Source Separation - New Toilets for Indian Slums

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Abstract
A new toilet center has been constructed in a slum in Bangalore/India, which allows separated collection of urine and feces. Urine is used directly as a fertilizer on an agricultural education campus. The feces are professionally composted. The compost is used to grow medical plants on the campus as well as for banana production. A new sustainable development concept is being tested here, one which tackles the problems of sewage water and feces and creates an opportunity for one aspect of slum development: The income generated by the project (users fee, compost, bananas) can cover 50 % and more of the running cost of the toilet centers.

New Toilets for Indian Slums

Context

Rajendra Nagar is a large slum with inhabitants belonging to different caste, religion and race. The majority of households in the Rajendra Nagar Slum do not have their own toilet, and have access to only one functioning communal toilet. The establishment of numerous compost toilet centers is considered to be of a matter very great urgency. The lack of toilets is only one indication of the appalling living conditions for many thousands of slum residents, particularly women. They have so far been forced to defecate in the open field before dawn or after dusk. Sexual harassment and rape has been an associated problem. These toilets are aimed to bring about considerable improvement in such conditions for women and children.

Apart from addressing the plight of women, the project also deals with the cultural and religious context of India in which the handling of feces is a stigma. People who handle feces, in particular those who are “scavengers” and earn their low income through sewage-disposal are condemned to the lowest level of social ranking. This project aims to initiate a process of changing attitudes. Specially designed toilets, a carefully devised logistical system for the transport of the feces, as well as thorough composting (which minimizes handling of feces) serves to demonstrate that the handling of feces can be conducted professionally yet simply and cost effectively and need not be a social stigma. On the other hand, it can become an innovative income potential for the slum residents. The project therefore contributes to fighting scavenger’s discrimination.

Project Objectives

- Improving living conditions: establish toilet centers to improve living conditions in the slum and to minimize the risk of disease spreading during monsoon flood periods.
- Scavengers discrimination: The project shall open now income perspectives and generate a better social status for the scavengers community.
- Integrating feces and urine into its appropriate environmental perspective: When feces and urine are accepted to contain valuable nutrients which are otherwise lost, they will be seen to be integral to soil enrichment and a valuable part of the nutrient-chain.
- Compost and fertilizer production: collecting urine and feces (by using urine separation toilets) for the production of compost and fertilizer.
- Generating income for slum development: the compost and urine can be used in agriculture (mainly for non-food production but research into food production is also to be conducted). The income will be used for paying the running costs of the systems.
- Integrating slum dwellers and self-responsibility: the slum dwellers will be instructed to operate the toilet systems themselves. Representatives of the slum shall be involved in the project. The project will maintain an emphasis on women and children, but total participation from the whole community will be sought to ensure success of the program.
- Changing values in a long-term perspective: in the cultural context of India handling feces is a social and cultural taboo. Since the sanitary problem is considered to be key problems of low-income settlement, solutions to solve these problems are urgently required. Resolving a cultural stigma is the key to solve this problem and therefore a long-term goal of this project.

Finding an appropriate Solution

The following figure 1 shows the procedure of the participatory decision-making process carried out together with representatives of the slum population. Based on a need - demand evaluation as well as on considering economical and ecological aspects the decision was made to establish a toilet center with source separation toilets:

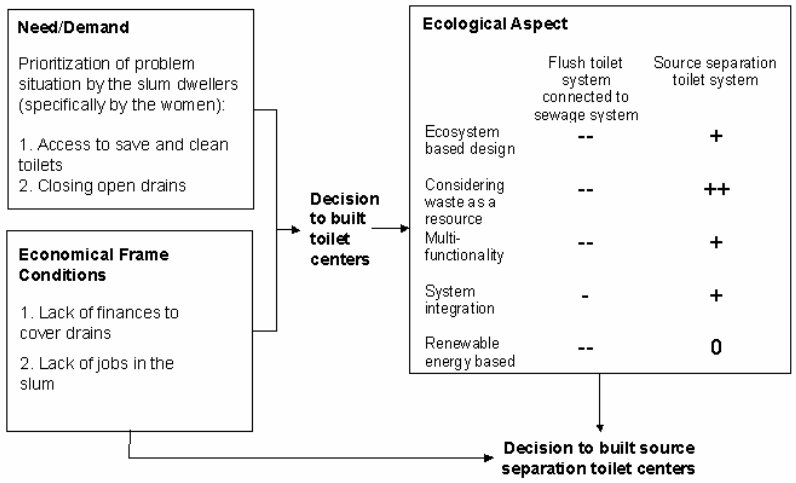

Figure 1: Decision making process

System design and system operation

The Bangalore project is based on implementing a closed loop concept (see figure 2).

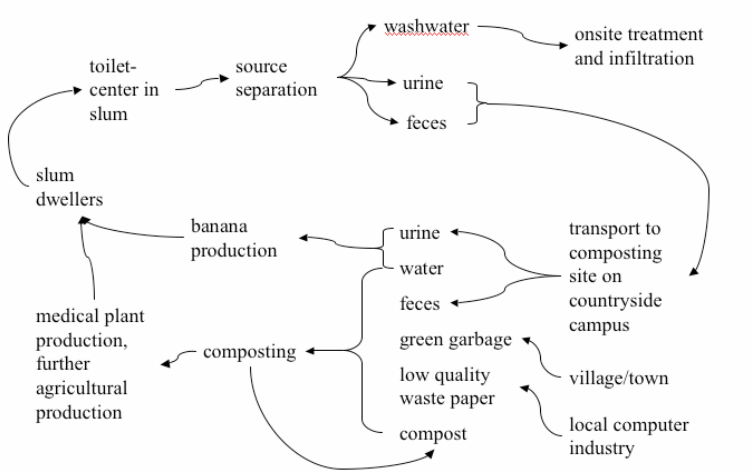

Figure 2: Closed loop design

A toilet center (with 4 toilet rooms for women and 4 toilet rooms for men) is serving 600 – 800 users per day. In the toilet center feces, urine and wash-water are collected separately (see figure 3 & 4). The wash-water is being treated onsite in a small sand-filter system planted with Papayas and Bananas. The feces and the urine are separately collected in 120 l PE bins. Each day clean and empty bins replace the filled ones. One third of the volume of the clean fecal storage bins is filled with waste paper before it is placed in the service chamber. The paper soaks water from anal washing. No waste paper is filled into the urine storage bins! The full bins are transported to the composting site. It is realized that transport of the “resources - feces and urine” is needed to close nutrient cycles between urban and rural areas. On the composting site the feces is mixed with waste paper and biodegradable garbage. The compost and the urine are used for agricultural production. The agricultural production can be sold on the local market.

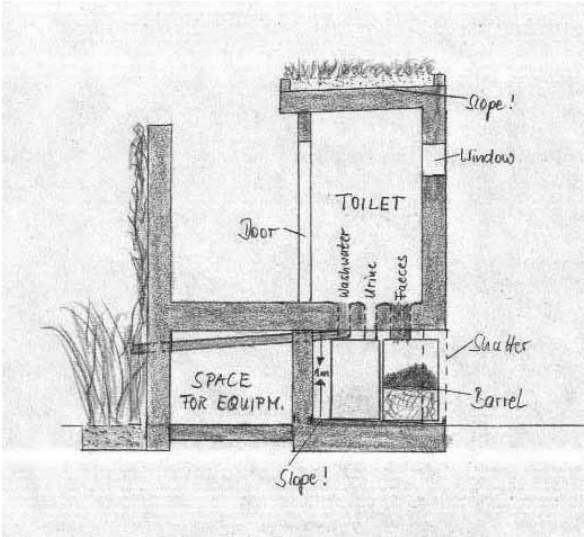

Figure 3: Cross section of the toilets

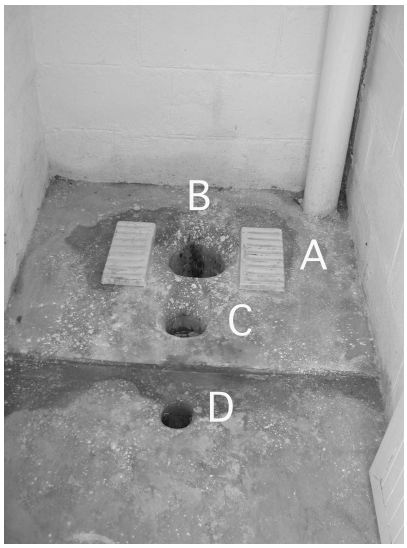

Figure 4: Squatting platform (same type for men and women). A: Footrest B: fecal hole, 20 cm Ø C: urine hole, 10 cm Ø D: wash-water hole, 10 cm Ø. Distance between holes: 25 cm.

On the composting site fresh feces is poured on a pre-prepared bed of compost and waste paper, when covered with green waste and compost (see figure 5). The first turning of the "compost sandwich" is done after 3-4 weeks. Further turning of the compost has do be done every 2-3 weeks.

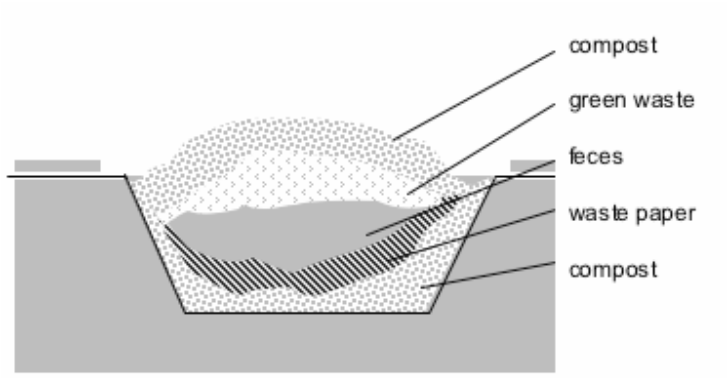

Figure 5: Composting process step 1

After 2-3 months the compost of the "Compost Sandwich" material is moved to the compost heaps (see figure 6). The heaps are covered with tarpaulin in order to avoid water loss caused by evaporation and in order to regulate the temperature in the compost heap in an optimal range of 45 and 55 °C. A digital rod thermometer is needed to control the temperature. From time to time the tarpaulin has to be removed for watering (e.g. during rainfall). The compost has to be kept humid but not wet. The compost has to be turned every 3-4 weeks. After 2-3 months the compost is ready for utilization.

Figure 6: Composting process step 2

Safety Aspects

All work staff involved in the project was served with a comprehensive vaccination program. While working at the compost facility the work staff has to wear special working clothes (trousers, jacket, gloves, boots). It is strictly forbidden to smoke, eat or drink on the composting site. Working clothes and tools are kept separately. The working clothes are washed once per week. The tools are cleaned at the end of each working day. Injuries of the skin must immediately be disinfected and protected from further infection by dressing the wound.

Controlling the Compost Process

Among the most important controls is the daily check of the temperature in the compost heaps. This allows to be sure working within the safety zone for hygienization (45 and 55 °C). The temperature is measured with a digital rod thermometer. While the composting process on the stacks lasts, humidity has to be controlled at least each time the material is restacked. If necessary it has to be corrected by adding liquid or by mixing with dry or wet compost.

Agronomic Parameters of Compost Sample			
Parameter	Result	Guide Number	Limit
pH	6.5		
dry matter (dm)	59.3 %	46 %	
org. matter	46.3 %	35 %	
total N	31.1 kg/t dm	13 kg/t dm	
P	10.7 kg/t dm		
P_2O_5	24.4 kg/t dm	7 kg/t dm	
K	7.8 kg/t dm		
K_2O	9.4 kg/t dm	9 kg/t dm	
Mg	6.8 kg/t dm	8 kg/t dm	
Ca	32.1 kg/t dm	70 kg/t dm	
Pb	43.5 kg/t dm		120 kg/t dm
Cd	0.4 kg/t dm		1 kg/t dm
Cu	155.0 kg/t dm		100 kg/t dm
Hg	0.6 kg/t dm		1 kg/t dm

Figure 7: Compost analyses (sample taken in August 2002)

Urine and Compost Utilization

The urine can be used for all kinds of highly Nitrogen consuming agricultural crop.

Costs/Economics

The 600 – 800 users produce 200 t of urine and 100 t of feces per year. This leads to a yearly production of 50 t of compost and 50 t of bananas. Figure 8 shows a first estimation of the economics of the system.

Investment			
Construction of Toilets	$7'000		
Construction of Compost site	$4'000		
Running costs per year		**Income per year**	
Salaries (8 Workers)	$8'000	Users Fee	$3'000
Transport	$2'220	Bananas and Medical Plants	$5'000
Administration	$1'600	Nutrient Value of compost and feces	
Maintenance and Depreciation	$3'250	($ 750)	
Total Running Costs	$15'070		$8'000
Net Costs	**$7'070**		
Cost per user and Year	**$12**		

Figure 8: Economics of Bangalore system

Further Development

The project is still under development. The experiences of the first project phases prove the feasibility of the concept. The following aspect will be in the focus of the next years:

a) Process optimization:

- Optimization of urine utilization (e.g. for Banana production), feces composting and fecal compost utilization.
- Optimization of process, operation and maintenance (in progress)
- Using new additives like dry leaves, etc.
- Monitoring (Nutrient and Hygiene Aspects)

b) Knowledge Transfer and Assessment

Education and Information (Workshops Seminar with NGOs, Governmental Officials, etc.)

- Knowledge transfer to rural villagers and farmer, schools, etc.
- Comparative assessment of the system (nutrients, energy, environmental impact, economic viability)

c) Product utilization

d) Training programs for poor farmers.

Scientific Study

Scientists from the Indian Council of Agricultural Research (ICAR) have been contacted for a scientific study of the compost. A significant level of interest has been shown and plans are being worked out for a systematic study of the impacts of the compost on various kinds of agricultural produce. If successful, the project will only be established as one that will need to be implemented on larger scales by the Government bodies, but will also result in enormous economic benefits to farmers who are struggling with severe agricultural land related problems.

Results / Impact / Assessment

By S.S. Wilsson, local project manager *"The toilet-center in the Rajendra Nagar slum was built with the objective of separating urine and feces and converting feces into compost rich in nitrogen content, a practice ignored or shunned over decades. Initially it was feared that reintroducing the practice of converting feces would be opposed due to prevailing culture observed and respected by the people. Considerable time and effort was made to convince the people that human feces is not a waste product, but a rich resource for production of compost. To this date the toilet-system is working satisfactorily and to our expectations. For improvement, further methods are being tested to bring about greater efficiency and to curtail expenditure. Labor is the main constraint and must be dealt with carefully as otherwise workers will put down their tools and quit without notice. Scavengers are not freely available for employment hence replacements are difficult. Thus every part of the project is of paramount importance and must be handled with personal and constant supervision. Undoubtedly there is immense appreciation from the people using these toilet-facilities since they were suffering without toilet facilities for a long period. More specifically, the women are very grateful for providing toilet facilities. The women in particular are very happy and content because this toilet provides them all facilities*

such as water, electricity and reliable wardens who keep the toilet in a very hygienic state all the time. Above all women using the toilet have the assurance of safety and security because the project is run by a responsible organization that pays personal attention to all aspects of this project. Conclusion: After two years we have achieved the desired objectives and it is noteworthy to mention that the public has cooperated well and has accepted that human feces and urine are a valuable resource. Although initially there were some constraints with regard to cultural practices we have comfortably overcome all negative thinking. It is hoped that this eco-friendly toilet will be replicated and the public will realize the value and benefits that could be derived from human waste and urine."

Conclusions - Lessons learned

- Cultural and social aspects: Even working in a cultural context where handling feces is considered to be very problematic, the project proved to be feasible. But referring communication is a key prerequisite to success.
- Technical aspects: The entire design of the project proves to be feasible. More work has to be done in up-scaling aspects: The existing projects serves toilet access to ca. 600 users. The entire project design has to be adjusted for bigger scale applications.
- Economical aspects: The target of the project was to cover all costs investment and running costs by the generated income. The experiences of the existing project show what this can not entirely be achieved. But the average annual net cost of the project of ca. USD 12 per persons proved the project to be economically feasible.
- Agricultural aspects: Having started with mainly an interest in toilet centers, the long term effects on improved agricultural production is a challenge.
- Safety aspects: The experiences prove that a save handling of the feces as well as the production of a high quality compost is feasible.

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