19 The reuse of human excreta in Bangladesh

Dr. Avizit Reaz Quazi and Engr. Refatul Islam
NGO Forum for Drinking Water Supply and Sanitation

Abstract

This study was conducted in Bagerhat, Faridpur, and Rajshahi districts of Bangladesh in order to better understand the reuse of human excreta in the country.

The study comprised reviewing literature on the subject, before carrying out empirical observations in February and August 2005. The research included in-depth interviews, key informant interviews, group discussions, transect walks, and direct observation of the ways, systems and purposes of reuse of human excreta.

The study found that human excreta is used: (a) as fertiliser for production of plants particularly by sowing of plants on 'saturated' latrine pits; by mixing human excreta with poultry, animal and other organic solid waste, including sludge of Bio-gas; and by using wastewater for agriculture and aquaculture
(b) for the reproduction of alternative energy through bio-gas plants.

Often, in cases of reuse of human excreta in agriculture, projects seem to be to be informal and based on individual initiatives. Biogas plants are often the outcome of planned intervention and specific projects by the government and NGOs. Bio-gas plant technology is costly and therefore is not affordable for the poor.

Where human excreta is reused, both in agriculture and in the production of bio-gas, some fundamental questions need to be addressed, such as sludge disposal, aspects of environmental pollution, health risks, and agricultural products.

The study found that people reusing excreta are Muslim, Hindu and Christian by religious affiliation, although the literature suggests that Islam discourages contact with human excreta. The reasons people give for reusing excreta are tradition, indigenous knowledge and financial benefits.

This survey presumes that the reuse of human excreta is implemented from the perspective of environmental sanitation. In this process of re-use the key focus should be on 'adoption of scientific procedures' in preparing compost and its safe utilisation. Such safe and hygienic behaviour and handling would promote health and well-being of the population. Institutions engaged in promoting hygiene and sanitation should incorporate reuse of human excreta into their programme.

Given the development situation in Bangladesh, it is expected that the government and non-governmental organisations (NGOs) including private institutions be intensively involved in the reuse of human excreta in producing bio-gas and for composting as well through eco-toilet and household composting plants. The government should adopt a policy for reuse of human excreta, allocate budgets to develop affordable and appropriate technologies, and provide subsidies to the poorest. NGOs meanwhile can raise awareness of safe and effective utilisation of excreta; provide training to users, caretakers, and private producers; conduct advocacy at national and local level; monitor and facilitate field level operations; and carry out action research to ensure the effectiveness of technologies and approaches in accordance with socio-economic and environmental contexts.

Once simple and affordable designs of bio-gas plant, eco-toilet and composting plant are developed and the community is willing to be involved in the reuse of human excreta, the private sector could be engaged in ensuring the availability of hardware materials and the building skills in the localities.

Introduction

Latrine coverage in Bangladesh has significantly increased during the last ten years, from 28% in 1995 to 65% in 2005. However, this progress has not addressed the issue of total management of environmental sanitation. The management of disposal, treatment, and reuse of human excreta, solid waste management, and wastewater disposal have not been adequately addressed.

Each year, Bangladesh produces seven million metric tons of human faeces and 70 million metric tons of urine (Bangladesh Observer, 15th May 2004).

Much of this is deposited in water bodies and open places, so polluting the water sources, ground water and the environment in general. As a result, a large number of people in Bangladesh suffer from sanitation-related and water-borne diseases and other health problems caused by poor sanitation practices.

The proper management and reuse of human excreta (human faeces and urine) could ensure not only the improvement of environmental conditions in human settlements but also promote the economic and social well-being and health of the population.

Human excreta can be used to generate energy and as fertiliser for agriculture and aquaculture. Reuse of human excreta could make a significant contribution to reducing environmental degradation, eradicating poverty and developing rural areas of Bangladesh.

A lack of access to conventional fuels (gas, oil and coal) means people living in rural areas of Bangladesh are using biomass as a resource for fuel beyond the acceptable limit to meet their household energy needs. In Bangladesh, around 62% of the total national energy requirement is met by biomass fuels. Annually, 40 million tons of biomass fuel, in particular, firewood, agricultural residues, leaves, cattle dung, straw, and rice husk, are used as a source of energy (Kazi, 2002).

Biomass fuel is mainly used in rural areas. About 83% of rural households depend on biomass fuel for cooking. As half of the household income in rural areas would be spent on fuel, women spend long periods of time gathering lower grade biomass fuels from agricultural and animal residues.

However, the use of given biomass as fuel is creating environmental degradation at an alarming rate. For example, the process of organic recycling of the soil is affected severely by the decrease of microbial population and the fertility of the soil. Therefore to improve the efficiency of their agricultural production, farmers are using increased doses of chemical fertiliser. To develop productive harvests, soil must contain at least 3% of organic compound, yet this has decreased to less than 1%, due to gathering of lower grade biomass. This situation is not sustainable.

Cutting trees to meet fuel requirement is leading to further environmental degradation. By 2004, forest areas had been reduced to less than 9% of the total land area of Bangladesh by 2004, when it should be at least 25% of the total land area. The use of lower grade biomass fuel by the rural poor is exposing women to smoke that causes acute respiratory infections, chronic obstructive lung diseases, low birth weight, lung cancers, and eyes problems (Biswas). Reuse of human and animal excreta as an alternative source of energy and fertiliser could greatly contribute to solving these problems.

Reuse of human excreta using safe environmental sanitation approaches would not only improve people's health, but also reduce the problem of accessibility of safe drinking water and sanitation, alleviate poverty, improve the rural economy, relieve women from physical hazards and generally safeguard the environment.

Nevertheless, when reusing human excreta, it is imperative to follow scientific procedures, as excreta contains pathogens – particularly bacteria, viruses,

BOX 1 Benefit of reuse of excreta

Excreta fertilising potential of a family of five adults

Excreta is to be valued both because of its nutrient content and soil-conditioning and humus-building potential. Based on a daily excreta production of 110g per /person, a family of five adults theoretically produces enough excreta to produce adequate nitrogen and phosphorus to cultivate a rice plot ranging between 40x40 m and 40x50 m in size (Edwards, 1992).

Benefit in use of excreta for aquaculture

Fish cultivated using composting as fish feed (in excreta reuse systems) are of high quality and are equal or even superior in taste and odour to fish cultivated in other ways. Fish fed high-protein natural food cultivated in manure were much leaner, only 6% fat compared to fish raised on high-protein feed pellets and gain with 15 percent and 20% fat respectively (Edwards, 1992).

TABLE 1 Potential of biogas from human waste in Bangladesh

Feed materials	Total population ($x10^7$)	Waste disposal rate (kg/head/day)	Gas production rate (m^3 /kg)	Amount ($x10^6$, m^3/day)
Human excreta	11.50	0.40	0.07	3.22
Cattle dung	2.42	11.50	0.03	8.35
Poultry manure	13.79	0.18	0.06	1.49

Source: Rahman M H et al ,1996

protozoa, and helminths – which cause serious health problems if not properly treated.

Literature review

To understand the practices related to reuse of human excreta in Bangladesh, it was important to carry out a review of relevant literature. We found that documentation about the reuse of human excreta in Bangladesh is scanty. Only a few documents are available which just talk about the initiatives taken by agencies in developing bio-gas plants under specific projects.

Current practices

A survey in the late 1980s opined about unintentional excreta reuse in Bangladesh. It found that 'night soil' – a euphemism for excrement – was not added directly to ponds; in fact, ponds were often used for bathing and washing kitchen utensils. However, latrines constructed in ditches behind houses remained almost dry in the summer but filled with flood water during the monsoon. Fish that entered the ditches with floodwater benefited from the eutrophic water, and night soil from the latrines continued to feed fish that grew in the ditches. The fish was harvested towards the end of the monsoon season when the water level had dropped. Consumers were generally reluctant to accept fish harvested in such ditches, however they were unaware of the origin of such fish when the product was bought in the market. (Edwards, 1992). In the last few years, national newspapers of Bangladesh have reported on intentional fish farming using sewage water. Newspapers reported that people are practising large-scale fish cultivation in the lagoon of the sewage treatment plant in Dhaka (Prothom Alo, 9th February 2002 and 29th September 2003). A recent city survey on wastewater irrigation also reported about this practice (Quazi, 2005).

Religious issues

Some literature highlighted difficulties related to the reuse of excreta in Muslim society. They argued that the Islamic culture professes the avoidance of

BOX 2 Health Risk related to reuse of Human excreta

Agriculture

The main health risks to workers who use excreta-related waste for fertilisation or irrigation are faecal-oral infections and soil-transmitted helminths. Where workers come into contact with contaminated surface water, schistosomiasis could also be a problem. Consumers of the crops are at risk of faecal-oral infections and ingested soil-transmitted helminths (Rottier and Ince, 2003).

The health risks of using untreated excreta-related waste for fertiliser should be reduced by minimising the contact between crops and pollution as much as possible (for example, through subsurface irrigation). Excreta-related waste should only be applied before the crops are planted or up to one month before they are harvested.

Aquaculture

Non-bacterial faecal-oral infections, bacterial faecal-oral infections, water-based helminths, and excreta-related insect vectors categories need to be considered as potential sources of infection in excreta-fed aquaculture systems. The intestinal bacteria and viruses of warm-blooded animals do not cause diseases in fish but they may be passively transferred to humans by fish raised in excreta-fed systems. Water-based helminths parasitic to humans may be transmitted by fish which act as worm intermediate hosts, for instance liver flukes. Schistosomiasis, a disease caused by the water-based helminth Schistosoma, has a snail intermediate host, and may also spread through excreta-fed ponds. There does not appear to be much risk from the breading of insect vectors in well-managed excreta-fed ponds. (Edwards, 1992)

Avoidance of using fresh excreta for aquaculture, eating well-cooked fish, snail control, depuration of fish (that is, keeping fish in clean water for a period, prior to harvest) reduces these health risks.

Biogas

Handling excreta and regularly removing the sludge from a biogas plant could be a health risk. The sludge could be heavily contaminated with pathogens and should be handled and disposed with the same care as fresh excreta (Rottier and Ince, 2003).

all contact with human excreta. Excreta and urine, along with semen, corpses and other specified substances, are regarded as spiritual pollutants. Quranic edict and Islamic custom demands that Muslims minimise contact with these substances (Edwards, 1992). It was also reported that the people of Bangladesh, who are predominately Muslim, are reluctant to accept fish harvested in ditches fertilised with excreta. However, it was also quoted that the reuse of treated sewage effluent seems to be perfectly legitimate from the Islamic point of view. The Eminent Scholars of Saudi Arabia expressed unanimous approval of reuse of treated wastewater effluents for all purposes including religious washing (Edwards, 1992).

The reluctant attitude of the people of Bangladesh in reusing human excreta was also mentioned in a study conducted in 2003 (Quazi, 2003). According to the document, people kept silent when the possibility of reuse of human excreta was discussed – they evinced discomfort with the whole idea through their gesture. Those who have a two-pit latrine showed reservation and argued that they were not using two-pits latrine for composting purposes but to increase the longevity of the latrine. Only a small number of respondents said with some hesitation that human excreta can be used as manure if full composting is ensured.

However, this hesitation is not universal. An earlier-conducted study provides a different picture. The majority of the respondents replied affirmatively in favour of using human excreta as manure (DPHE, UNICEF and VHSS, 1995). However, the practice of reuse of human excreta for agriculture was not found in the literature, although the use of wastewater for irrigation was clearly mentioned.

Wastewater in agriculture

Recent surveys in the cities of Rajshahi and Dhaka conducted by the respected City Corporation revealed the use of drainage water in peri-urban areas for irrigation purposes. The survey indicated that approximately 145 and 550 hectares of land are irrigated by untreated waste water in the peri-urban areas of Dhaka and Rajshahi respectively. The common agricultural products grown on waste water are: cauliflower, lao (bottle gourd), sweet pumpkin, pauishak (Indian spinach), palongshak (spinach), dantashak (amaranths) potato, tomato, pulse, oil seeds, wheat, paddy, and sugarcane. The survey also found that for several years diluted wastewater was used in nine lagoons/ponds in Pagla sewerage treatment plant (each pond was 1,000 ft by 1,000 ft in size) for aquaculture. Yearly production was 562.5 tons of fish. But since early 2003, the government of Bangladesh has imposed a ban on aquaculture in such lagoons. Still, some aquaculture is being undertaken on a very limited scale. The production is now just 18.75 tons per year, some 3% of past production. The survey also revealed that general customers are not comfortable with the idea of wastewater irrigated products, although it was observed that when they purchased such products from the market, they were not aware of the origin and the methods of cultivation. However, the same survey indicated that farmers who are practising wastewater irrigation are consuming these products (Quazi, 2005). The use of wastewater is also undertaken by NGOs, for example the NGO Prisam is involved in the cultivation of duckweed to feed fish (Skillicorn et al).

Low-cost technology

The practices related to the reuse of human and animal excreta for biogas production as a renewable energy source are reported in several documents available from the web pages on the project initiatives taken by the Local Government Engineering Department (LGED), Bangladesh Council for Science and Industrial Research (BCSIR) (Renewable Energy Information Network, Rahman, 1998).

In Bangladesh, the first biogas plant was built in 1972 by the Bangladesh Agriculture University (BAU). However, the bio-gas plant based on night soil was only constructed at Faridpur Muslim Mission in early 1990s by LGED.

Since the first introduction in the mid-1990s, more initiatives were taken by various organisations, particularly by LGED and BCSIR. It has been reported that LGED and BCSIR have already installed more than 20,000 biogas plants in the country. Most of the biogas plants are based on cow dung and only a few are on human excreta.

It is worth noting that LGED has successfully constructed human excreta based biogas plants in a number of religious institutions that involved Madrasash, Islamic missions, orphanages and mosques. One of the aims is to install a biogas plant based on human waste to test the general assumption that reusing human excreta in the Islamic culture is not feasible. The literature review also indicated that a considerable percentage of bio-gas plants are not functioning due to lack of proper use and maintenance by the users.

Objectives of this study

Following the literature review, a study based on field work was undertaken in order to:

- Understand the reuse of human excreta including other organic waste in Bangladesh.

- Determine ways, processes and purposes of reuse of human excreta in the rural areas in Bangladesh.
- Assess the extent to which the reuse of human excreta meets the requirement of environmental sanitation.

Methodology for collection of data at field level

Structured interviews were made by telephone, and recorded, with:
(i) the 14 regional managers of NGO Forum who cover almost the entire country
(ii) staff members of national and international agencies engaged in water and sanitation activities
(iii) consultants who are directly involved in water and sanitation programmes.

These interviews did not provide adequate information about the use of 'saturated'[1] latrine pits and human waste for agriculture. The study had incorporated a few group discussions with local NGOs who are partners of NGO Forum. They provided information about the reuse of human excreta in agriculture as well as the use of saturated pits to grow plants and identified a few places where such practices take place.

Based on these interviews and group discussions, the following three study districts were chosen,: Bagerhat, Rajshahi and Faridpur. In total, 18 cases of reuse of human excreta were studied:

- 6 cases of users of saturated latrine pits used for growing plants. This is practised in Doiboyga Kathi, Joka, Nurullahpur villages of Morrelganj Upazila (sub-district), and Paschim Khada village of Sharankholan Upazila under Bagerhat district;
- 4 cases of users of compost containing human excreta for producing vegetables, fruits, nuts, and trees. This is practised in Haldhibunia and Malgazi villages of Mongla Upazila under Bagerhat district and in Bil Mahmudpur village of Sadar Upazila in Faridpur district;
- 8 cases of users of bio-gas plants. This is practised in Dhopagata village of Mohanpur Upazila and Rakkhitpara village of Baghmara Upazila in Rajshahi district

The field study area was restricted given the time and financial constraints.

We observed the selected sample areas in February and August 2005. The basic techniques of observation were: in-depth interviews, key informant interviews, transect-walks and direct observation of the reuse system, the ways it was used and the outcome.

Key research instruments were: interview schedule, check list, audio and visual documentations.

Categories of informants were: Users of reuse of human excreta; senior staff members of institutions working with water and sanitation; social elites; engineers who have constructed the reuse system and are responsible for its monitoring and maintenance; and caretakers.

Field Findings

An increase in reuse of human waste for agricultural production

During our observations, we found that four out of six villages in four upazilas use 'saturated pits' for the production of plants. These villages are Doibogya Kathi, Joka, and Nurullahpur under

[1] The word saturated is used in the article to refer to a state of limited utilization of a system that is completely exhausted

Doibogya Kathi Union of Morrellganj Upazila and Paschim Khada village of Randha Union of Sharankhola Upazila. A total of 367 households in these four villages use saturated pits for the production of plants in a planned way.

The basic reasons expressed for using saturated pits are:

1. based on experience – it was reported that saturated pits are better fertilisers than chemical fertilisers as the efficiency of the fertiliser is sustained over a longer period of time. They measured this by quality and quantity of the plants produced;
2. information from neighbours and acquaintances that saturated pits are better fertilisers as they produce healthier plants and more yield;
3. information from television programs about the effectiveness of latrine pit fertiliser;
4. indigenous knowledge – ancestors believed that latrine pits were better fertilisers and this belief has been transferred from one generation to the next.

The plants that were sowed on the saturated pit are: coconut tree, betel nut, bamboo, mango tree, Chambal (tree), Mitha Alo or Guz Alo (a special kind of vegetable where the bulky root grows in the soil, and small roots appear on the thin and long creepers above ground).

As well as being used in saturated pits, it was found that human excreta is also used in cultivation. In two villages, Haldhi Bunia of Chila union and Malgazi of Chandpai Union under Mongla Upazila, cases were found of human excreta being used as fertiliser.

Human excreta and other organic compost can be used to produce compost. This is done by digging a hole in which an adequate amount of human excreta is collected from used latrines. The human excreta is kept there for some months, after which other organic waste, such as poultry manure, cow dung, household and kitchen waste and leaves, are added. The composting process takes a few months. The compost can be used in the agricultural field for the production of vegetables, fruits, nuts and trees. Vegetables grown include brinjils, danta, barbiti (a kind of bean), tomatoes, potatoes, cauliflower, cabbage, puishak, lady's finger, and gourd. All the farmers we spoke to were of the opinion that such compost is capable of producing more crops than when using chemical fertiliser, with the products appearing healthier and looking better.

Reuse for biogas production

The reuse of human excreta is not limited to agriculture but can also be used for the production of alternative energy, biogas in particular. The eight cases that were studied provide some understanding about its use and purpose. Biogas plants using human and animal excreta were found in specific projects undertaken by government institutions. We investigated eight biogas plants in the Mahmudpur village of Sadar upazila in Faridpur district, and Dhopagata village of Mohanpur Upazila and Rakkhitpara village of Baghmara Upazila in Rajshahi district. Two plants linked to the community latrines use its excreta for biogas production. The energy generated is used for cooking in a single household.

One community latrine linked to a biogas plant is installed in an Islamic religious institution and reuses waste to provide the energy for cooking meals for orphans. The remaining five biogas plants were built for individual use in these five households.

BOX 3 Cases of used latrine pits for production of plants

In Paschim Khada, Sayeedur Rahman Akkon, a Muslim and a primary school teacher, had constructed a pit latrine in mid 1980 which was saturated in early 1990. Mr Akkon had covered the saturated pit with soil and kept it for a year and in 1992 sowed two bamboo saplings of the thin and short 'Molibansh' variety. Within a few years, these saplings had grown into a bamboo bush of around 10 to 15 feet high and two inches in diameter. From this bush he had collected at least one hundred bamboos, each selling for Tk 30 . He had also cultivated a similar type of bamboo on plain land without using any type of fertiliser and had found that the bamboos grown on the latrine pit were thicker in size and the growth of the bush better than that of the bamboo bush cultivated at the plain land. This led him to conclude that plants grown on the saturated pits have better results.

In the village of Joka of Doibogya Kathi union of Morrellganj upazila, Asken Sheikh, a Muslim and a shrimp farmer, had constructed a latrine in 1999 that was saturated in 2003 and sealed with soil. He had constructed another latrine in close proximity. After a year he sowed a coconut sapling on the saturated pit as he had heard that a coconut tree planted on a saturated produces more coconuts than one planted on plain land.

In the village of Joka, Yunus Ali, a Muslim and a peasant, had a small golpata (a type of mangrove) and bamboo business. He constructed a latrine in 2000 which was saturated in 2003, sealed with soil and kept for six months. After that he sowed a sapling of betel leaf in mid 2004 and mango seeds in mid 2005. The betel leaf tree is growing and three mango saplings are visible on the saturated pit surface. He used this saturated pit for growing plants as other people had told him that plants grown on such pits develop better. He also practices disposal of organic household waste in a dug hole and uses the compost as fertiliser.

Another example from Joka is Shujid Kumar Biwas, a Hindu who works as an agricultural labourer, who in season prepares betel nut trees by removing the bark by layers in order to collect the juice from the tree. His family had constructed a ring pit latrine in 1998 which was saturated in 2002 and sealed with soil. After few months he sowed a coconut sapling. Another pit latrine that was constructed during the same period was saturated in 2000 and sealed with soil. After almost a year, the family sowed a betel nut sapling and a chambal tree sapling. Both have been growing for at least four years. His family chose this practice because of indigenous knowledge that latrine pit are good for growing plants, passed to them by his maternal grand father, Mahendro Nath pal.

In Nurullahpur village, under Doibogya Kathi Union of Morrellganj upazila, Abdul Salam Sheikh, a Muslim and a peasant, built a pit latrine in 2000, which was saturated in 2004. He sealed it with soil and kept it for four months before sowing some root vegetables known locally as Mitya Alo or Gouz Alo, which are characterised by a bulky root growing in the soil, and thin and long creepers above ground where small roots also appear. The life of these root plants is about three years and both the roots grown in the soil and small roots grown on the creepers can be cooked and eaten. He used the saturated pit for planting this particular vegetable after watching a television programme about cultivation of vegetables, Mati O Manus (which means land and human), that the use of a saturated pit is good for growing vegetables. However, his family members were not happy that he had grown vegetables on the pit and have told him they will not eat it. Mr Salam has therefore decided to sell his entire crop in his local market and is expecting that it will provide him with an annual profit of Tk 500.

In Doibogya Kathi village, Kalam Sheikh, a Muslim and an agriculture labourer, sealed his pit latrine in 2003 after it became saturated. After a few months, he sowed bamboo saplings on the saturated pit, which have now been growing for a year and a half. He chose this method because he had heard that saturated pits are very effective for growing plants. His father's brother, Hatyem Sheikh, an agricultural labourer, constructed a latrine in 1997 that was saturated in early 2000 and was sealed with soil. After a few months he sowed a coconut sapling which has been growing for the last five years.

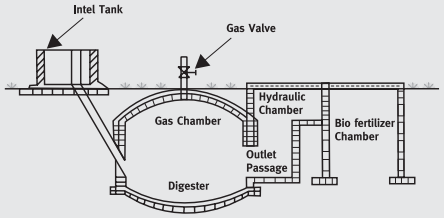
BOX 4 Basic design of the bio-gas technology promoted by government agencies

The introduction of biogas plants in Bangladesh started with the floating dome Indian type plants. Later these were replaced by fixed dome Chinese-type plants. Currently, the majority of the plants are fixed dome household-based biogas plants.

The present fixed biogas plants have an underground cylindrical shaped biogas digester constructed with brick walls and concrete. Depending on the nature of raw materials, inlet connections/tanks with digester vary. The digester is also connected to the outlet tank, which includes a hydraulic chamber, and bio-fertiliser pit. The size of the plant depends on the availability of raw materials and demand for gas. It works according to the principles of constant volume and changing pressure. When the rate of gas production is higher than that of gas consumption, pressure inside the digester rises and expels some digester contents into the outlet compartment. When the consumption is higher than production, pressure inside the digester falls and the expelled materials in the outlet compartment run back to the digester.

Biogas technology employs the technology of anaerobic digestion. It is based on the natural breakdown of organic materials under bacteriological attack in the absence of oxygen, producing a combustible mixture of gas, with up to 70% methane.

FIGURE 1 BCSIR design of a fixed dome biogas plant



Fixed Dome Biogas Plant

Source: BCSIR ,Biogas technology (Brochure in Bangla), Biogas Pilot Plant-2nd phase, Dhaka

The study found that cow dung is the main raw material in biogas plants. Although all five household-based biogas plants are linked to the household latrines, human excreta contributes only 10% of the total raw materials, while cow dung provides 90%. Use of cow dung increases with the increased demand for biogas for cooking.

However, all three community-based plants (different to household-based plants) use only human excreta for the production of biogas. The raw materials of these plants are supplied through an inlet pipe from community latrines to the digesters. An extra inlet tank for adding cow dung was constructed during the installation of the plant but were later closed, which indicates that the plants are currently able to supply the desired amount of biogas for cooking.

The use of biogas can reduce the cost of household fuel significantly. The fuel cost for those households using cow dung has decreased to less than half of previous costs, while households using human excreta are paying a very insignificant amount for energy for cooking.

The biogas plant installed at the religious institution provides energy for cooking for one quarter of consumers, meaning fuel costs have reduced by a quarter of the total cost involved.

The study found that residues from biogas plants are generally managed in an unhygienic way, being disposed into the water bodies and open places. An exception has been found in the religious institution. The Arambag Islamic Trust initially decomposes the residues with soil and organic solid wastes. After 10 to 15 days this resulting product is used as fertiliser. A few users of

BOX 5 How human excreta is used in cultivation

Mr Mohammad Abu Siddique is a Muslim and a labourer from Mongla Harbour. He owns some land within his homestead which he uses for cultivating different types of vegetables – brinjal, green chilies, 'dantashak' (amaranths); and fruits – lemon, papaya, guava, banana, pomegranate, mango, jackfruit, Safeda (Sapota) and jam, a fruit-like blackberry; nuts, date, peanuts, coconuts, betel nuts; and different types of trees – kaorah, and shundari.

When cultivating these crops, he uses compost made from human waste (10%), organic solid waste and poultry manure as fertiliser. He collects human faeces from the latrine that has been used by his family for the previous12 months and mixes it with other organic waste to produce the compost. Initially, he dug a hole of 2ft deep, and 3-4ft wide. Once the latrine has been used for one year, he stops using it for between one and one and a half months. After this period he collects all the faecal material with the help of a sweeper and carries this material to the hole that is dug to produce the compost.

He preserves the faecal material in the hole for a month and then adds to it other organic waste consisting of poultry manure, kitchen and garden waste, and leaves. All this is mixed together and kept in the hole for another one and a half months to decompose. The hole is covered with wood, banana leaves and palm leaves. He estimates each hole provides him with 40-50 kilograms of compost. After collecting the compost from the hole he processes the soil by digging and mixing the compost with soil, then he sows vegetable seeds and saplings of fruits and trees in it. In August 2005, he used the compost for cultivating brinjals, green chilies and danta in a 3 decimal area and to sow 20 guava saplings. When handling the compost he uses plastic boots and gloves which he owns from his job as a labourer.

He learned about the benefit of such compost from the Agriculture Office at Mongla in 1987 and for last three years since 2003 has used such compost on his land. He adds that the cultivation of these vegetables is particularly good during October-February, and for another three months for certain vegetables.

He gets a satisfactory amount of produce from his field. In August, some plants, particularly brinjal, were bigger in size and better in quality than usually expected at that time of year, with one of his brinjal weighing 800g. He earns in a year Tk 10-12,000 from selling vegetables cultivated on his land. Bringal alone gave him a profit of Tk 4,500.

Of the 32 guava saplings he sowed, 12 grew into trees, giving him 200 kilograms of guava. He did not sell this, rather it was consumed by him and his family, neighbours and visitors. He has 16 coconut trees which provide him with nearly Tk 10,000 per year from selling the coconuts. His 13 papaya trees give around 20 kgs of papaya which he sells. He noticed that the production of banana and papaya had significantly reduced during the year due to flooding which caused water logging for a long period of time and affected fruit production. He thinks that the use of compost in the production of agricultural outputs provides 60% higher profits than products grown with chemical fertiliser. He is concerned about his main job, labouring at the Mongla harbour, as he says securing work is becoming difficult as the number of ships entering the harbour is continually reducing. As a result, he gets just one duty shift a month which, earning just Tk 450. This is not enough to survive on, so he is devoting more time to agriculture.

Furthermore, Mr Siddique adds that in the villages of Satgaria, Malgazi and Haldibunia, many households use compost consisting of organic waste of any source, with around 100 households using human waste. However about a year ago, a local NGO ran an awareness campaign, called 'miking' because information is relayed by mobile speakers), informing people that the use of human faeces in agricultural food produce is hazardous to their health. This miking resulted in reducing the use of human waste in cultivation.

The use of human excreta and other organic compost is also practised in Malgazi in the Chaddpai Union. We observed three more cases, including Kuldeep Mondol and Biprotip Mondol both of whom are Hindu by religious affiliation, and Maneendra Halder who is a Christian. All three produce compost by using a hole in which human excreta is transferred to from used latrines. The human excreta is kept there for three months, after which other organic waste such as poultry manure, cow dung, household and kitchen waste, leave, is added. It is left to decompose to produce a compost which is later used in agricultural fields for the cultivation of vegetables, fruits, nuts and trees. These three cases also grew a number of different kinds of vegetables, such as barbiti (a kind of bean), tomato, potatoes, cauliflower, cabbage, 'puin-sak' (green leaves), lady's finger, and Lou-bottle-gourd. All the farmers feel that the compost is capable of producing more crops than chemical fertiliser and that the products appeared more healthier and looked better. In the words of Kuldeep Mondol: "Last year I used chemical fertiliser but this year I got more yield by using compost. This year I have got beans and fibrous vegetables double in quantity than last year."

BOX 6 Household-based bio-gas plants: A few instances of reuse of human and animal excreta

Gulam Mustafa lives in Dhopagata village, Baghshimaile union of Mohanpur Upazila in Rajshahi district. He works at the Agriculture Extension Directorate, as a block supervisor, and had thought about the possibility of using biogas technology. His nephew was involved with the biogas pilot plant-second phase project of BCSIR as a deputy assistant engineer. He encouraged him to install a biogas plant instead of a sceptic tank for his building which was under construction. Subsequently, in 2003 he installed a household-based biogas plant for cooking purposes in front of his house, taking advantage of the BCSIR project. The total cost of the plant was Tk 14,000 however, he spent only Tk 6,500 of his own money as Tk 7,500 was given to him from the BCSIR project. The plant occupies one decimal of land, valued at Tk 4,000. The design of the biogas plant is similar to the design promoted by BCSIR.

The digester of the plant is attached to his family latrine through an inlet pipe. The raw materials used by the plant are cow dung (90%) and human excreta (10%) supplied by six people. Each week he adds two bags of cow dung (100kg) to the plant through the inlet tank. As the family does not have any cows they have to purchase cow dung from other people, at a cost of Tk 15 for 100kg. Previously, the family used to spend Tk 400-450 per month on kerosene for cooking. Now that they have the biogas plant the household is spending just Tk 60-80 on kerosene.

Ms Jharna, housewife of the family, said that previously she used to cook with kerosene but was not comfortable doing so as the operation and maintenance of the kerosene oven is difficult. Now she enjoys cooking with biogas and finds it as good as natural gas. She says that the plant produces enough gas to cook three meals a day for her family, which consists of six adult members. When guests visit, she has to add some additional cow dung to the digester. Furthermore, to ensure cost effective utilisation of biogas, they use pressure cookers for cooking.

They family is Muslim and educated and are comfortable with using biogas produced by human and animal excreta for cooking. Until the plant started functioning, Ms Jharna was not very comfortable with the idea of using biogas for cooking. However, after the plant was installed gradually her perceptions started to change as she found no difference between natural gas and the gas available from the plant, especially as it produced no bad smells. Furthermore, the biogas stove is relatively easier to use than the kerosene stove. However, the family felt that an auto firing oven would help them to avoid the releasing of biogas while lighting the oven. This may be indicative of their 'unconscious' discomfort about the raw materials used. Other members of the family also expressed similar views. To date, there have been no problems with the plant except for some minor issues with the stove which have meant waiting for the project engineers to repair them. They have not been given any training on maintenance of the stoves.

During observations, it was found that plant area was mostly clean, although the sludge tank was covered with bamboo mat and sludge is disposed in a very unhygienic way, into an open space attached to the river. When the issue was raised with Mr Mustafa, he said that the problem would be rectified as he planned to use this sludge as compost for agriculture land owned by his family. At present a small part of the sludge is used for roof gardening.

In the entire Dhopagata village, this was the only biogas plant that reused both cow dung and human waste. However, in Rakkhithpara village, Bagmara upazila, we found four such plants. Like Mustafa's plant, we found that all four disposed of sludge in an unhygienic manner, polluting the surrounding environment. The plants were installed under the BCSIR project and had a similar design.

Of four households in Rakkithpara, only one is using a small portion of the sludge to cultivate patol (a kind of vegetable). It is to be noted that in these plants, no tests were conducted on the quality of sludge of the plants. As a result, the risks to health could not be assessed.

In is important to note that all the biogas users are resourceful. Each has a well-structured house made of bricks and concrete and annual household income ranges between US $1,300-1,400. Further, all the families are Muslim and no complaints were reported about the plants and use of human and animal excreta as raw materials. One of the users, Abdul Waheed, was a teacher at a religious institution, and finds no reason why he should not use a biogas plant. Indeed, he has constructed a community toilet for his poor neighbours. Their excreta is collected in the digester of his biogas plant as raw material, alongside cow dung. He added that he also uses a pressure cooker for cooking. In both villages, we saw no evidence of the reuse of excreta other than in biogas plant.

household-based biogas plants also use a small part of the residue for roof gardening and in other cultivations. It was observed that the households using biogas energy are relatively resourceful in terms of money. The construction of a biogas plant requires Tk 12-14,000, with 40 sq m of land needed for the installation of the plant.

Therefore, household biogas plants are not feasible for the poor due to high construction costs and the availability of adequate biodegradable material (human waste; cow dung; chicken manure). Biogas is not the sole environmental sanitation solution contributing to poverty alleviation.

On the other hand, the study also found that a biogas plant based on reuse of human excreta inevitably requires a certain amount of excreta that one or two households cannot supply. Therefore, a good number of households have to unite to generate enough raw biodegradable materials for the biogas plant to function properly and to meet the demand of energy of a single household. It was observed that two community latrines had been built to collect the excreta of poor families to power one biogas plant. The produced biogas is being used to power the house of the owner of the latrines and plant. In this manner, affluent households can support the sanitation coverage of the poorest in a community.

The designs of the biogas plants studied are basic fixed dome designs, which are promoted by government institutions; only the number of inlets for the supply of raw materials is varied. No complaints were recorded on the design and the functioning of the plants. However, owners expressed a preference for an auto-firing of the oven to avoid the release of biogas during its

BOX 7 Case study – Use of community latrine for biogas production

Mr Abul Kalam, whose relative was involved with a biogas pilot project, through his initiative in 2004 – has constructed two community latrines for his neighbouring nine poorest families, a total of 31 people. They used to practice open defecation on the bank of the river. Now the majority of them use these toilets.

Mr Kalam also constructed a bio-gas plant based on the BCSIR design. The inlet tank where cow dung was added is now sealed and human excreta is the only raw material used in this plant. The biogas produced from the plant is supplied to his house through a 150 feet gas pipe. His family uses a two-burner stove to cook three meals for the five of them. The total cost of the plant is Tk 15,000 (US$ 250), half of which had been shared by the BCSIR project. The annual income of the family during the construction of the plant was approximately US$ 1,400.

Now, Mr Kalam saves nearly Tk 300-400 per month, as he no longer purchases any biomass as fuel. However, when guests visit then they use their traditional oven made of mud fuelled by biomass. His family uses a pressure cooker, having been taught how to use one during a demonstration on using the gas for cooking. The family members are very strict on using a pressure cooker and not the traditional uncovered pot.

This family also are happy with using the biogas plant but like many other people interviewed, they said that they would prefer an auto-firing oven over the present one. Users of the plant haven't received any orientation and training on taking care of the plant and on the use of the plant in a hygienic way.

During observation it was found that the sludge of the plant is disposed in the open place through outlet pipe in a very unhygienic manner and the community latrines were not clean. The owner of the plant informed that in each year 640 kg of sludge of the plant is used on their agricultural land to improve the soil condition and during this study a farm of betel leaf on 2 decimal land was observed where the sludge of the plant was used. However, no testing whatsoever was carried out to have any understanding about the quality of the sludge. In the Dhopaghata one more such type of plant was observed and the condition related to sludge disposal was found to be similar. In Rakkhitpara no biogas plant based on exclusive human excreta was found.

BOX 8 Muslim religious institution is reusing human excreta for generating biogas for cooking and agricultural purposes

The entire village of bil Mahmudpur of Aliabad Union in Faridpur Sadar Upazila did not reuse human excreta, except for a biogas plant constructed by Arambag Atim Khana, established under Arambag Islami Trusts in 1986. Nearly 200 children, most of them orphans, live there. Cooking for this large number of children is a difficult task. For cooking, they used 'bushtech' – a processed material made of wooden dust – and had to spend Tk 20 -22 per month on fuel.

However, in 1999 LGED encouraged the trust to construct a bio-gas plant for cooking by taking advantage of the huge amount of human excreta generated in the community latrines of the orphanage. In response to a proposal from the LGED a plant was constructed. LGED contributed to the installation costs.

The plant has a 10-inch diameter fixed dome digester. It is connected to two units of toilets which includes six urinals and five lavatories that are regularly used by nearly 200 people, most of them children. The design of the plant is similar to that of BCSIR. The cow dung inlet tank is sealed, as only human excreta is used as raw material for the plant. The produced bio-gas is used for cooking purposes. The amount of biogas produced it is not enough to meet the cooking needs of he entire orphanage population, but the 20 to 25 persons it does cater for saves the orphanage nearly Tk 3,500 per month. Further, the trust has ensured proper management of human excreta.

There were no complaints from the chefs about the reuse of human excreta as a source of energy for cooking. The children too said that they did not feel uncomfortable knowing that food was being cooked by the energy generated from the reuse of human excreta. The caretaker of the plant, Mr Tariquzzaman, and the cooks say that since the installation of the plant they have not experienced any difficulties in operation and also no major repairs have been needed. During observation it was found that the plant area was very clean and sludge disposal is done in a very hygienic manner, with the sludge point covered. A female member of staff is paid to collect the sludge from the plant and dispose it into a hole with all other solid organic waste such as leaf and kitchen waste. After 10 to 15 days this compost, is used for cultivating groundnuts and vegetables in an area of 2.5 acres. Sludge is not used in aquaculture, though the institution has aquaculture. It is to be noted that no preventive hygienic measures are taken in handling the sludge.

lighting. This could be an indicator of their unconscious discomfort about the raw materials. Furthermore, the use of a pressure cooker by almost all of the users may have a similar significance, although it has not been explicitly expressed. All users said that the fire generated by the gas made cooking easier.

The study found that the users were not given the necessary guidance on sanitation and hygiene related to biogas plants. The caretakers of the plants did not have the capacity to manage even a small technical problem, which could be the result of lack of training.

Conclusion

The study found six cases of users of saturated latrine pits who are growing plants, four users of compost consisting of human excreta, producing vegetables, fruits, nuts, tree and eight cases of users of bio-gas plant in nine villages in three districts. This has given an understanding of the way human waste is reused, the purpose of reuse, and its outcome.

We have seen that the reuse of human excreta and the composting of human and animal excreta and other organic waste is being used in cultivating plants, including various kinds of vegetables, fruits, nuts and trees. Overwhelmingly the users expressed their satisfaction about the reuse of excreta in that the products grown on the saturated pit and organic compost are healthier, larger in quantity and size, and have look better. This produce can also provide them with some financial benefits.

Reuse of human excreta has often been encouraged by ancestors who practised it and passed on their indigenous knowledge to the next generation. The

present reusers learned about the benefits of human excreta as fertiliser from mass media, NGOs, government organisations and neighbours.

However, the way human excreta is reused, sludge of bio-gas plants disposed, latrines used, waste collected and mixed for preparing compost, are not convincingly safe. Individual initiatives are exclusive in the case of reuse of human waste for cultivation while governmental support is provided for the construction of bio-gas plant projects.

The reuse of human excreta is often discouraged by Islam – although during the study we found an orphanage which is managed and administrated by the Madrassa (an Islamic religious academic institution), as well as a teacher of Madrassa and many Muslim families all of whom reuse human excreta through bio-gas plant and use urine in agriculture. As this was a limited study, the sample cannot be extrapolated to the entire country. The practice of reusing human excreta for cultivating agricultural products for human consumption exists not only among Muslims but also among Hindus and Christians.

Despite the limited nature of the study, the reuse of human excreta as well as excreta of animal and other organic waste is happening in Bangladesh. However, the way it is used may be 'improper' and 'dangerous' for the health and environment of poor communities. The issue of reuse of human excreta needs to be addressed by the government, non-government organisations and international agencies.

Recommendations

This particular study focussed on a limited area and therefore does not provide an understanding of the reuse of human excreta for the entire country of Bangladesh. Therefore, the magnitude of reuse of human excreta in the entire country has to be assessed through extensive research. This proposed study should also look at the purposes of reuse of human excreta.

As the study revealed that safe and hygienic utilisation of human excreta was not practised, serious health risks exist for the people managing the re-using processes and for the consumers of the agricultural produces. The same applies to the general environment, which is likely to get heavily contaminated with improperly treated sludge from biogas plants. We recommend government and support agencies consider activities to support capacity building and information sharing related to safe and hygienic waste utilisation. Furthermore the extent of health risks to human beings from all aspects around the reuse of human excreta needs to be fully investigated.

The study also recommends that the government, non-government organisations and private entrepreneurs engaged in sanitation, incorporate reuse of human excreta into their policies and undertake initiatives and activities for safe reuse of excreta.

Given the development situation in Bangladesh, it is expected that the government, non-government organisations, including private institutions, will be intensively involved in the reuse of human excreta. The government should adopt a policy for the reuse of human excreta, allocate a budget to develop affordable and appropriate technologies, and provide subsidies to the poorest communities. NGOs can raise awareness of safe and effective utilisation of excreta, provide training

to users, caretakers, and private producers, conduct advocacy at national and local level, and carry out research to ensure the effectiveness of technologies and approaches in accordance with socio-economic and environmental context and monitor and facilitate field level operations.

Once simple and affordable designs have been developed, and communities are willing to be involved in the reuse of human excreta, the private sector can engage in ensuring the availability of hardware materials, the provision of technical building skills, and the marketing and promotion of the reuse options in their area.

References

Biswas K W, *Bangladesh's Energy sector: The past, present, and future of renewable energy technologies*

DPHE, UNICEF and VHSS (1995) *Women in the context of sanitation, water supply and hygiene: A village based study*, unpublished

Edwards P (1992) *Reuse of Human Wastes in Aquaculture: A technical Report*, UNDP-WB-ASP, USA

Kazi A (2002) *The Urgency of Application of Biogas Technology: Bangladesh Perspective*, Bangladesh Renewable Energy Newsletter, vol.1 No-2, Bols 2 & 3 July and December 2002

Quazi A R (2003) *Impediments Towards sanitary Latrine Coverage: The case of Rural Bangladesh*, NGO Forum for DWSS, Dhaka

Quazi A R (2005) *Wastewater Irrigation in Dhaka*, unpublished

Quazi A R (2005) *Wastewater Irrigation in Rajsahi*, unpublished

Rahman M H, Mottalin M A and Bhuiyan MH (1996) *A Study on Biogas Technology in Bangladesh*, 22nd WEDC Conference, 1996, New Delhi, p-340

Rahman M H (1998) *Reuse of human and animal wastes in Bangladesh*, 24th WEDC conference, Islamabad, 1998

Renewable Energy Information Network, *Bio Energy Development*, http://www.lged.org/sre/bio-energy.htm

Rottier E and Ince M (2003) *Controlling and preventing disease : the role of water and environmental sanitation interventions*, Loughborough, UK, Water, Engineering and Development Centre

Skillicorn P , Spira W and Journey W *Duckweed Aquaculture; A New Aquatic Farming System For Developing Countries*, The World Bank Emena Technical Department, Agriculture Division http://www.p2pays.org/ref/09/08875.htm

The Bangladesh Observer, 15th May 2004

Acknowledgements

The authors would like to thank Mr. S.M.A. Rashid, executive director, NGO Forum, and Dr Shah Jalal, professor at the Department of Anthropology at Jahangir Nagar University for providing editorial support. They would also like to acknowledge the support provided by Mr. Mizanur Rahman, and Mr Qamruzzaman of NGO Forum and Md. Motasheen Bilah of Mohanpur during the field survey.