Nothing left to waste

The prospects for faecal sludge-based organic fertiliser in Bangladesh

Digbijoy Dey, AT M Ridwanul Haque, Babar Kabir, Elisabeth Kvarnström, Peter McIntyre, Sharmin Farhat Ubaid

September 2015

in association with

For more information on the content of this report, please contact: Digbijoy Dey, digbijoy.de@brac.net at BRAC WASH, Dhaka, Bangladesh.

The present version has been reviewed by Annika Nordin (researcher Swedish University of Agricultural Sciences) and Ingeborg Krukkert (IRC). This report has been edited by Peter McIntyre and Tettje van Daalen and formatted by Marion Giese.

Cite this material as follows:
Dey, D., Haque, R., Kabir B., Kvarnström E., McIntyre P., Farhat Ubaid S., 2015. *Nothing left to waste*: *The prospects for faecal sludge-based organic fertiliser in Bangladesh*. The Hague: IRC and Dhaka: BRAC.

For more information on the BRAC WASH programme, contact BRAC or IRC.

BRAC Centre
75 Mohakhali
Dhaka-1212
Bangladesh

Tel: +88(0)2 988 1265/ 882 4180-7
Email: info@brac.net

IRC
Bezuidenhoutseweg 2
2594 AV The Hague
The Netherlands

Tel: +31(0)70 304 4000
Email: info@ircwash.org

Contents

Tables

Figures

1 Executive summary

Since May 2006 the BRAC WASH Programme in Bangladesh has enabled more than 30 million people to achieve hygienic sanitation, contributing to an increase in sanitation coverage from 33% to 83% in programme areas and rapid progress towards universal access. Long-term sustainability depends on finding robust approaches to the collection, treatment and re-use of faecal sludge from millions of pit latrines in use in rural areas. BRAC WASH has researched how to develop a viable process for faecal sludge-based organic fertiliser.

In rural areas most families have single-pit latrines that need to be emptied when full, or to be sealed up and a replacement pit dug. Since 2007, BRAC has promoted the use of hygienic double-pit latrines. Use of double-pit latrines, where appropriate, is also recommended in the Bangladeshi Draft National Water Supply and Sanitation Strategy. More than one million double-pit latrines are in use in BRAC WASH areas, delaying the need for emptying and allowing time for the faecal matter to decompose while the resting pit is sealed.

This paper focuses on a study undertaken by BRAC WASH to treat and safely use faecal material from double-pit latrines as an organic fertiliser for rice and other crops.

The study investigated the removal of pathogens from pit waste through simple solar drying and conducted field trials of faecal sludge-based fertilisers. The results are promising and a market survey showed high levels of interest amongst farmers and fertiliser dealers for safe, affordable organic products to supplement the use of chemical fertilisers. BRAC has applied to the Bangladesh Agricultural Research Council for an organic fertiliser permit.

2 Introduction

Progress in reducing open defecation and use of improved sanitation in Bangladesh has been impressive. Between 1990 and 2012 rates of open defecation in rural areas of Bangladesh fell from 30 percent to 3 percent and access to improved sanitation rose from 30 per cent to 57 per cent[1].

In 2006, BRAC initiated a comprehensive intervention on water, sanitation, and hygiene (the BRAC WASH Programme). The main focus is on behaviour change that impacts on people's health and welfare: sustainable use of sanitation, safe use of water and the adoption of hygienic practices. The programme originally covered 150 upazilas (sub-districts) and subsequent phases expanded to 250 upazilas out of a national total of 488. During the period 2006-2013, the programme reached 63.5 million rural people with hygiene education. The second phase of the programme (2011-2015) focused on sustaining progress, with special attention on low cost and sustainable sanitation in areas that are geographically remote, geologically difficult or socially deprived.

[1] World Health Organization and UNICEF, 2014.

The programme has promoted the use of sanitary latrines that separate faeces from human contact and do not cause contamination of water sources. In intervention areas 30.7 million people can now access sanitary toilets. Construction was supported through grants and by promoting demand. Repair of unhygienic latrines was helped by loan support. In the same areas 1.9 million more people can access water free of arsenic and faecal contamination[2].

At the outset the programme promoted single-pit latrines but since 2007 has championed double-pit models, with the preferred option now being a twin-pit latrine where the superstructure remains in place and a switching system directs material to one of the two pits. Typically these pits comprise three concrete rings to form the pit lining, and a top slab with an integral plastic pan and "goose-neck" style water seal. Most slabs are made of concrete but it is possible to use a smaller concrete or plastic 'SanPlat' laid on top of a latrine cover made from wood and other 'natural' materials (Figure 1).

By the end of 2013, more than 800,000 households had received a double-pit latrine with support from BRAC[3] and by 2015 more than one million of these latrines were in use in programme areas.

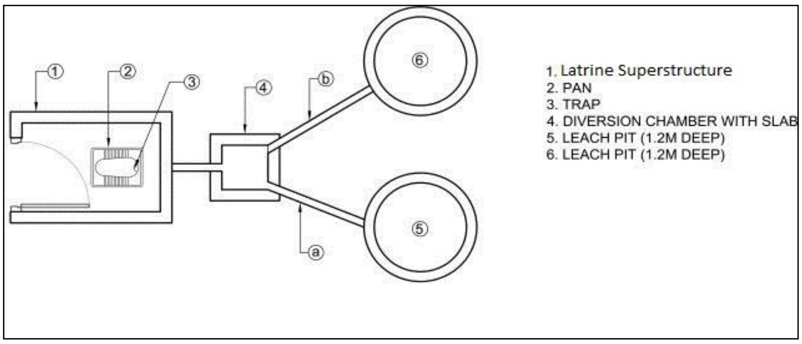

Figure 1 Twin-pit latrine model. The superstructure remains in place and a switch mechanism directs material to the pit currently in use

Action is required to deal with human waste once hygienic latrines are full. Environmentally safe collection, transport, treatment, and productive re-use of treated human waste within a well-constructed and well-managed sanitation service delivery chain has the potential to safeguard the environment, improve public health, and provide financial benefits to users and service providers.

Typically the first pit is sealed for a year or more before emptying. Although it is usually assumed that disease-causing organisms will be destroyed by natural processes during this time, concerns remain about the safety of the faecal sludge from these latrines.

[2] Sanitation status at household level in BRAC WASH I areas: changes from baseline to end line survey page 33 BRAC Research Monograph 2013.

[3] No of double-pit latrines BRAC MIS Report 2013.

3 Approach and methodology

This paper describes technical and market research carried out as part of the BRAC WASH II programme to explore the potential of agricultural re-use of human faecal waste derived from double-pit latrines in Bangladesh.

Calculations based on UN Food and Agriculture Organization (FAO) figures suggest that the average family in Bangladesh produces the fertiliser equivalent of 25 kg of urea, 10 kg of triple super phosphate (TSP) and about 13 kg of muriate of potash (potassium chloride) yearly[4]. Bangladeshi farmers have traditionally used faecal sludge from livestock and humans as a fertiliser or soil conditioner because of its positive impact on yields. This traditional use of faecal sludge to enrich agricultural fields is not usually disclosed to buyers, due to a perception that consumers would not willingly buy crops produced in this way.

The re-use of treated faecal waste in the agricultural sector has potential but there are obvious constraints; notably any product has to be safe for human use and acceptable to consumers. The safe use of composted faecal sludge as organic fertiliser would not only have a positive impact on the agriculture sector, but would also provide a sustainable solution to the increasing accumulation of faecal sludge in rural pit latrines.

3.1 Faecal sludge sampling and testing methodology

This study looked at faecal sludge recovered from typical BRAC double-pit latrines in rural Bangladesh.

Micro-biological and chemical tests were carried out on faecal material collected between May 2012 and December 2013 from ten representative pits from each of the seven climatic zones of Bangladesh (Figure 2)[5]. All the pits tested had been resting without being used for a year or more.

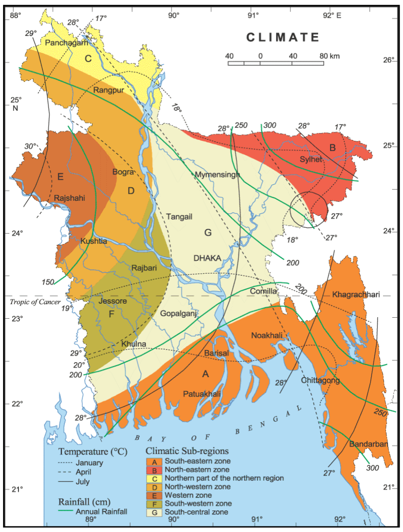

Figure 2 Seven climatic zones of Bangladesh

---

[4] http://faostat.fao.org/site/575/default.aspx#ancor.

[5] The BRAC WASH programme is implemented in all seven zones.

Following the standard sampling procedure of US EPA[6], samples were collected from three different depths of each pit. Pathogen analysis was done on all three samples assessing E.coli, Salmonella, C. perfringens and helminths (cestode and nematode). The formol ether method was used for helminths enumeration and the zinc flotation method (us-epa) for viability analysis. Samples from the three depths were mixed into a composite sample for each pit which was analysed for pH, macro- and micro-nutrients, and heavy metals.

Solar drying was used as an additional treatment and the same tests were repeated. For this second round of tests, samples from all seven zones were mixed, sun-dried and tested at the onset of the experiment and after 7, 15, 30, 45, 60 days of drying.

3.2 Field trial methodology

BRAC WASH designed an experimental study with the assistance of BRAC Agriculture and Food security programme expertise, to capture and re-use resources such as nutrients, organic matter, energy and water, by using the sun dried faecal sludge as a fertiliser. A standard plot was designed for field trials and different doses of faecal sludge and chemical fertiliser were applied to rice (the staple food). The plot contained 25 decimal of land. The trial was undertaken to observe the growth and yield under both controlled and normal environmental conditions.

In the first field trial the BRAC agricultural laboratory compared three treatments: an optimal dose of chemical fertiliser on its own, and then the same dose of fertiliser with a further 10 tons/ha (wet weight) of either cow dung or faecal sludge. Each treatment was replicated three times under a controlled environment in fields at the laboratory site. The field was monitored by scientists and data was stored every day. The second trial measured the yield under the fluctuating, natural conditions of an ordinary agricultural field and was done by regular farmers. This compared the yield between crops grown using the conventional dose of chemical fertiliser for rice (as regularly practised by farmers), and crops grown using two-thirds of that chemical fertiliser dose plus 9.5 ton/ha of faecal fertiliser. Cow dung was not used in this trial.

3.3 Market research methodology

A sample of 70 farmers, 70 fertiliser dealers and 70 pit emptiers were interviewed, asking specific questions related to the fertiliser market and soil conditioning. To achieve a representation of markets and soil conditions across the whole country, 10 farmers, 10 fertiliser dealers and 10 pit emptiers were selected randomly from each zone.

Interviews mapped demand by asking farmers about factors such as monthly usage of different fertilisers, expenditure on organic fertiliser, their familiarity with the use of sludge as fertiliser, their willingness to pay and their overall acceptance of faecal sludge as a fertiliser.

In addition 70 fertiliser dealers were interviewed about their interest and willingness to participate in the production and/or marketing of faecal-sludge-derived products.

The pit emptiers were interviewed about the frequency of pit emptying, pricing and regional differences, monthly income, different uses of faecal sludge, methods of attracting

---

[6] US-EPA The sampling procedures and protocols for the national sewage sludge survey, August 1988.

customers, areas of disposal and problems with dumping sludge. They were asked for their opinion on the acceptability of faecal sludge-based products, suggestions for developing the business concept and whether they would be interested in aligning themselves with such a business.

4 Results

4.1 Results of the field trials

Faecal sludge taken from a pit that has been sealed for 12-13 months weighs about 15-20 kg and still contains 25-30% moisture. All the samples complied with the Bangladeshi standard for organic fertiliser except for potassium and pH, which were both below the standard, and the moisture content was too high. There was also a trend showing reduced viability of helminths and this effect was greater with a longer period for drying. Drying for seven days reduced the measured E.coli content to < 1 cfu/gram in all samples. In most cases the pH was below the value of 6-8.5 required in the Bangladesh national standard. Phosphorus (P) content was, for some samples, above the standards for organic fertilisers while Potassium (K) was lower than the standard.

Table 1 Chemical analysis report of faecal sludge (Average of 70 samples)*

Value	pH	Moisture Content	Organic Carbon	Organic Nitrogen (N)	Phosphorus (P)	Potassium (K)	Sulphur
Average Value of sample	5.9	30.07	17.11	1.45%	1.51%	0.39%	0.3%
National Standard	6.0 – 8.5	10-20%	10-25	(0.5 – 4.0) %	(0.5 – 3) %	(0.5–3.0) %	(0.1–0.5) %
	Zinc	Copper	Arsenic	Chromium	Lead	Nickel	Mercury
Average Value of sample	0.05%	0.03%	13 ppm	26 ppm	15 ppm	18 ppm	0.05 ppm
National Standard	Max0.1%	Max0.05%	Max 20 ppm	Max50 ppm	Max 30 ppm	Max 30 ppm	Max 0.1 ppm

* Selected heavy metals were analysed based on the guidelines of the Bangladesh Agricultural Research Council (BARC)[7]

4.2 Treatment to improve results

Figure 3 shows the number of species of viable helminths in mixed samples before drying and after 7, 15, 30, 45 and 60 days of sun drying. In all cases, after 60 days, viable helminths dropped to zero while pH increased.

[7] http://www.barcapps.gov.bd/documents/books/Fertilizer%20Recommendation%20Guide%20-%202012.pdf.

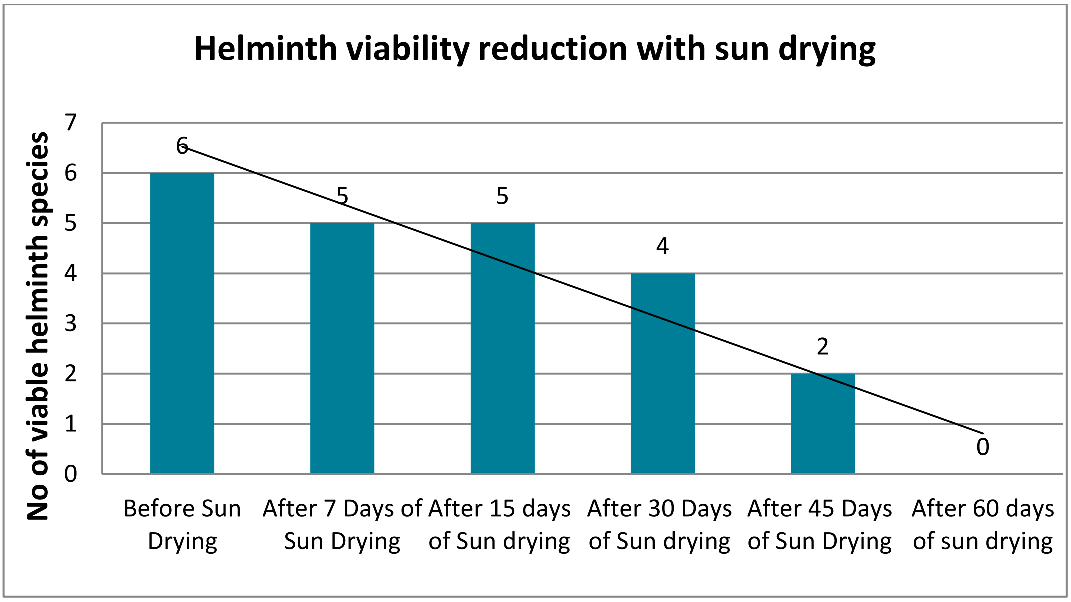

Figure 3 Viable helminths in mixed samples after sun drying

In terms of nutrients, the main deficiency was in the potassium (K) content. Organic matter rich in potassium was added to the sludge which not only raised overall K level but also increased the pH level. Three different organic substances (sawdust, rice husks and oil cake) were mixed in at different ratios. Chemical analysis showed that the addition of sawdust was more effective than rice husks or oil cakes. Sawdust can be recommended based on its availability in rural areas and its ability to increase K concentration to meet Bangladeshi organic fertiliser standards. 10% addition of sawdust has the ability to increase the pH up to 0.5.

Table 2 Chemical analysis report of double-pit latrine content (faecal sludge) after sun drying for 60 days and a 10% (wet weight) addition of nutrient

	pH	Moisture Content	Organic Carbon	Organic Nitrogen (N)	Phosphorus (P)	Potassium (K)	Sulphur
Average Value of sample	6.3	18.56	17.11	1.45%	1.51%	0.66%	0.3%
National Standard	6.0 – 8.5	10-20%	10-25	(0.5 – 4.0) %	(0.5 – 3) %	(0.5–3.0) %	(0.1–0.5) %
	Zinc	Copper	Arsenic	Chromium	Lead	Nickel	Mercury
Average Value of sample	0.05%	0.01%	5 ppm	20 ppm	15 ppm	10 ppm	0.05 %
National Standard	0.1%	0.05%	20 ppm	50 ppm	30 ppm	30 ppm	0.1 ppm

4.3 Results of the field plot trial

BRAC WASH has tested the nature of treated faecal sludge as an organic fertiliser. This was done through a field trial with the help of the BRAC Agriculture and Food Security department. The field trial was held in the BRAC field station. The idea was to test the fertilising value of the faecal sludge-based fertiliser in a preliminary field trial. A common variety of rice (breed-Aloron) was chosen for that. Three different doses of fertiliser were used as treatment for the trial. One treatment consisted of only chemical fertiliser, the second of chemical fertiliser together with faecal sludge-based fertiliser and the last treatment contained chemical fertiliser with cow dung. The yields were similar across the three different treatments. No anomaly was seen among the plants from their regular behaviour.The method of cultivation was no different from other fields using organic or chemical materials; the plants grown with faecal sludge did not need any special care or management. Disease and pest control were standard for both treatments.

BRAC field trial plot (Photo: BRAC, Bangladesh)

As agricultural soil is depleted in organic matter in Bangladesh, this would also make a significant contribution towards enhancing organic matter in the soil[8].

As a result of the findings in the laboratory tests and the field trial, BRAC has applied for an organic fertiliser permit with the Bangladesh Agricultural Research Council, which will carry out its own investigations.

---

[8] Akter, Alam and Chowdhury (2012), Soil Organic Matter, Mineral Nutrients and Heavy Metal Status of Some Selected Regions of Bangladesh. J.Environ.Sci. & Natural Resources, 5(2):01-09, 2012.

4.4 Results of market analysis

Interviews with farmers, fertiliser dealers and pit emptiers gave insights into demand and pricing options against rival products; vital knowledge for any new product entering a market. Farmers represent the target market for organic fertiliser and their perspectives are therefore important.

Of the farmers interviewed, 39% already use organic fertiliser (Figure 4). Of these more than a quarter use faecal sludge. However, Figure 4 also shows that more than 60% of the farmers use only or mostly chemical fertilisers and more than 80% use at least some chemical fertiliser. They do so because they are not satisfied with available commercial organic fertiliser due to its low quality and higher price. Currently, only 19% of farmers use mainly organic fertilisers and only 3% were completely organic. Figures are for all forms of organic fertiliser—not only those based on faecal sludge.

Farmers cited improved yields and the lack of quality commercial organic fertilisers or cow dung as reasons for using chemical fertiliser (Figure 5).The vast majority of respondents (93%) believe that organic fertilisers are beneficial in terms of yield and crop growth. However, the use of commercial organic fertiliser is shrinking due to the sub-standard quality of some products on sale. Of the farmers interviewed for this survey, 39% used cow dung on its own, while 37% of farmers prepared their own fertiliser using cow dung mixed with kitchen waste and poultry litter, and 14% of farmers purchased organic fertiliser from market place. Overall 26% of farmers had experience of using faecal sludge-based fertiliser and 13% said that this resulted in a better yield. One farmer said: “This is the first year I have used faecal sludge. The harvest is better than in previous years.”

One third of the farmers listed conditions they believe would be necessary for faecal sludge-based fertiliser to become a profitable business proposition: it should be less costly than other organic or chemical fertilisers; raw materials (undisturbed or treated dried faecal sludge and ash) should be readily available, the fertiliser should be odour and germ free with packaging as good as for other organic fertilisers, and consumers should be ready to accept produce grown with such a product.

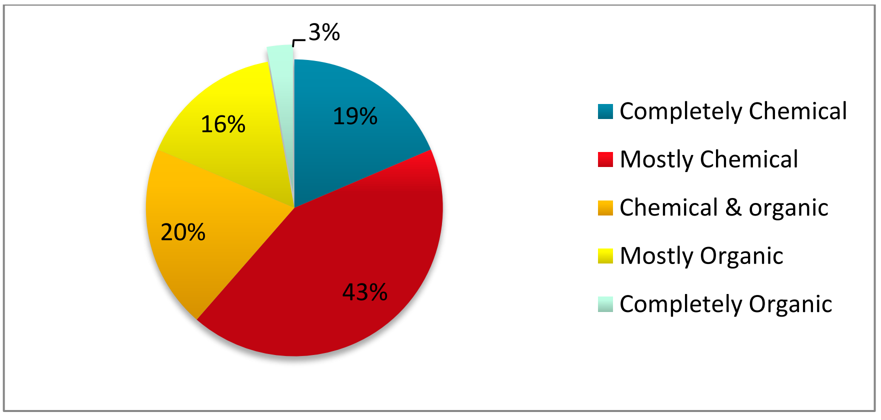

Figure 4 Use of different fertilisers by farmers

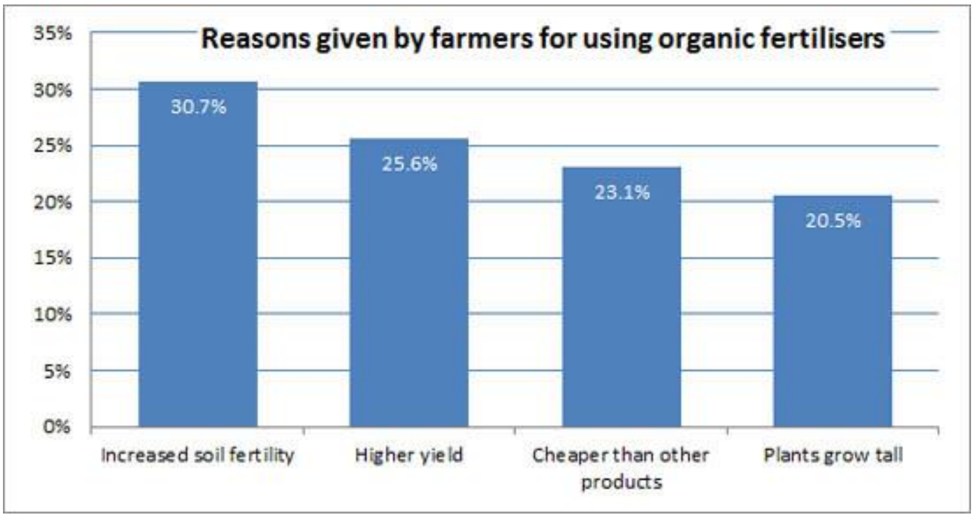

Figure 5 Reasons for using organic fertilisers

NB: Figure 5 shows reasons amongst farmers who did choose organic fertilisers. Between them they represent only 39% of the total farmers in the survey. 61% of farmers did not use any organic fertilisers.

Many fertiliser dealers are also farmers and were able to look at the issue both as sellers and users. In most of the study areas fertiliser dealers mainly sell chemical fertiliser and Jaibosaar, an organic fertiliser targeting small scale farmers. Prices vary from Tk.10-80 per kg (US$ 0.13-1.03) for organic fertiliser. Fertiliser dealers expressed strong interest in becoming entrepreneurs either as producers or sellers of faecal sludge-based fertilisers, as using faecal sludge is already a common practice for some crops. The majority who expressed an interest (66%) were interested in starting a production business across the whole chain from collecting pit contents to processing, packaging and marketing. Those who were not interested cited the need for additional manpower and capital while some believed it would adversely affect their social status. Almost all the dealers we interviewed would be interested in selling the fertiliser. Only one dealer expressed disgust at the thought of selling fertiliser made from faecal sludge.

Many of the fertiliser sellers are also farmers and in this survey 57% of fertiliser sellers said that they would purchase faecal sludge at Tk.15 (US$ 0.19) per kilo. The farmers in the survey who would use faecal sludge-based fertiliser also said they would be willing to buy it at a price of Tk.15 per kg, which is considered to be a possible price point.

Just over three-quarters (75%) of the 70 pit emptiers interviewed, were interested in working with faecal sludge products. Those who were not interested cited lack of time, lack of confidence in the product or disgust at associating faecal sludge with food production.

Sludge collection (Photo: BRAC, Bangladesh)

Most pit emptiers emphasised the need to generate awareness among farmers and suggested meetings, promotion campaigns and talking about the benefits while selling or cleaning. To generate awareness they suggested advertisements, posters and leaflets, an exhibition plot, and meetings with farmers. Almost a quarter of the emptiers said it would be more beneficial to show the actual results at a demonstration plot than simply to talk about the product. They expressed the view that that many farmers have misconceptions or do not know the benefits of faecal sludge.

5 Conclusions

Laboratory results showed that faecal sludge that has been undisturbed in a sealed pit for a year or more can be pathogen free after 60 days of sun drying in Bangladesh and comply with national fertiliser standards after addition of rice husk and saw dust. Blending dried faecal sludge with other organic materials produces a product which has a positive impact on crop yields.

More than three quarters of the pit emptiers and two thirds of fertiliser dealers who were interviewed showed an interest in developing a faecal sludge-based organic fertiliser business. Fertiliser dealers showed a willingness to sell this type of fertiliser. Business stakeholders are supportive and most farmers will purchase faecal compost if the quality is good and the price is within the range of Tk.15-18/kg.

There is a big opportunity to develop a business model on faecal sludge-based organic fertiliser, as its use in a much less safe way is already a conventional practice in agriculture. Faecal waste is rich in major nutrient elements and has a beneficial effect on soil fertility, which is depleted by excessive use of chemical fertiliser.

Investing in the development of suitable and safe faecal-sludge-derived products is justified by the willingness of producers, dealers and farmers to participate in such a market.

The survey points to the need to raise awareness among farmers and dealers and amongst consumers of farm crops to develop a successful business and address supply and demand issues. The need to demonstrate efficiency of the product was raised by the pit emptiers as one awareness strategy. There is clearly a market for faecal sludge if it is promoted, packaged and priced in an appropriate way.

The double-pit latrine in general and twin-pit latrine in particular is cost effective and durable and has the potential to be the start of a chain leading to the safe disposal of human waste and its productive re-use. Processing faecal sludge for use in agriculture is a promising avenue which has the potential to contribute to good environmental management and reduce dependence on imported chemical fertilisers in Bangladesh.

Chemical fertiliser is subsidised in Bangladesh which gives it a potentially unfair competitive advantage over organic fertilisers. Organic fertilisers are much better as soil enhancers as well as producing improved yields when substituting for some of the chemical fertiliser. Moreover, the use of a fertiliser based on faecal sludge addresses a social problem in Bangladesh that is going to become ever more acute – how to deal with sludge from millions of pit latrines. It would seem to be a win-win policy to at least ensure that the organic compost is not at a commercial disadvantage. There is clearly scope for a good quality faecal sludge-based organic fertiliser if it can be produced at a competitive price. This area merits further investigation.

About BRAC

BRAC is a global leader in creating large-scale opportunities for the poor. Founded in Bangladesh in 1972, it is now the world's largest development organisation. Over 100,000 BRAC workers touch the lives of an estimated 135 million people in 11 countries, using a wide array of tools such as microfinance, education, healthcare, legal rights training and more.

About IRC

IRC is an international think-and-do tank that works with governments, NGOs, businesses and people around the world to find long-term solutions to the global crisis in water, sanitation and hygiene services. At the heart of its mission is the aim to move from short-term interventions to sustainable water, sanitation and hygiene services. With over 40 years of experience, IRC runs projects in more than 25 countries and large-scale programmes in seven focus countries in Africa, Asia and Latin America.