new perspective to combat the threat of 'superbugs' which are resistant to a wide range of antibiotics. Hence, as a project initiated by two senior faculty members at the Amrita School of Biotechnology, Drs Sanjay Pal and Ajith Madhavan, we took up the idea of solving improper sanitation associated health risks by developing lytic agents /viruses against human enteric pathogens and parasites," said Dr Pal.

The project is selected for the DBT-BIRAC-BMGF Grand Challenge Award, the work being carried out is well on its way to establishing the Proof-of- Concept.

According to Dr Pal, preliminary results have shown very encouraging results with up to 90 percent reduction in microbial flora from sewage. Strategies to tackle helminth and protozoa pathogens are also being designed.

"The impetus for us to pursue this work on affordable and effective solutions to the sanitation needs in India," mentioned Dr Pal.

4. Water-free toilet

Scientists at the Institute of Chemical Technology, Mumbai (ICT) are evaluating the concept of using fine sand-like material and an air blower to create a water-free toilet interface that is free from odour and flies.

"In the project, we propose a toilet that requires no water for flushing and is self-cleaning, therefore it can also decrease the spread of diseases. Toilet uses an unique mechanism to convey faecal matter away from the user replacing traditional water

based mechanism, The quantity of faecal matter is in the order of 500g and almost 5-10 litres of water is used for flushing greatly increasing the volume of waste to be treated. The toilet mechanism we propose has potential to greatly decrease the amount of waste to be treated further reducing costs. The mechanism is such that the user is always presented with a clean interface, removing another hindrance to the use of the toilets. There is immediate isolation of human waste from flies and other vectors and surface waters, and there is no need of plumbing infrastructure; hence can implement on a mass scale in poorly serviced urban communities," said Dr Parag R Nemade, UGC Assistant Professor in Engineering Science, Department of Chemical Engineering and Department of Oils, Oleo chemicals and Surfactant Technology, ICT, Mumbai. The approximate targeted cost per use is < 20 paise. The concept is the winner of RTTC challenge.

5. Ultrasound for sanitation

Bangalore-based Pradin technologies has come up with a concept of using ultra-sound to reduce water usage in a toilet. It will also test the ability to enhance the settling of faecal particles in a storage tank using ultra-sound.

"In phase-1 we are focusing on reducing wash water use & accelerating the settling time of waste by the use of ultrasound in the new toilet seat design & the waste settling tank. This is a proof of concept experiment to freeze on the process parameters. . The use of ultrasound is brought to converge in this application maybe for the first time. There will be few iterations before we deem it ready for commercial use. The system has to be finally a self-sustaining one without connections to the grid or the main sewerage lines," said Dr Dinesh Bindiganavale, founder director at Pradin technologies.

The project is in the beginning stage of the concept and the researchers believe they will get promising results by end 2015. The project is funded by DBT, BIRAC and Bill &Melinda Gates foundation.

6. EToilets

ESS has developed an eToilet (Patent Pending). These are built of Stainless Steel or Mild Steel enclosures and have electronic systems for enhancing user experience and for tracking the health status of eToilets. EToilets have automated access control systems, sensor enabled water minimization, and self-washing and floor wash mechanisms. These eToilets have simple user interfaces and has integrated a comprehensive maintenance plan which ensures that the eToilets are clean and hygienic for every user. The eToilet has a facility of pre-flushing before entering, automatic flushing once usage is done, in-built water tanks, sensors for water and electricity conservation, automatic platform cleaning and power back-up with coin operated entry. Keeping in mind individual needs these toilets are programmed to flush 1.5 litres of water after three minutes of usage or 4.5 litres if usage is longer. The performance status of the units can also be monitored via web using GPRS connectivity of the units.

Solar powered toilets: In addition to these, ESS has also introduced solar powered, self-cleaning eToilet, with inbuilt solar panel and metallic platform for schools. The model called e-Lite14 eToilet for schools has automated self-cleaning and washing mechanisms and automatic floor wash system, automatic ceiling light, in-built sensors to conserve electricity and water and an overhead water tank. The company has installed 600+ of these toilets in more than 13 states in India covering whole of Kerala, Tamil Nadu, Karnataka, New Delhi, Himachal Pradesh, Nagpur, Haryana, etc.

"These eToilet has been recognized by over 34 + National and international awards. Eram has also been awarded the World's Most Innovative Companies- India List 2014 by US-based Fast Company's Annual Most Innovative Companies issue," said Mr Sadath. ESS is also the recipient of RTTC grant.

7. Biodigester

DRDO has developed Biodigester technology for resolving the problems of un-decomposed human waste. The innovation degrades and converts the human waste into usable water and gasses in an eco-friendly manner. The generated gas can be utilized for energy/ cooking and water for irrigation purposes. The process involves the bacteria which feed upon the faecal matter inside the tank, through anaerobic process which finally degrades the matter and releases methane gas that can be used for cooking, along with the treated water. The Bio-digester tank can be manufactured and customised as per the requirement.

DRDO has installed these bio-toilets for army in high altitude locations. Under a Memorandum of Understanding (MoU) with Railways, it planned to install these biodigester in all trains in the years to come. DRDO has contributed this technology to "Swach Bharat Abhiyan".

Organizations supporting sanitation

Sulabh foundation has developed an environmental friendly two-pit, pour-flush compost toilet known as Sulabh Shauchalaya which is affordable and does not require scavengers to clean the pits. The toilet has been implemented in more than 1.2 million houses all over India, according to the company website.

Wockhardt foundation has launched "bio toilet programs" and installed these toilets at various places like one in Bharat Nagar (Bandra-East), Mumbai.

RICE is a nonprofit research organization which initiate and build relationships with policy makers to advocate policy goals and report research findings related to child health including links with sanitation, nutrition, and maternal health; contribute to the design and execution of research and policy advocacy projects.

These evolving technologies thus can play a pivotal role in the area of sanitation and can help overcome the issue of open defecation, which is rampant in India.