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PERFORMANCE OF ECOLOGICAL SANITATION (ECO-SAN) TECHNOLOGY IN KESHABPUR UPAZILA OF BANGLADESH

S. SARWAR, M.R. SHAIBUR* AND I. AHMMED

Department of Environmental Science and Technology, Jashore University of Science and Technology, Jashore-7408, Bangladesh

*Corresponding author & address: Molla Rahman Shaibur, E-mail: shaibur75@just.edu.bd; shaibur75@yahoo.com
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ABSTRACT

Sarwar S, Shaibur MR, Ahmmed I (2020) Performance of ecological sanitation (eco-san) technology in keshabpur upazila of Bangladesh *Int. J. Expt. Agric.* 10(1), 6-12.

This study was conducted to evaluate the performance of Ecological Sanitation (Eco-San) technology in Sagardari Union, a waterlogged region of Keshabpur Upazila under Jashore District, Bangladesh. The main objective of the study was to find out the technical feasibility and socio-economic benefits. To achieve research objective, a structured questionnaire method comprising of both open-ended and close-ended questions was employed. A sample of 40 households having Eco-San toilet was selected. Results clearly represented that social acceptance of Eco-San toilets was 31.25% in all attributes, indicating that the use of Eco-San toilet was below normal attitude. About 50% users were suffering from displacement for anal washing. More than 80% of the users were directly suffering from difficulties for adding ash into faeces hole. Compare to normal toilet, Eco-San toilet provided fertilizer, which ultimately converted human excreta (mainly faeces and urine) into organic fertilizer. Instead of using chemical fertilizer, Eco-San fertilizer was very effective to produce different types of nutrient rich rice, vegetables and fruits. We found that the users of Eco-San toilet earned more than 1000.00 Bangladesh Taka (BDT) per month as compare to the normal toilet users. Finally, the present study concluded that the Eco-San toilet was a good practice for maintaining sanitation condition which ultimately improved socio-economic profile in the study area. This study recommend to improve the quality of Eco-San toilets for further benefit and sustainable environment.

Key words: *ecological sanitation, economic benefits, food quality, social acceptance*

INTRODUCTION

Bangladesh is the 12th densely populated country in the world with population density of 1,115.62 people per square kilometer (km^2). About 80% of the total population lives in the rural areas, whose livelihood are centered on agriculture and related activities. There are 64 Districts in Bangladesh. Jashore is one of them. Geographically it is in the South-Western zone of Bangladesh. It is located at 88°40′ to 89°50′ East and 22°47′ to 23°47′ North. It is bounded by Jhenaidaha and Magura Districts on the North, Satkhira and Khulna Districts on the South, Narail and Khulna District on the East. Jashore District encompasses 2606.98 km² and consists of the eight Upazila. These are Abhaynagar, Bagherpara, Chaugachcha, Jashore Sadar, Jhikargachha, Keshabpur, Manirampur and Sharsha (Bangladesh Bureau of Statistics; BBS 2011). Our study area Sagordari Union is situated in Keshabpur Upazila.

Bangladesh is known as one of the most susceptible countries across the globe under natural calamity. Inconsistent behavior of seasons, droughts, rapid declining trend of the groundwater, sea level raising, frequent floods, waterlogging, river erosion, flash floods and mudslides in hilly regions led severe water and sanitation crisis. Considering these situation, promotion in sanitation sector and ensure its sustenance are also very burning issues. Due to improper sanitation, surface water and groundwater is being polluted. As a result, the population of Bangladesh suffers from sanitation related and waterborne disease. From the global health burden an estimation of about 4000-6000 children dying each day from diseases associated with lack of access to safe drinking water, inadequate sanitation and poor hygiene practices (Azahar 2009).

The Eco-San is a cycle or a system which treats human excreta as a resource. The Eco-San resource are free from pathogen and one used for agriculture purposes (Figure 1). The Eco-San is appropriate method of human excreta management, where the cxcreta could be used as both organic matter and fertilizer. Bangladesh is predominantly based on agriculture, that is highly intensive and also subsistence of people to meet up demand of food security (Rahman and Thapa 2003). At present, agriculturists, policy planners and farmers feel a great demand of organic farming for productivity, stability and sustainability of agriculture in rural Bangladesh. Due to realize the crucial need of organic matter in soil and lack of alternative source of organic matter, human excreta should be used as fertilizer for its high nutrient content in Bangladesh agriculture.

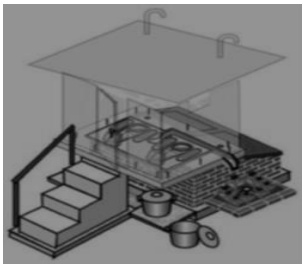

Fig. 1. Typical feature of Eco-San toilet in Bangladesh
(Source: Japan Association of Drainage and Environment, JADE 2013)

Sanitation is one of the key factors of sustainable development. In order to be sustainable, a sanitation system is not only economically viable, socially acceptable and technically or institutionally appropriate, but also protect the environment and natural resources. The benefits of Eco-San are well known e.g (1) it does not need water to function; (2) it protects the environment; and (3) it allows the nutrients to be returned to the soil as fertilizer (Winblad *et al.* 2004). The Eco-San is increasingly recognized as a realistic alternative to provide safe sanitation and thereby reduce the health risks associated with poor sanitation.

To create such an eco-friendly and sustainable agriculture practices, Eco-San toilets act as easy solution in safely transforming human faeces and urine into high potent organic fertilizers and producing nutrient rich food crops. Majority of the population of Bangladesh do not have adequate knowledge about the benefit of Eco-San toilet that is why they are suffering from various types of water and excreta-borne disease. The Eco-San has been considered as an integrated approach that collaborates with various schools of thought such as circular economy, general system theory, industrial ecology and life-cycle thinking. The Eco-San provides effective ways for agricultural sector through nutrients recycling (Langergraber and Muellegger 2005).

Human urines contain with high level of nitrogen (N; 75% to 87%), phosphorous (P; 45% to 50%) and potassium (K; 50% to 54%). Similarly, human faeces contain 10% N, 40% P and 12% K (Azahar 2009). Fractions of human excreta depends not only its quantity, physical characteristics and chemical composition but also influenced by age, diet, calorie intake, geographical location, income and socio-economic factors (Faechern *et al.* 1983). It has been found that on an average, one person excretes almost 500 kg of urine and 50 kg of faeces each year (Wolgast *et al.* 1993). In developing countries, faecal production per person per day is 130 - 520 g (Schouw *et al.* 2002). It has been found that per capita rate of urine production is 0.6 - 1.2 L and faeces is 120 – 400 g (Polprasert *et al.* 1981). It has been found that per capita excreta contains daily nutrient loading about 7.6 - 7.9 g N, 1.6 - 1.7 g P, 1.8 - 2.7 g K and 1.0 - 1.1 g S (Schouw *et al.* 2002). Its means huge amounts of primary nutrients are being released by human beings every day that creates problem for the environment including bad odour (Esrey *et al.* 2001; Graham and Polizzotto, 2012; Meinzinger 2010). The main objectives were to study the technical feasibility and socio-economic benefits of the Eco-San toilets.

MATERIALS AND METHODS

Study Area Selection

Keshabpur is a Upazila of Jashore District in the Division of Khulna, Bangladesh (Figures 2a, b, c). It has an area of 258.53 km^2 and is bounded by Manirampur Upazila on the North, Tala and Dumuria Upazila on the South, Dumuria Upazila on the East and Kalaroa Upazila on the West.

The study was conducted at Sagordari Union in Keshabpur Upazila due to its high vulnerability to waterlogging for last seven years. From geographical perspective, the village is located in the catchments of river "Kabadak". Due to the siltation of the river, three Unions such as Trimohini, Sagardari and Bidyanandakathi in the Western part of Keshabpur were affected. As a result, the river has lost its flowing capacity due to sedimentation. Every year the river spreads over the adjacent area of these Unions due to heavy rainfall during the monsoon. Almost eight months of the year, most of the land area remains monotonously flat and low elevated portion becomes inundated (Bangladesh Bureau of Statistics; BBS 2012).

Data Collection

A field survey was conducted in the study area where 94 Eco-San toilets were installed. Samples of 40 households were selected for our study. Randomly the data were collected from May to June in 2018. A well-structured questionnaire was prepared considering different information such as general, socio-economic, operation and maintenance conditions. Data regarding benefits of the application of materials of Eco-San, and other related information were also collected. Household interviews were conducted in the households of the community. This was done with assistance of a guide from the study area to locate the household residence. Where the household head or landlord was not present, any adult in the household was interviewed. Data were collected using a structured questionnaire comprising both open ended and close ended questions. Each household interview took about 30 minutes, including an introduction of the study and the researcher. We also visited the Eco-San toilet to see its actual condition. The questions were prepared in English but translated into Bengali for making it comfortable.

Evaluation of Socio-economic Acceptance of Eco-San Toilets

To find out the socio-economic determinants such associal values, income and education play a dominant role. Evaluation of the social and economic benefits from Eco-San toilets were our main objectives of the study. Evaluation of socio-economic acceptance was done by questionnaire survey. The survey includes level of education, occupation and number of children; socio-economic information e.g. monthly income, income source, having farmland or not, level of satisfaction, medical expense, loss in income due to illness, benefit of urine and faeces considered.

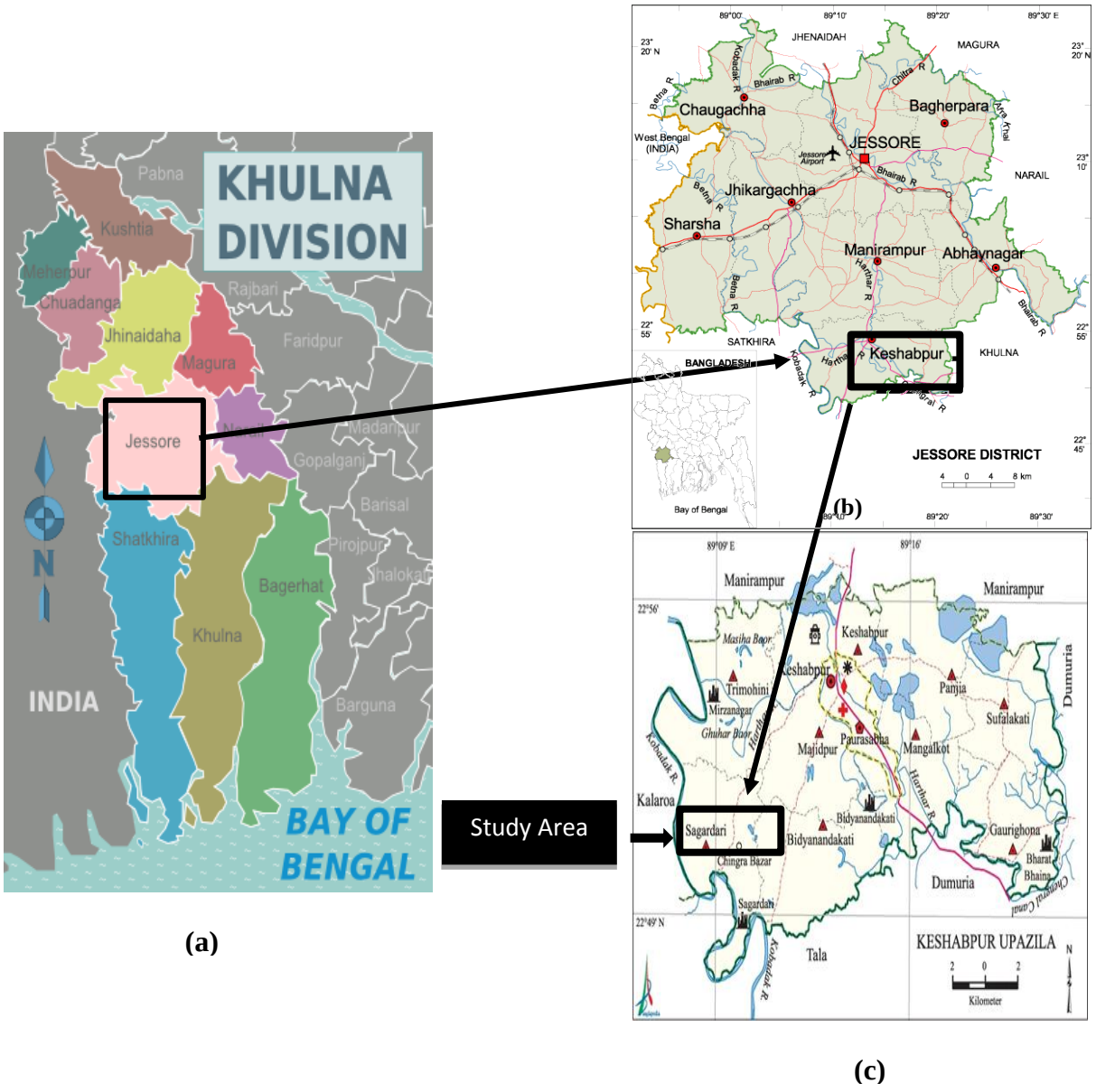

Fig. 2. The figures (a) Showing the Jashore District in Khulna Division, (b) Map of Keshabpur Upazila in Jashore District (c) Map of Sagardari Union in Keshabpur Upazila where the research was conducted (Source: Google Earth on 14 October, 2019).

RESULTS AND DISCUSSION

Social Acceptance of Eco-San Toilets

The toilets were generally accepted by rural users in the study area. Social acceptance was determined based on the attributes that were accepted individually at different stages. We found that about 31.25% people were willing to use Eco-San toilet (Figure 3a). It means, only about one-third of the people were satisfied with the Eco-San toilet. However, about 42.35% people were not interested to use Eco-San toilet. About 26.24% people did not give any opinion to use. May be, they were thinking to use Eco-San toilet. If we can maintain successfully and ensure sustainability of Eco-San, then about 26% people may be interested to use Eco-San toilet. It will mostly depend on the maintenance and ultimate positive outcome of Eco-San toilets. More research should be required to draw the final conclusion and we will do it near future.

We investigated to find out the reasons of not using Eco-San toilet (Figure 3b). Most of the people perceived that the maintaining of Eco-San toilet was difficult. But actually, it is a very good technique. Awareness should be given to the common users. The only thing is that it is needed to take proper maintenance. When improper management took place, it created some problems e.g- waterborne disease (WBD). Moreover, management of excreta was difficult. About 30% people were being affected with WBD and about 42.25% created

environmental pollution. However, about 20% gave their clear satisfaction from getting benefits from Eco-San toilets as compared to usual toilet.

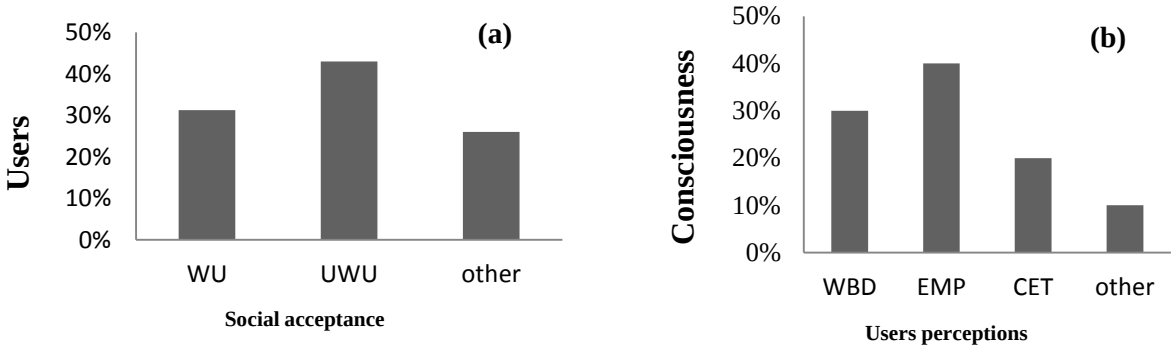

Fig. 3. (a) Social acceptance of Eco-San toilets, and (b) Users perceptions of Eco-San toilets. NB: CET = Comparison between Eco-San toilets and other common types of toilets especially pit latrin; EMP = Excreta management and pollution; UWU = Unwilling to use; WBD = Water borne diseases; and WU = Willing to use.

Difficulties in Different Operations and Maintenance Associated with Eco-San Toilets

We tried to find out technical problems especially in operation and maintenance of Eco-San toilet. The performance of Eco-San toilets was mainly dependent on its design and location. Our result clearly showed that about 50% users were suffering from difficulties for anal washing (AW; Figure 4a). Usually, the washing was done inside of the toilet and the space inside of the toilet is very congested. This type of problem was common in the majority of the users. About 40% users were not interested to add ash in faeces hole (AH), this was because, the adding of ashes was little bit difficult, because the hole was very little. Moreover, the collection of ashes was bit difficult and also the users were not willing to use ashes. Therefore, the users had to tolerate various problems such as bad smell, flies and unhygienic environmental condition.

Operation of lid was another main problem. Usually, the lids were made up of concrete, resulting in heavy weight. The heavy weighted lids were very difficult to maintain. Another problem was that, during defecation, the people made the lid dirty. About 17.50% users faced operational difficulties as mentioned in Figure 4a. These problems could be removed by maintaining good management practices. Good management practices could be ensured by regular monitoring and proper cleaning of the lid. If we can recover the above problems, the use of Eco-San toilet will be very popular to the inhabitants of the study area. Proper functions of Eco-San toilets depend on the nature of users and the mode of maintenance steps they took.

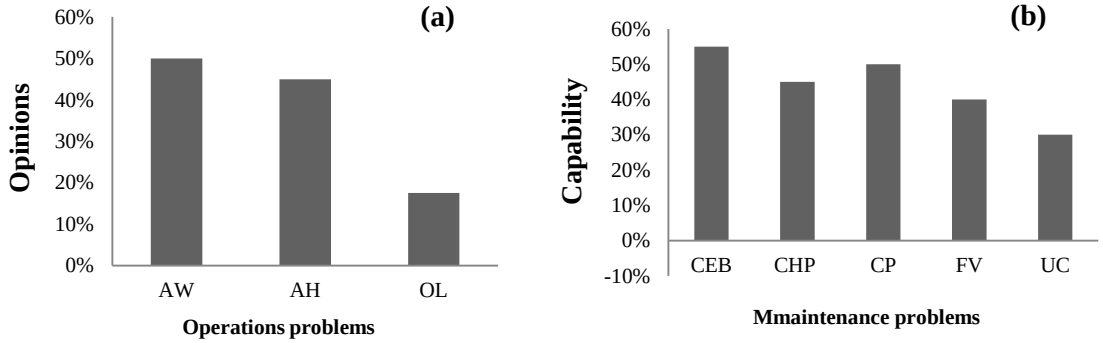

Fig. 4. (a) Difficulties in different operations associated with Eco-San toilets, and (b) Maintenance problems. NB: AH = Ash in hole; AW =Anal washing; CEB = Cleaning evaporation bed; CHP = Corrosion of heat panel; CP = Corrosion of pipes; FV = Faeces from vault; OL= Operation of lid; and UC= Urine container

Cleaning up of evaporation bed (CEB) was one of the main maintaining problem (Figure 4b). We found that about 54.25% users faced problems in CEB, because they were not habituated with the Eco-San toilet system. This was because most of the people of the study area were illiterate and they did not know how to use and maintain the Eco-San toilet. Usually, they wash their anal on the urine collected bed, resulting in huge volume of water in the urine collection chamber. Frequent removal of urine container was difficult and bothering.

About 50% users did not show any interest to repair the heat panel. This was because; it was made up of iron sheet that might be galvanized iron. It protected the rain water and passes heat into the vault. In presence of air, corrosion took place in some part of the sheets. Due to corrosion, plain sheet was turned into porous sheet

through which water entered into the vaults. So, user should take care of the sheet for being porous. Frequent removal of heat panel was bit difficult, expensive and laborious. It meant that maintenance of heat panel was difficult. To protect the corrosion of pipe was another problem. Usually, the pipes were present outside of the toilet. Therefore, there was highly possibility to break up the pipe. About 45% users faced this type of problem. In this case, the user's need another extra care by providing external protection measure.

About 40.50% users did not want to remove faeces from vaults. Faeces vault was the container where faeces were accumulated and fertilizer was produced. Most of the cases, people were not very much interested to remove the decomposed faeces to agricultural fields. Additionally, about 25% users did not feel comfortable to use urine container for collecting urine during defecation. These types of problems occurred due to abhor. Moreover, it creates dreadful odor to the sensitive people. But, if we could properly manage the faeces and urine, it could be converted to good organic fertilizer for agricultural crop production.

Collection and Storage of Urine

When the urine container was full, it was removed and disconnected from the link pipe of the Eco-San toilet. Immediately after removing, another container was placed for urine collection in Eco-San toilet. In the beginning, the farmers applied the urine directly after collection. But the result was not so impressive and most of the cases it showed negative effects. After consulting with the agricultural officers, the farmers kept urine for two months in the suggested places which gave positive result. Generally, urine container was sealed with air tight cap properly and was placed in dark and cool room until it was applied to agricultural field. Usually, both male and female were habituated to carry urine to agricultural land. The urine may be stored for at least two months before applying to fields. Application of this type of urine gave positive result.

Conversion of Faeces into Organic Fertilizer

Usually, there are two vaults in each Eco-San toilet. When one vault was filled up with faeces, it was kept for around two months for being composted. During this period, enough wood ash or lime was added and kept for around 6 months. To avoid the spreading of possible pathogens and unhygienic condition, partly composted or raw faeces were composted properly. In order to keep the optimum ratio of carbon/ N, raw faeces were composted with bio-waste for curing at least 6 months. Composted faeces were removed from the vault by sink a long handled shovel and was spread out on the yard in the sunlight for around 7 days to make complete dry. After drying, faeces were collected and were stored into black poly plastic bags for field application. The manure can be put into the trenches or pits and covered with soil before plantation.

Application of Eco-San Fertilizer and Urine in Agricultural Land

The usual way to utilize composted faeces was to spread on the field in a systematic way (Salkioja-Salonen 1983). Some users buried faeces in pits for some days and then incorporated into the soil of farms for crop production as an organic fertilizer (Figure 5a). Sometimes, the composted faeces are put near the roots of the plants in different times of crops life cycle.

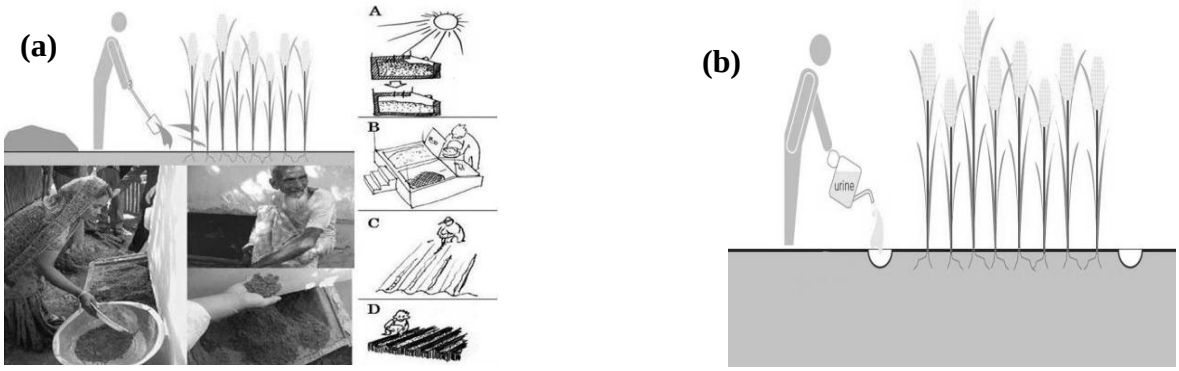

Fig. 5. (a) A general view of composted faeces application in agricultural land (Stenstrom *et al.* 2011; JADE 2013), and (b) A general sketch of application of urine in agricultural land (Stenstrom *et al.* 2011).

Figure 5b represents a general view of application of urine in crop fields. Urine was applied into the soils (not on the surface) and at a distance of at least 15 cm from the plants. Usually, 50 mL dose of urine was applied when the crop was planted on 4 weeks, showed higher plant growth and yield. Urine was stored into 5 L graduated plastic container. The concentrated urine was mixed with water at the ratio of 1:10. But just after urination, urine was mixed with water at the ratio of 1:5. Both the cases, the urine was poured into the hole (Figure 5b) and covered with soil immediately to minimize the losses of nutrients by evaporation.

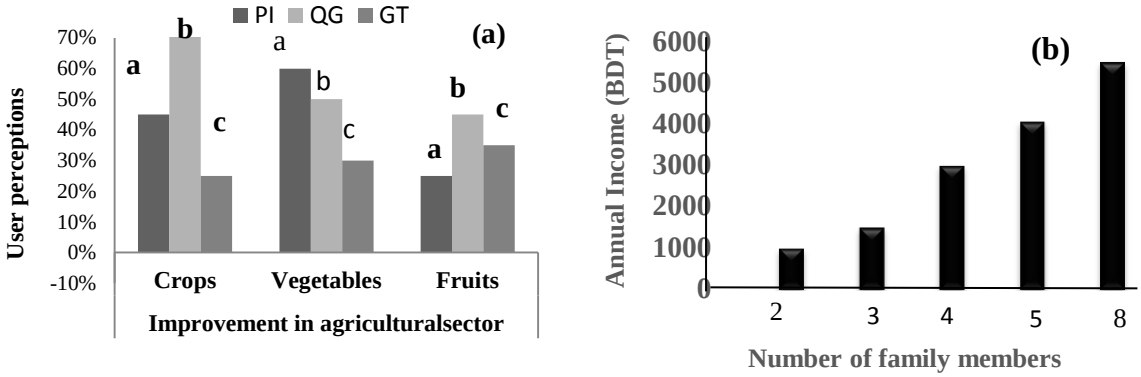

Fig. 6. (a) Responses of crops to Eco-San fertilizer and urine**,** and (b) Financial benefits of Eco-San family. NB: GT = Good Taste; PI = Production Increased; and QG = Quality Good

Responses of crops to Eco-San fertilizer and Urine

Effects of urine and faeces were positive for crop production. Almost all of the Eco-San users were small farmers. Main professions of them were agriculture in which Eco-San fertilizer was used for rice, fruit and vegetable production. We found that the production of rice, fruits and vegetables was much higher in the field of Eco-San fertilizer as compared to commercial fertilizer. Now-a-days, the farmers are using the Eco-San fertilizer with or without chemical fertilizer. It was found that the effectiveness of chemical fertilizer was much higher in presence of Eco-San fertilizer as compared to only chemical fertilizers. It was also found that, the addition of Eco-San fertilizer reduced the use of chemical fertilizer. After application of Eco-San fertilizer, the production, taste and quality of crops increased vigorously (Figure 6a). Among them the quality was the best. Quality means colour and freshness of the vegetables. Usually, people are enjoying the crops treated with the Eco-San toilet fertilizer for maintaining the good health condition.

Financial Benefits of the Users

Figure 6b showed that the annual income increased with increasing number of family members. Amount of profits varied based on the number of members in each family from 3 to 10. It was found that out of 40 sampled households, 15 households got 3,000 Bangladesh Taka (BDT) per year. Similarly, 15 households got 4,000 BDT per year where the family members were 4. But maximum profit 6,000 Tk per year was found from 5 households where the family members were 8. It was very sad that 5 households which had the number of 3 did not get enough profit. The maximum farmland stands besides the river Kabadak, remain under water for almost 6 months in a year. Therefore, it was difficult to grow more than one crops in a year. The situation became worse when they were not able to grow crops in the same field more than single time per year. It was very rare to use the same land for second time in a year.

CONCLUSION

From the above discussions, concept on ecological sanitation was being increased along with using Eco-San toilets that produced organic fertilizer from human excreta for applying in the farmland as a replacement of chemical fertilizer. Our study found that about 31.25% people were willing to use Eco-San toilet. It means, only about one-third of the people were satisfied with the Eco-San toilet. The users were using Eco-San fertilizer that was an important issue of social acceptance. We tried to find out the reasons of not using Eco-San toilet. Most of the people perceived that the maintaining of Eco-San toilet was difficult. But actually, it was a very good technique. Common uers should improve their warness. We tried to find out technical problems especially in operation and maintenance of Eco-San toilet. The performance of Eco-San toilets was mainly dependent on its design and location. Our result clearly showed that about 50% users were suffering from difficulties for anal washing. Good management practices could be ensured by regular monitoring and proper cleaning of every chamber. If we can recover the above problems, the use of Eco-San toilet will be very popular to the inhabitants of the study area. Economic point of view, Eco-San toilets were not only good source of organic fertilizer but also source of profit. It had been found that Eco-San toilets were able to decrease the medical expense, income loss due to illness along with increasing the income of Eco-San families. It was found that using Eco-San organic fertilizer, production rate of rice, fruits and vegetables was higher than other types of agriculture. Users recommended that they got more quantity than previously when they used only chemical fertilizer in same land. In this circumstance, they practiced well with hygiene behaviors. One more initiative was also found through the CBO (community based organization) that took into account. Sanitation was treated as a business in the study area. It proved that performance of Eco-San toilets was good in waterlogged areas in perspective of Bangladesh, because faeces were managed at dry state. No water had chance to enter into the faeces vaults of which height

was more than flood level and structure was sealed with cement. So, it was found that Eco-San toilets would be sustainable technology in flood prone area. It was concluded that social and economic aspects of Eco-San toilet would be possible to increase if the problems were recovered through its modified design and good management. At the same time its microbial quality should be properly managed to get proper sanitation facilities. We recommended that government, NGOs, donor organizations should come forward to encourage people about the contribution of Eco-San toilets to achieve sustainable solution. Further, if we could bring Eco-San product into resources, it will be very effective and helpful for the people. For this reason, our people should be very aware of using Eco-San toilets.

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