

## Improvement of Human Health, Environment and Mitigation of Fertilizer crisis by Using Resource-based Ecological Sanitation in Senbag, Bangladesh

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### Abstract

Bangladesh is an agricultural country located in south Asia. In Bangladesh 39% people use proper sanitation system. Maximum villagers are used to unhygienic toilets and people in urban slum use open and unhygienic toilets. The methodology of the research was desktop study and Questionnaire survey in Noakhali, Bangladesh. Agriculture mainly depends on chemical fertilizer in Bangladesh. These chemical fertilizers are Urea, TSP, MOP, Zink etc. Urea is the main demandable fertilizer which is source of nitrogen and Phosphorus is second demandable fertilizer, TSP and SSP are main source of phosphorus. This study area sanitation coverage percentage is 96%, which is better than in whole country percentage. But in that area 95% people use pit latrine 5% people use septic tank. The Government and non government organization as BRAC, BARD, SPACE, and BASA work together for 100% sanitation coverage in the whole country. Farmer cultivate mainly paddy and they also produce jute, potato, brinjal, wheat, sugarcane, betel leaf, Mustard seeds etc. Farmer use huge chemical fertilizer for more production for which chemical fertilizer demand is increasing every year. Bangladesh government cannot provide chemical

fertilizer to the farmers because maximum fertilizers have to import from foreign countries. Chemical fertilizer make weaker the soil texture and fertility. So organic fertilizer can be use for more crop production. Ecosan toilet is a solution for organic fertilizer. Farmers can use treated excreta as organic fertilizer. On the other hand people can easily use Ecosan toilet during the flood time and can save ground water and surface water pollution. Different method used for application of excreta in the field. Urine can be used undiluted at the sowing time. Also urine can be applied in one large dose or several doses during the cropping season and urine can also be diluted with water. Undiluted urine should be used at the sowing time or planting time. When the undiluted urine is applied in fields soil particle changes the urine to nitrate, plant can used the nitrate as nutrient. Treated faeces should be applied in field during planting or sowing time. It should be covered with soil before cultivation of plant. High phosphorus contains nutrient for plant root formation and it also improves soil water holding capacity which improves the pH of the soil. Treated faeces can be applied in field in different ways. According to the questionnaire survey, sixty five percent people agree to use Ecosan toilet with government subsidy and

technical assistant. The cost of Ecosan toilet construction cost is cheaper than traditional sanitize toilet. There is a new low cost design shown for Ecosan toilet and the amount is BDT 7005.00 per toilet. So from this study it can be said that if in future 100 percent people use Ecosan toilet and treated excreta fertilizer in agricultural field, it will reduce about 584 metric ton urea (nitrogen) and 84 metric ton TSP (phosphorus) chemical fertilizer use per year in my study area.

**Key words:** Eco-village, fertilizer, Urea, soil texture, excreta, Ecosan.

## 1. Introduction

Bangladesh is located in south East Asia and is the eighth largest populated country in whole world. The total area of Bangladesh is about 147,570 km<sup>2</sup> and the total population about 160,4 million where 76 percent people live in rural area[1]. Bangladesh is divided in seven divisions having sixty-four districts. Bangladesh is a multicultural country having 89,7 percent people are Muslim, 9,2 percent are Hindus, 0,7 percent are Buddhist, 0,3 percentage are Christian religion and animism is 0,1 percent[2]. Three sides of the country are surrounded by Indian border whereas Bay of Bengal stays in the south and small portion of the border is adjacent to Myanmar (Fig 0.a). Three of the districts are hilly regions in Chittagong division where most of the people residing belong to the tribal community.

In Bangladesh 39 percentage people use proper sanitation system. Maximum villagers are used to unhygienic toilet system also urban slum people use open and unhygienic toilets. Government and different foreign and national NGO's took decision for 100 percent sanitation within the year 2010. In whole Bangladesh, public toilets and village area urine toilets are directly connected to drains or small holes which are in open area,

finally the urine makes it way to rivers and canals. Literacy rate is 53,5 percent in Bangladesh[2], which provides us a vivid picture as to why the people do not realize that urine and faeces contain different kinds of pathogens, organic nutrient and heavy metals (cadmium, chromium, lead) these pollutants are the major factors of environment pollution and water pollution. Lack of proper sanitation system means that people are affected by different kinds of diseases.



Figure 0: A) Bangladesh map (Saurav Shukla August, 2010) with, B) study location shown in red [2]

In Bangladesh 90 percent village people directly or indirectly depend on agriculture [1]. Due to high population growth agricultural product demand are increasing day by day. On the other hand poor urban & maximum rural area people use their land for construction purpose, so agricultural land decrease day by day. Fertilizer demand is increasing and the cost of fertilizer has

reached to four times higher than 10 years before. Villagers use cow dung and fire wood for domestic cooking, so they cannot use cow dung in agricultural fields as compost or soil manure.

We cannot ignore the use of pit latrine, which is the vital cause of ground water contamination by different kinds of pathogens. So, in order to increase agricultural land nowadays people are inclined towards deforestation and clearing off green vegetation day by day. At present Bangladesh is having 17 percent vegetation or forest [3]. This percentage is not sufficient for our country and on top of it most of the inhabitants in rural area use wood for domestic cooking as it is the only alternative for their day to day living.

Ecological sanitation can help to solve these types of problems in Bangladesh. This study, looking on how it could be done, has been conducted in Senbag Thana (Noakhali district) in the southern part of the country near Bay of Bengal (Fig. 0.b).

### 1.1 Problems and Project Aims

Most of the people living in the rural areas use open latrine and pit latrine, which are unhygienic. In rainy season at some point of time the rain continues constantly for a long time causing flood in low land areas. Floodwater mixed with human excreta and water gets contaminated. From open latrine, human excreta directly mix in drain water or surface water so micro organism from human excreta effect on human body directly or indirectly, causing different kind of contaminated diseases. Everyday, many children die of lack of proper sanitation.

Ring latrines (same as a pit latrine, but with cement rings to secure the hole) are one of the main causes for groundwater contamination. For increasing agricultural product demand people use huge amount of chemical fertilizer but in this time is not possible for poor farmer to buy huge amount of high rated fertilizer. On the other hand over

chemical fertilizing is so bad for soil structure and phosphorus is non-renewable, limited resources. In our country we have no sufficient energy for producing nitrogen fertilizer.

In this research we have therefore tried to figure out the construction of Ecosan toilets which are culturally acceptable, collection and storage for treatment of excreta, the quality and quantity of the fertilizers produced and about the outcome of the usage of the Ecosan project fertilizers in agricultural fields. After the usage of the Ecosan fertilizers the cost and production growth inspires me to implement it as a major source of fertilizers being friendly for the environment pollution control. The most vital aspect is the difficulties people are suffering from improper sanitation, which provoked me to introduce a sustainable process that is Ecological sanitation.

### 1.2 Research question

How can we introduce Ecological sanitation in study area to minimize fertilizer crisis, to save water contamination, save human health by develop low cost optimum design for urine collection tank and vault for excreta storage system?

## 2. Methodology

The study is based on two sources of information, a literature review and a large number of telephonic conversations and emails with the people in the study area and nearby localities.

The data provided from the study site has been collected with the help of direct interaction with government and non-governmental organizations. The most vital and rigorous part of my thesis was to know the views of people in the study area about the Ecosan project in Bangladesh. we had spent most of the time calling and talking to the residents in the study area and the socials leaders who play a major role in convincing the locals.

For the Ecosan projects already in Bangladesh, the data was collected from non government organizations like the Bangladeshi Academy for Rural Development (BARD) and the Society for People's Actions in Change and Equity (SPACE). The mode of communication was telephonic and email exchanges. The data was basically about the user acceptance, collection period, storage time and maintenance, vault volume/size and the number of users per family.

In the study area, the fertilizer demand and the cost of various fertilizers (last five years) data collected from Upazilla Agriculture office, the officials were directly consulted over phone and with the help of our family members and friends acting as messengers to the above said organization. Traditional sanitation system and the sanitation coverage in the study area data were collected from Upazilla Sanitation Office. In regards to the construction materials, vault dimensions, design and the cost of the construction materials we got a chance to interact with few engineers from Bangladesh who were present in Sweden during our study and had frequent telephonic chat with the engineers, masons and construction materials dealers.

Apart from the data collection, we have tried to provide a clear picture of the traditional toilet system, environmental pollution and the usage of Ecosan projects in Bangladesh with the help of figures and pictures taken from various sources. In concern to the source of the pictures collected my family and friends were a great help to me.

### 3.1 Traditional toilet system in the study area

In study area, 37.5 % people are literate and maximum family build their house by wood, still sheet and floor is made by cements concrete [4]. So they make their toilet outside of their home. Some people made toilet inside their home. Inside toilet are sanitized only, but outside latrine are

maximum unhygienic. Middle class people use pit latrine, which are made up of bricks, cement and they made tank for excreta storage. Some family builds latrines by brick but them through excreta in open area or small pond or wetlands by plastic pipe. They don't understand it is very bad for our environment and human health.

Different NGOs help poor people to build ring latrine, it is said to be sanitized latrines, but ground water can easily contaminated by this type of toilet excreta. As the system of this latrine at first they make a hole in ground then put 4 to 6 cement rings in a hole but the bottom part of hole is open. In monsoon season continuous rain or heavy rain some time cause flood in low area so water enters to the latrines easily and in this time the hole is filled with flood water mixed with excreta. Till now few people prefer to use totally open toilet as a result environmental pollution, water pollution and pathogens can speared easily and effect on human body. In village, people have domestic animals like duck, hen, dog etc. and they may feed on the excreta from the open toilet area and speared excreta in one place to another place.

### 3.2 Sanitation coverage in the study area

In the study area sanitation coverage percentage is 96%, sanitation coverage that is better than in compared to the rest of the country percentage. But in our area 95% people use pit latrine, 5% people use septic tank. Government and NGO's mainly BRAC work for 100% Sanitation coverage [4].

### 3.3 Fertilizer demand in study area

In the study area total area is 155,8 kilometres<sup>2</sup> and total cultivated land is about 12 145 hectares and total population is about 216 309. Average highest temperature is 34.3 degree centigrade and lowest temperature 14.4 degree centigrade in Noakhali district. Farmer cultivate mainly paddy and they also produce Jute, potato, brinjal, wheat,

sugarcane, betel leaf, Mustard seeds etc. For more production, farmer use huge chemical fertilizer due to which chemical fertilizer demand is increasing year by year (table 1).

Table 1: Show fertilizer estimated demand in study area 2007 to 2010 [5].

Year	Urea <i>metric ton</i>	TSP( phosphorus) <i>metric ton</i>	MOP( photassium) <i>metric ton</i>
2007	3000	325	250
2008	3200	350	275
2009	3310	400	300
2010	3410	400	350

#### 4.1 Interview with different types of village people

To find out Ecosan acceptability in the research area It was interviewed 62 village people. we divided them in category of schoolteacher, student, farmer, banker, lawyer, NGO officer, shopkeeper and religious leader (table 2). we talked with them, took the answer of my questionnaires that are tabulated below.

Table 2: An Interview results of different types of village people

Designation	Male	Female
School teacher	8	3

Student (University, Collage ,High school)	15	6
Farmer	10	3
Bankers, law year and NGO officer	6	0
Shop keeper	7	0
Religious leader( Muslim and Hindu)	4	0

There were 6 questions in my questionnaire those we asked to the village people and make a percentage of our question that are also tabulated below.

Table 3: questionnaire answer in percentage

QUESTION	Positive	Negative
1. Do you like or practice farming?	57 (96%)	4
2. Do you realize the fertilizer crisis in Bangladesh?	60 (97%)	2

3. Do you have any information about Ecosan toilets?	6 (10%)	56
4. Can we use treated, dry composted human excreta and urine as a organic fertilizer in our agricultural land?	38 (61%)	34
5. Do you realize bad effect of present sanitation system on environment?	49 (67%)	13
6. Are you willing to build Ecosan toilet if the government or non-government organization provide financial support?	40 (65%)	20

## 4.2 Proposed Toilet Design

From our findings, we propose a urine diversion double vault dehydration toilet. We added an anal cleaning part and footer (Fig. 1). Anal cleaning facility is very important issue for our culture. We also add two toilet comets permanently, so no need to transfer comet from one vault to another. Toilet seat setup 1 meter high from surface (Fig. 3) and vault open part back side of the toilet (Fig. 2). Urine storage small container set besides the toilet wall and evapotranspiration bed right side of the toilet in sunny area (Fig. 1).

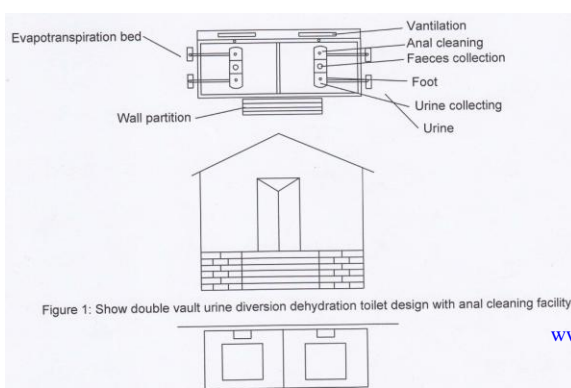


Figure 1: Show double vault urine diversion dehydration toilet design with anal cleaning facility

## 4.3 Dimensioning Toilet Components

### 4.3.1 Dimension for urine storage container

In Bangladesh, estimated urine collection per person per day one liter and number users is 5 persons per family. In rainy season farmer cannot liquid urea fertilizer in agricultural field so urine should be storage 3 month or 90 days. So for urine storage need the container volume (V Storage).

$$V \text{ Storage} = \text{Number of users} \times \text{Urine collection per person per day} \times \text{Storage time (days)} = 5 \times 1 \times 90 = 450 \text{ litres}$$

### 4.3.2 Dimension for faeces storage vault

In Bangladesh, estimated average faeces production per person per day 300 g. Number of user each toilet 5 persons. We proposed a 12 months faeces storage period. We estimated the size and volume per vault compare with Philippine and China urine diversion dehydration toilet vault.

For security reasons extra volumes has been calculated in respect to height, width and length.

Faeces collected per vault = Faeces collection per person per day x Number of users x collection period (day)

$$= 300 \text{ g} \times 5 \times 365 \text{ days}$$

$$= 547\,500\text{g}$$

$$= 547,5 \text{ kg}$$

Volume of collected Faeces = 0,827 meter cube (estimated)

Vault size for one vault = 1,2 meter length x 1,2 meter width x 0,6 meter height. = 0,864 meter cube (estimated)

Vault size with security reason = 1,2 meter length x 1,2 meter width x 1 meter height (0,4 meter for security reason)

### Conclusions

The design has anal cleaning facility, a very important aspect to be culturally acceptable in our country. The cost of Ecosan toilet construction is cheaper than traditional sanitized toilet.

So we can say that, if in future 100% people use Ecosan toilet and treated excreta fertilizer in agricultural field, we can reduce by about 584 metric ton urea (nitrogen) and 84 metric ton TSP (phosphorus) chemical fertilizer use per year in my area (total population multiply by per person per year production) and 17% Urea and 21% TSP chemical fertilizer use will be reduce (compare to 2009 fertilizer use in study area).

If we get 65% people acceptance, so we can reduce 377 metric ton urea and 55 metric ton TSP chemical fertilizer use in our area. We can reduce 11% urea and 14% TSP chemical fertilizer

demand (compare to fertilizer use in my area 2009). As a result farmer can save money and they can face fertilizer crisis in future and increase rice production and others crops, vegetable and fruits production. We can save the environmental pollution and human health and villagers can use easily short or long time flood period because Ecosan toilet vault and seat set up from the surface level and flood water cannot mix with excreta.

In conclusion, we can say that most of the people are agreeing on using Ecosan toilets. The main problems are construction cost is higher than traditional pit toilet, but pit toilets are not hygienic. The users acceptance is increasing in in place they already use Ecosan toilet and the people contribute only 30% for total cost to build Ecosan toilet. So we can say that if people get idea to proper maintenance in Urine Diversion dehydration toilets in Bangladesh we can get benefit from Ecological Sanitation in many ways. We can use excreta as organic fertilizer in agriculture, in this time the chemical fertilizer demand will be decrease and farmer can save money. In Bangladesh we have no phosphorous and potassium rock reserve for chemical fertilizer production. As natural gas is the vital component for urea chemical fertilizer production and by the use of Ecosan toilet we can save the natural gas which can be used in house hold cooking instead of urea production and save deforestation.

On the other hand some people claims that Ecosan toilets is not fit for our cultural and religion, but the religious leader opinion that no boundary in religious purpose for use treated excreta as fertilizer in field.

The Government and Sanitation sector can full fill their mission for 100% hygienic and proper sanitation. We can save our ground water and surface water from pollution and it will be easy to save out Environment. We can also save our child mortality and our heath from water and sanitation

born disease by use of Ecosan toilets. Finally we can get benefit agriculturally, environmentally, health aspects and economically from proper use of Ecological sanitation.

### Recommendations

If people use Ecosan toilet in Bangladesh, they will get benefit in different ways. But the main problem is the construction cost which is higher than traditional pit toilet cost. In our country 39 to 40% people use sanitary toilet but 95% people use pit toilet. So I can propose to Government and NGO's if they can provide financial support to build Ecosan toilet, which will be a great benefit for the people. The government and non government organization can to increasing user acceptance and can describe benefit of Ecosan toilets by seminar, posturing, announcement by mike, make video and show it in village area.

The same way, religious leader can contribute to the use the excreta use in field. They can teach the rural people and can describe no religious boundary use human excreta as fertilizer in field if users maintenance the rule, regulation and proper handling.

The media (T.V., Radio, and Newspaper) can make different programme to alert people about environment and ground water pollution, chemical fertilizer will be crisis in future and advantage of excreta reuse. Media can also teach the people about proper maintenance and handling of Ecosan toilet by different programme. Government and NGO can trained sanitary toilet business man and Mason.

Users should use hand gloves when they handling the excreta and people should maintain the store time before the use. The ministry of education can add Ecological sanitation in sanitation chapter in

primary and school label as a result will be people can get idea from their childhood time.

Agriculture department can provide opportunity for farmer to pathogenic test of treated excreta before use in agricultural land.

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