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Decentralised composting in Bangladesh, a win-win situation for all stakeholders

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Abstract

The paper describes experiences of *Waste Concern*, a research based Non-Governmental Organisation, with a community-based decentralised composting project in Mirpur, Dhaka, Bangladesh. The composting scheme started its activities in 1995 with the aim of developing a low-cost technique for composting of municipal solid waste, which is well-suited to Dhaka's waste stream, climate, and socio-economic conditions along with the development of public–private–community partnerships in solid waste management and creation of job opportunities for the urban poor. Organic waste is converted into compost using the "Indonesian Windrow Technique", a non-mechanised aerobic and thermophile composting procedure.

In an assessment study conducted in 2001, key information on the Mirpur composting scheme was collected. This includes a description of the technical and operational aspects of the composting scheme (site-layout, process steps, mass flows, monitoring of physical and chemical parameters), the evaluation of financial parameters, and the description of the compost marketing strategy. The case study shows a rare successful decentralised collection and composting scheme in a large city of the developing world. Essential for acceptance by consumers was that the composting scheme was able to get formal approval from the Bangladesh Agriculture Research Council on the use of the compost product for agricultural purposes as well as policy support by the Ministry of Agriculture.

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Financial success of the scheme is based on the fact that large bulk buyers of compost were found. The compost product is mainly sold to fertiliser producing companies which blend the compost with additives/nutrients to suit different customers. Sales of the products are then done through existing agricultural extension services and retail networks of these companies. Thus the compost marketing strategy of the composting schemes is based on letting others do the individual marketing of the compost. The case of Mirpur shows that composting can be a good alternative to conventional solid waste management options, reducing the amount of waste to be transported and dumped and producing a valuable raw material for fertilisers.

Keywords: Decentralised composting; Compost marketing; Biological treatment; Organic municipal solid waste

1. Introduction

Urban solid waste management is considered to be one of the most serious environmental problems confronting urban areas in developing countries (Pfammatter and Schertenleib, 1996; Sinha and Enayetullah, 2000a; WRI et al., 1996) and the city of Dhaka in Bangladesh is not an exception. Inadequate collection and uncontrolled disposal of solid waste results in a serious health threat to inhabitants and environment (Birley and Lock, 1999). Waste recovery such as recycling and composting is an obvious option of reducing the waste amount to be disposed of. Furthermore with composting, valuable nutrients and organic matter can potentially be returned to the soil.

Recycling of inorganic waste is common in many countries and mostly practised by the informal sector (Furedy, 1989; Furedy and Bubel, 1990; Sinha and Amin, 1995). Composting however, is usually still not wide spread, although in cities of low- and middle-income countries often more than 50% of the total waste amount is organic and biodegradable (Dulac, 2001; Stentiford et al., 1996). Many institutions doubt the feasibility of composting as a sustainable means of organic waste recycling. Indeed the image of composting is dominated by the failed examples of oversized, over-mechanised, and centralised plants (Hoornweg et al., 1999). Small scale and decentralised approaches are more successful but often also struggle with the marketing of the compost product (Gamage et al., 1998; Pitot, 1999; Tuladhar and Bania, 1998; Zurbrugg and Aristanti, 1999). Many previous projects regarding composting were initiated with a focus on technological or social issues. The importance of financial aspects and the availability of markets for compost were often neglected. According to the process cycle of composting, marketing is the last link in the chain. On the other hand, a detailed market analysis and a marketing strategy for the compost product are essential for the success and durability of a plant set-up and should be elaborated beforehand.

Five municipalities form the megacity of Dhaka, comprising a population of approximately 10 million and an area of 1530 km^2. The Dhaka City Corporation (DCC) is responsible for the management of solid waste for the main city municipalities, an area covering 360 km^2 with a population of 6.5 million. In the DCC area about 3000–3500 metric tons of municipal solid waste is generated daily and the total land required for disposal of solid waste in Dhaka City is estimated at 110 ha per year (Kazi, 1999). With increase in popula-

tion and horizontal expansion of the city, it has become very difficult to find adequate waste disposal sites for the future. Consequently long haulage will be necessary thus increasing transportation costs. The composition of mixed solid waste generated in Dhaka City shows an average of 70% by weight consisting of food and vegetable waste (Kazi, 1999). This amounts to a total of 2100–2450 tons of easily biodegradable organic waste which potentially, by a decentralised treatment approach, can be removed from the waste stream saving transportation and disposal volume and costs.

2. Approach

The study of the Mirpur-Dhaka composting scheme followed an approach that comprised: (a) a technical and scientific evaluation of the composting process itself, (b) an organisational and financial assessment of the collection and composting scheme, (c) an analysis of the compost marketing strategy, and (d) a rough financial analysis regarding the municipal institutions and their budget. Fig. 1 describes the issues considered for the assessment, which state the overall approach for the evaluation of the feasibility of a decentralised composting scheme.

The overall assessment was conducted by on-site investigations over 3.5 months. This approach together with earlier data recorded by the composting plant staff, ensured an understanding of the serviced community's organic solid waste stream, starting from the source of waste generation up to the customers of the final compost product. Following a short description of the composting process, the emphasis of this paper is set on the financial aspects as well as the marketing strategy of the Mirpur composting scheme.

Transparent bookkeeping by the plant manager and further investigations allowed a detailed analysis of the financial situation of the plant. Two scenarios were compared for a financial evaluation:

1. Financial situation with the production level at 1.7 tons of collected waste per day (situation during the study, January–March 2001).
2. Financial situation in the case of full design capacity at 3 tons of collected waste per day (situation after mid-2001).

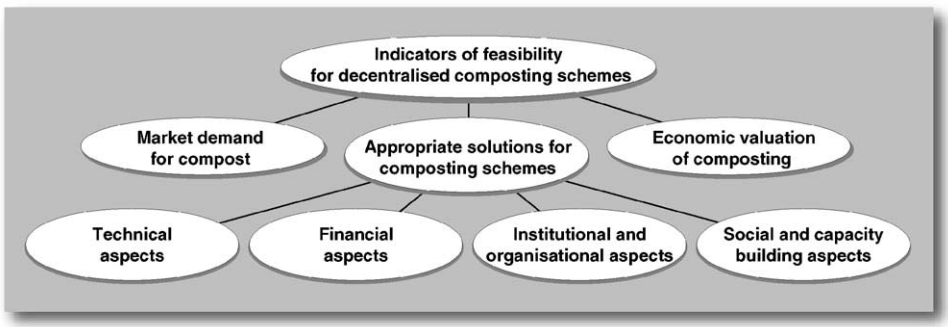

Fig. 1. Elements to assess the feasibility of decentralised composting plants.

Investment costs, running (operational) costs, and revenues were established on-site by means of interviews, recording of man-hours needed for the different process steps, and analysis of accounting books. Both cost categories comprise waste collection, as well as composting activities. The figures of the second scenario at full design capacity, were elaborated based on the experience gained with the current situation.

3. Results

3.1. Organisational set-up

The collection and composting scheme was initiated by *Waste Concern*, a non-governmental research based organisation, with a donor grant. Its aim is to improve the solid waste condition in Bangladesh. Waste Concern works in partnership with government, private sector, local communities as well as international agencies. Over time, with continuous exchange and discussions with the city authorities, Waste Concern has managed to build up an enabling environment of trust between all stakeholders. Their success bases on the professional, business oriented, scientific and social-entrepreneurship approach. Amongst other things, the activities of Waste Concern comprises solid waste management and resource recovery where composting plays an essential role. The organisational set-up of the collection and composting scheme follows a business approach, which implies that the collection and composting activities are sustained only by revenues generated from waste collection fees and compost sales. Table 1 gives an overview of all actors involved at the Mirpur collection and composting scheme.

Table 1
Actors involved in the decentralised composting scheme in Mirpur (Waste Concern is abbreviated by WC)

Actors/stakeholders	Actions
Waste generators	
Households	Give their solid waste to WC and pay for the collection service
(Vegetable markets)	Give their solid waste to WC
Waste Operators	
Waste Concern	Collects the solid waste from households and markets, sorts it into different fractions and converts the organic waste fraction into compost
Dhaka City Corporation (DCC)	Collects the inorganic rejects (after sorting) from the composting site of WC
Compost buyers/users	
M/S. MAP Agro Industries	Buy and enrich compost on behalf of Alpha Agro Ltd.
Retailers	Buy (enriched) compost from Alpha Agro Ltd. and sell it to the farmers
Nurseries	Buy compost from WC and use it for plant cultivation
Farmers	Buy compost from retailers and apply it on their fields
Waste Concern	Use their compost (raw and enriched) for their nursery and farming demonstration

3.2. Process description

Composting is one part of an overall improvement of the waste situation in the target area. Waste Concern established a house-to-house daily collection service by means of rickshaw vans (3-wheeled bicycles) with a capacity of 1.18 m^3. The collected mixed household waste is pre-sorted at the composting site, before composting. During the assessment study, in the first half of 2001, the plant treated 1.7 tons of municipal waste per day, which was collected from 790 households in the Mirpur city area. The design capacity of 3 tons/day was reached by the end of 2001, serving 1430 households. Currently 10 people are employed at the composting plant. Organic waste is converted into compost using the "Indonesian Windrow Technique", a non-mechanised aerobic and thermophile composting procedure (CPIS, 1993; Zurbrugg and Aristanti, 1999). The pre-sorted organic waste is mixed with additives, such as cow dung, sawdust and urea (Fig. 2), and piled around a triangular aerator rack made of bamboo, which allows improved air circulation inside the pile. The total composting process lasts 53 days, which can be described by a thermophilic phase (27 days at 45–70 °C) and a mesophilic phase (26 days at 30–45 °C). During the thermophilic phase, which initiates

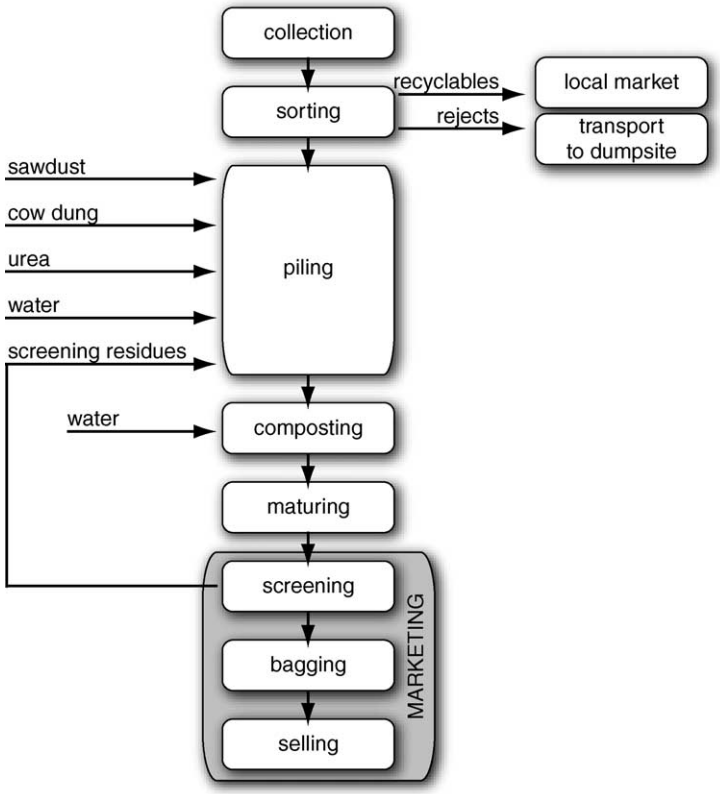

Fig. 2. Flow chart of the composting process.

very rapidly, the compost piles are turned frequently to regulate their temperature and ensure an equal decomposition level throughout the pile. The turning process, together with the monitored temperature data indicates that the pile is well hygienised and pathogenic organisms and weed seeds do not survive. Additional analysis of Helminth eggs confirmed this indication. Although nematode eggs such as Ascaris and Trichuris were identified, incubation showed that they were not viable in the compost (Rytz, 2001). As the pile temperature drops to ambient temperature (∼30 °C) the material is left to mature without turning or watering. Final compost samples analysed, showed a SOLVITA Maturity Index® of 6. Waste Concern adjusts the compost moisture content to the requirements of their main client, a fertiliser trading company. The mature compost is then screened (4 and 2 mm mesh sizes) and packed in 50 kg bags. In addition to compost sales, the composting plant runs its own nursery and a farming demonstration plot, where the effect of compost on vegetable yield is visualized for demonstration purposes. Fig. 2 shows a schematic diagram of the whole composting process.

3.3. Financial assessment

The plant in Mirpur was started as a demonstration project and was not run at full capacity until mid 2001. Therefore, two cases were compared for financial evaluation:

1. Financial situation with 1.7 tons of collected waste per day.
2. Assumed financial situation in the case of full capacity (3 tons of collected waste per day).

Regarding the investment costs it must be pointed out, that costs for land were calculated separately as the land was provided to *Waste Concern* by the Lions Club, Dhaka Northern for free.

Three types of revenues from the Mirpur scheme were also assessed and can be categorised as follows:

1. Income from collection fees (approximately Tk. 17 per household and month according to their financial situation). These are the fees charged by the collection scheme to the service beneficiaries (households) on a monthly basis.
2. Revenues from the compost sales (Tk. 2.5/kg).
3. Revenues from the sale of recyclables like hard plastic, cardboard, glass and metal.

Table 2 shows a summary and comparison of the costs and revenues for both scenarios shown on a yearly basis. The table shows, that the plant was barely financially viable when operating at 1.7 tons/day. Comparing the cost and revenues items it becomes evident that the revenues from the collection fees are partly cross-subsidising the composting activities. Hence, it seems advisable to combine composting activities with neighbourhood waste collection to ensure a viable operation of the scheme. An additional advantage of a combination of waste collection and composting is the direct influence on improving waste composition for composting in the collection area, as continuous contact with the customers is available and appropriate information may be disseminated (e.g. promoting source separation and separate collection). Since operating at full capacity the composting plant is clearly financially viable. The revenues from compost sales alone cover 91% of the

Table 2
Yearly costs and revenues of Mirpur composting plant (including waste collection)

Item	Capacity		Item	Capacity	
	1.7 t/day (US$/year)	3 t/day (US$/year)		1.7 t/day (US$/year)	3 t/day (US$/year)
Cost			*Revenue*		
Depreciation costs for collection investments[a]	268	448	Collection fees[b]	3366	6087
Depreciation costs for composting investments[c]	1647	1647			
Operation costs for collection[d]	1725	3119	Compost sales	5393	9728
Operation costs for composting[e]	5475	7511			
			Recyclables[f]	362	655
Total	9115	12725	Total	9121	16470

Note: 1 US$ = Tk. 58 (present rate, Feb. 2002).

[a] Calculated depreciation using lifetime of 5 years and interest rate of 15%.

[b] Total fees collected from the households for the waste collection service rendered.

[c] Calculated depreciation using lifetime of 10 years and interest rate of 15%.

[d] Cost items comprise salaries, uniforms and maintenance of rickshaw vans.

[e] Cost items comprise salaries, and expenses for electricity, water and additional feedstocks (sawdust, urea, cow dung).

[f] Total revenues form the sale of recyclables such as hard plastic, cardboard, glass and metal.

operation costs and 76% of the total annual costs of the scheme. The annual profit amounts to US$ 3745. As mentioned above, purchase of land was not included in the calculation, as it was given for use without charge. Land prices in the city of Dhaka are extremely high due to a high population density and lack of vacant plots. However, a study conducted by Waste Concern shows that there are potentially enough vacant small plots of land owned by different public agencies spread over the city which may be utilised for decentralised composting (Enayetullah and Sinha, 1999). Calculations based on current land prices in Dhaka and a minimum necessary land requirement for composting at low scale (380 m^2 for 3 t/day) show, that additional yearly costs of US$ 17,100 per year would arise. However, in case of smaller cities of Bangladesh such as Khulna, the project is viable even when considering the local land prices (Sinha and Enayetullah, 2000b).

The financial analysis confirms the results of other investigations on decentralised urban composting plants, showing that small-scale plants struggle with their economic viability if all costs have to be covered by the plant revenues (CPIS, 1993; Lardinois and Furedy, 1999; Pitot, 1999). However, in this case the analysis shows that a scheme with a capacity of 3 tons of waste per day can be viable when given an initial support by municipalities or other donors, as land acquisition in urban areas is always one financial key obstacle for initiating a composting plant. An initial support by municipalities can be justified, if one keeps in mind, that a decentralised waste collection and composting activity relieves a certain burden from municipal budgets of municipalities. For the Mirpur composting

plant, rough estimates show that the municipal waste transportation and landfill costs can be reduced by US$ 18,500 per year (based on full capacity of the plant) thanks to the decentralised composting approach. This estimate takes into account that decentralised composting reduces the amount of waste which needs to be transported by municipal trucks as well as the reduction of municipal expenses for final disposal of the waste. Of the 3 tons collected daily by Waste Concern, 2.52 tons are either composted or sold as recyclables. Thus based on a reduction of solid waste of 2.52 tons daily and estimated solid waste collection and transportation costs of the Dhaka City Corporation of US$ 16.4 per ton (World Bank, 1996), the composting scheme of Mirpur reduces the cost for the municipality (in collection and transport) by US$ 15,085 per year. In addition, final disposal costs were estimated based on the price of landfill surface area (US$ 24.5/m^2) and a factor converting waste weight to final landfill surface area required. This conversion factor was determined by assuming a waste density of 1.1 ton/m^3 and a dumpsite waste height of 6 m (e.g. 6 m^3 waste per square meter surface area). Again based on a reduction of solid waste of 2.52 tons daily this amounts to cost savings in landfill disposal of US$ 3414 per year.

With or without municipal support, any composting plant should however focus on long-term financial feasibility where operational costs are covered by revenues. Therefore, marketing strategies and the development of a market for compost are crucial for the long term success of a composting plant.

3.4. The role of compost marketing

Experience shows that many previous composting projects have either focused on technological aspects of composting or social aspects in marginalised population groups. Much less attention is given to a detailed assessment of the market for compost in the respective regions. The importance of the interaction of product quality, price and customer demand is often underestimated. Hence, many projects failed due to the lack of a market for the product thus leading to financial problems, which could not be solved. The potential market for compost does not only determine the size of the plant but also the composting technique and the post-treatment of the compost (Fig. 2), as potential customers have specific needs for their application of compost. Hence, to ensure sustainability of the composting scheme, market analysis and the market development should begin before the product is produced. The demand for the compost product can be influenced by various factors, some of which are listed below.

- the current use of organic municipal waste (e.g. life stock farming, fertiliser, soil blending);
- the customer segments (e.g. agriculture and horticulture, public agencies, land reclamation, etc.);
- the type and place of application;
- perceptions of existing and potential customers towards compost and their knowledge about compost use;
- the potential demand and seasonal variation;
- the required quality of compost;

- the availability of competitive products (e.g. cow and poultry manure, wastes from agro-industries, or chemical fertilisers).

An appropriate compost marketing and distribution strategy takes all these factors into consideration. Two main distribution strategies for compost can be described as:

- direct compost marketing to end users or
- compost marketing through a retailer or bulk supplier.

Which distribution strategy to use, depends on the existing resources for transport, which in the most cases is the limiting factor as many decentralised and community-based projects do not have the means for transportation. Transportation costs add to the product price thus automatically restricting the distance of distribution.

In the case of the Mirpur composting plant in Dhaka, Waste Concern decided to market the main bulk of their compost through MAP Agro Industries—a fertiliser company in Dhaka. MAP Agro Industries grinds the compost and enriches it with additional nutrients. Alpha Agro Ltd., a fertiliser trading company, distributes the final products in 40 kg bags through their distribution network all over the country. The products are sold to farmers as organic fertilisers for vegetables and many other crops like tea, paddy, wheat, lemon, etc. In addition to the sales to MAP Agro Industries, some nurseries buy compost directly at the composting site, and *Waste Concern* also uses some compost for their own nursery and demonstration plot. Realising the lack of awareness on the benefits of compost, Waste Concern also launched an information campaign using a farming demonstration site. A formal approval from the Bangladesh Agriculture Research Council for the use of the compost product for agricultural purposes as well as policy support by the Ministry of Agriculture is considered to be a critical turning point which strongly supported and enhanced consumer acceptance. The characteristics of the compost itself and the comparable fertiliser products as well as their market price are listed in Table 3. Compost nitrogen values show similar levels as vegetable fertiliser however lower than commercially available potato fertiliser. Compost shows clearly lower phosphorous and potassium contents compared to vegetable or potato fertiliser. Thus compost must be considered not as a fertilizer substitute only. Its additional benefits—such as improved soil texture and structure, improved retaining of nutrients, moisture, and air, erosion control, pH control and other benefits—are important factors in improving its marketability.

The compost marketing strategy used at the composting plant significantly reduces their costs for promotion and transportation. Waste Concern solely concentrates on the production of compost while benefiting from the distribution network of their main client,

Table 3
Nutrition contents of the "raw material" compost and organic fertiliser brands

Fertiliser type	Content				
	N (%)	P (%)	K (%)	OM (%)	Price (Tk./kg)
Compost	1.8–2.4	∼1.2	∼1.7	–	2.5
Vegetable fertiliser	1.5	15	10	30	6
Potato fertiliser	7	7	14	30	6

the fertiliser company. On one hand the plant's revenues from selling basic unrefined compost to MAP Agro Industries is lower than if they were to retail the product themselves. On the other hand, however, Waste Concern has the advantage of being able to sell more compost as Alpha Agro Industries has a vast distribution network and supplies farmers in the whole country. According to Lardinois and van Klundert (1993) for cases in Asia, the market radius for compost from decentralised plants is limited to 25 km. The example of Mirpur, Dhaka however shows that it is possible to market compost within a very large radius thus not only focussing on urban and peri-urban customers but especially on the rural sector. Focussing on one main customer obviously results in a certain dependency and risk for the supplier. To keep this risk low Waste Concern has negotiated a long-term sales contract and is also assessing further applications and customers for the produced compost (e.g. to tea plantations by direct sales). Recently, Waste Concern has signed an agreement with another company called Nature Farming to market the compost produced from newly established four more composting plants in Dhaka.

4. Conclusions and outlook

The case of Waste Concern in Dhaka is one example of a viable small scale and decentralised composting plant. Using an appropriate composting technology in combination with a sound financial management, as well as an appropriate marketing strategy ensures high quality compost and constant sales throughout the year. The awareness building programmes for users has started to show effects and the demand for normal and enriched compost is rapidly increasing. Waste Concern is negotiating with further large bulk compost users to limit dependency from their main customer. One main constraint for a replication of the composting scheme is the lack and high cost of land. However in Dhaka, different organisations as well as the municipality have recently shown interest in composting activities and are supporting the idea by providing land for such purpose, thanks to the demonstration effect of the Mirpur project. The Public Works Department has given permission to use land at six different sites, two of which are now developed and operating as composting plants. Dhaka City Corporation (DCC) has also provided land to *Waste Concern*, where a 5 tons/day capacity composting plant has been constructed just recently. Construction cost for the four new composting plants in Dhaka is being met by the Ministry of Environment and Forest of the Government of Bangladesh under its "Community Based Urban Solid Waste Management Project in Dhaka". These are being implemented by *Waste Concern* with support from the United Nation Development Programme (UNDP), since September 1998. This project is one of the components of Sustainable Environment Management Program (SEMP) of the Government of Bangladesh. *Waste Concern* has also designed another composting plant at Khulna, the third largest city in Bangladesh. The cost of the construction was borne by the Swiss Development Cooperation (SDC). The composting plant is now being run by a local NGO in Khulna. Since August 2002 the government has replicated the model developed by Waste Concern in 14 cities of Bangladesh with support from United Nations Children's Fund (UNICEF). Several cities agreed to provide land for such projects.

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