Title	**Implementation of ECOSAN: Challenges & Opportunities in Nepal**
Keywords	*ecosan, dry toilet, fertilizer, pathogens die off, appropriate technology, sanitation.*
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Short CV for Introduction Purposes (100 words max)	Dr. Roshan Raj Shrestha, 1963, received doctoral degree in Applied Natural Science from Department of Sanitary Engineering and Water Pollution Control University of Natural Resources and Applied Life Sciences (BOKU), Austria and postgraduate degree on Limnology (Water ecology) from Institute of Limnology, Austria and also received intensive course on Ecological Sanitation the alternative technology for excreta disposal system from Sweden. Dr. Shrestha has 16 years working experience on water and wastewater management. Currently Dr. Shrestha is Executive Chairman and Water and Wastewater Management Specialist of Environment and Public Health Organization (ENPHO), and also the Chairman of NGO Forum for Urban Water & Sanitation.
Photograph attached (jpg)	

. **1. Introduction**

The growing cities like Kathmandu has been affected by water crisis and environment imbalances in recent decade of urbanization. Thousands of migrating people and concrete cultures demand water and sanitation facility. Ironically, water is being wasted for flushing toilets than its use for drinking. Conventional sanitation facility is intricate in terms of commission and operation. It harbors many loopholes. It adds more wastewater than manageable. Rivers and ponds now are merely open sewer for most period of the year.

An alternative approach to gradually wane the existing scenario has been put forward in recent years as solution to water crisis and pollution control. However, the concept of this approach is not new for farmers of the Kathmandu Valley who have been practicing the use of night soil in combination with animal waste, kitchen and other agricultural waste as the main fertilizers in the agricultural fields for decades. In this context, apart from fulfilling the sanitation purpose, the Ecological Sanitation (ECOSAN) system is reviving the traditional yet forgotten art of applying night soil to the agricultural fields.

After receiving training on ECOSAN by a water and sanitation expert from Environment and Public Health Organization (ENPHO) and an engineer from Department of Water Supply and Sanitation (DWSS) from Sweden in the year 2001, supports a lot to promote this technology in Nepal. Now many leading organization working on water supply and sanitation like Department of Water Supply and Sanitation (DWSS), Water Aid, ENPHO, Lumanti Support Group for Shelter (Lumanti), Development Network (DNET) and Nepal Water for Health (NEWAH) have initiated pilot programme on ECOSAN around peri urban areas of the Kathmandu Valley. Till date 123 units of ECOSAN are under operation and many are under planning for construction in peri-urban communities of Kathmandu Valley. Today, ECOSAN has been recognized by national sanitation policy (SACOSAN, 2003).

ENPHO is the leading NGO in Nepal promoting ECOSAN since 2002 with financial support from Water Aid Nepal. It has conducted following activities to broaden the concept of ECOSAN in Nepal :

- Organized talk programme for policy makers and NGO professionals after receiving intensive training course by a professional of ENPHO in 2001.
- Provided technical support to organizations like DNET, DWSS, Lumanti for implementing ECOSAN in Kathmandu peri-urban areas
- Piloting ten units of ECOSAN at Khokana, a peri-urban community of Kathmandu Valley in 2002.
- Installed ECOSAN system in a modern house in 2003 as an integral component for sustainable water management practice.
- Conducted research on crop productivity with application of urine and extension of ECOSAN toilet construction in other peri-urban communities in 2003/04.
- Conducted research on pathogen die-off in ECOSAN toilet in 2004
- Is presently conducting research on household waste composting with urine application
- Foresees to establish Khokana as a Eco-Village and demonstration site for ECOSAN
- Organizing demonstration tour in project area on the occasion of World World Water Day and Earth Day since 2003.

2. Implementation of ECOSAN in Peri-urban setting in Kathmandu Valley

Peri-urban centers of Kathmandu Valley embrace historical importance, ethnicity and are dominated by farmer communities. However living condition of this settlement is poor and unhygienic due to inadequate water supply and lack of sanitation facilities. In order to improve sanitary condition, pit latrines were promoted a decade back in a peri-urban settlement; unfortunately, most of these structures are not functioning due to high water table. Functional pit latrines have also problems like overflow, odor and fly. In addition, most of these centers lack sufficient drainage system. Therefore, all the surrounding ponds and dug wells are now extremely polluted due to the seepage from pit latrines and surrounding runoff, which were the major drinking water sources in the past. By realizing those facts, ENPHO selected few peri-urban centers viz, Khokana, Lubhu, Imadol and Siddhipur for demonstration of ECOSAN system. Those communities are located within about 5 kilometers periphery of the city.

2.1 Piloting of ECOSAN in Khokana Village

ENPHO established partnership with a local community based organization (CBO) to introduce ECOSAN concept in Khokana. 10 households who were agreeing to built these units were selected irrespective of the income level. ECOSAN was designed by blending Kerala and Vietnamese styles (SEI, 1998) and each system has twin vaults

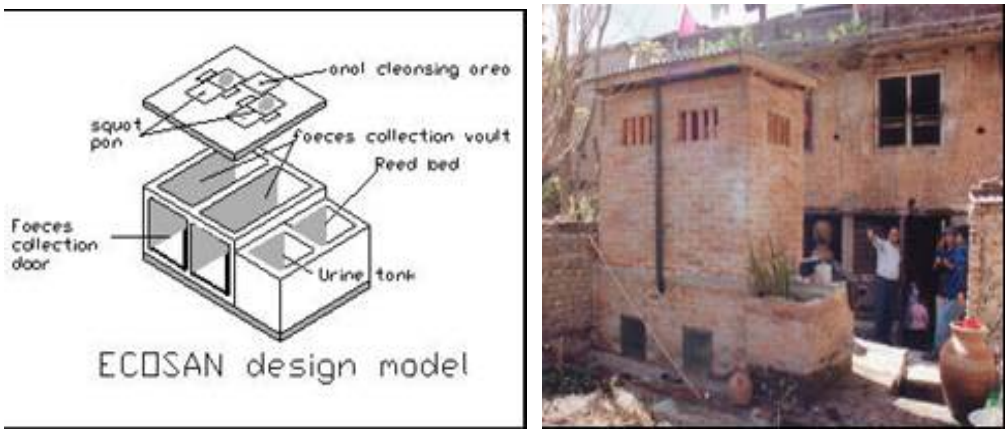

Photo 1: The first ECOSAN Model

(0.5m3 each) with separate inbuilt pan over them, urine collection tank (100 liters) and reed bed treatment system for treatment of anal cleaning water. The vault size was calculated for a family of six persons to be used for a period of six months. These toilets have zero discharge of wastewater and suits Nepalese custom which require water for anal cleansing. (Photo 1). Ash is used as a covering material after defecation.

The users were trained for proper use of urine to different crops by agronomist from ENPHO and excess urine is applied in compost heaps by farmers themselves

2.2 Scaling up ECOSAN and improvement in design

Even though the toilets were well accepted by the community, cost was a limiting factor for further scaling up. The cost for each toilet was around 270 USD as compared to about 150 USD for a normal pit latrine. Therefore, ENPHO came up with different design during the course of implementation to reduce the cost.

ENPHO selected 4 additional peri-urban communities (Lubhu, Imadol, Siddhipur, and Thimi), with similar settlements as Khokana village. The program was implemented from April 2003 and is ongoing. Altogether 93 units of ECOSAN units have been built so far in 2 years of period. Following steps were adopted for the implementation of the program :

a. Formation of user's committee or partnership with local community based organization
b. Public awareness and creation of demand
c. Household visit, site selection and commitment from users for their contribution
d. Design and construction
e. Orientation and field visit for new ECOSAN users
f. Regular monitoring and supervision
g. Orientation on use of urine and faeces

Formation of user's committee or partnership with local CBO was the entry point for the implementation of the program. ENPHO provided necessary orientation and training to CBO and supported to recruit a full time local supervisor and part time motivators to create awareness and ECOSAN demand at household level. ENPHO drafted ECOSAN distribution policy with consultation with CBO where users had to bear the cost for unskilled labor and the super structure. ENPHO trained local mason or skilled labor for construction of ECOSAN as per approved design. Construction was done under supervision of technicians from ENPHO.

The basic concept of the design is the same with a double vault structure, separate urine collection tank and treatment unit for anal cleaning water. In the new design, pans are from Vietnamese style with the addition of anal cleaning area. Vault size was reduced to a capacity of 0.4 m^3. Following three types of squatting slabs provided with pans were built (Photo 2).

Photos 2: Different types of ECOSAN pans

2.3 Orientation and Demonstration

Orientation on the toilet and its components and training on its proper use and maintenance was provided to the users' groups. Periodic community meeting, consultation, monitoring and sharing the innovative ideas for future plans are regularly conducted in all the programme communities. ENPHO developed Information, Education and Communication (IEC) materials on proper use of toilet and a manual on application of urine in the field. Interactive CD and information on ECOSAN has been produced so that interested professionals or organizations can learn about it with possibilities of investment for future projects. In addition, ENPHO and other partner organizations organized demonstration tours to these ECOSAN installed sites; best water practices sites to mark various occasions. Thousands of people get opportunity to observe the best water and sanitation practices. ENPHO also includes ECOSAN as a separate issue in its training components.

Photo 3: ECOSAN n modern house

3. ECOSAN in Modern House

One of the authors, Dr. Roshan Raj Shrestha, has also built ECOSAN system in his house to demonstrate its feasibility in urban settings and as an integral component of sustainable water management practice (Photo 3). The toilet has been in use since past 2.5 years. It is urine separating, dehydrating toilet with a bucket collection system in ground floor of the house. The urine collected from the system is used in the kitchen garden. The collection bucket is changed every four months.

4. Research and Development

4.1 Study on faeces volume and nutrient content in faeces and urine

The faeces volume analysis conducted so far from the first ten ECOSAN toilets depicted that a 0.5 m^3 vault is filled in roughly 6-7 months time for a family of 6 members. Analysis of urine showed 9.12 g/l – nitrogen, 0.26 g/l –phosphorus, and 0.85 g/l – potassium. If an adult excretes 500 liters of urine per year, it is equivalent to 4.5 kg nitrogen, 0.1 kg phosphorus and 0.4 kg potash.

4.2 Experiment on application of urine and crop productivity and recommended urine application dose

ENPHO has been conducted experiments in application of urine on various seasonal crops like potato, rice and radish with community participation. The experimental plots were laid out in Randomized Complete Block Design (RCBD) with 20 sub-plots each of size $10m^2$ for potato, $9m^2$ for rice and $1m^2$ for radish. Urine and fertilizers was calculated on the basis of recommended dose of 150:100:30 NPK kg/ha for potato, 80:40:30 NPK kg/ha for rice and 100:60:80 NPK kg/ha for radish.

Five application strategies were adopted for each of the experiments and four replications made for each application strategy (Upreti *et al*, 2005).

a. single dose of urine only at the time of sowing
b. chemical fertilizer only
c. single dose of urine at the time of sowing with additional dose of P & K
d. total urine dose divided in to two doses – half apply at the time of sowing and half in 25 to 30 days
e. total urine dose divided into 3 doses and each dose apply : at the time of sowing, after 25 to 30 days of sowing and after sowing and after 60 days of sowing or before harvesting.

These experiments did not show significant different in productivity of radish and rice with application strategies in any of the variables tested. Therefore, there is possibility of growing these crops with application of urine only. However, high productivity of potato was reported with application of chemical fertilizer than urine application. Though the productivity (11.74t/ha) is less in application of urine, it is still within the national average yield of potato (11t/ha). Therefore productivity with the application of urine cannot be underestimated.

However, this study might be too early to conclude real impact of urine on the crop and also since the effect of urine application on crop yield can only be observed after several years of urine application and many crop cycles (Johansson *et al*, 2001). It has also been documented that crop yield can be increased if sanitized faecal matter is also used in combination with urine (which provides sufficient amount of N) since faeces are rich source for K, P and organic matter (Vinneras *et al*, 2004; Jonsson *et al*, 2004).

4.3 Pathogen Die Off

Need was also felt for a better understanding on the fate of microorganisms in the faeces during the storage period and the safety of the product for handling and reusing. Thus, a study was conducted to understand the fate of indicator microorganisms viz. *E. coli*, Total Coliforms, Enterococcus and *C. perfringens* in the faeces during storage period under field conditions. The study showed that factors like temperature, pH and moisture were not in the optimal range to have produced a noticeably large single effect on the reduction of the indicators. But a combined effect of all the factors together apparently lead to a decrease of these microorganisms integrated over time. However, the estimated reduction for *E. coli*, total coliforms and Enterococcus cannot be considered completely sufficient for safe handling. Thus, the overall scenario of reduction of the indicators in the prevalent storage conditions show that optimisation of the factors like increase in pH, decrease in moisture and if possible increase in temperature is essential to meet the reduction requirement of indicator microorganisms within the storage period of 6 months (Manandhar, 2004).

5. Conclusion

Today, the concept of ECOSAN has been accepted by concerned agencies from the policy level to WATSAN implementers due to the various activities conducted till date. However, this system has not yet been scaled up. It needs strong motivation at donor communities working on WATSAN sector. Organizations like UNICEF, Asian Development Banks and World Bank are the major funding agencies in Nepal working on water and sanitation sector but they have not yet considered ECOSAN as an alternative sanitation approach. Similarly, behavioral and attitudinal change is required at consumer level for its acceptance by people. This change is possible through demonstration projects and education. This concept should be taught in schools, universities and in the communities through formal and non formal education.

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