UWEP
Urban Waste Expertise Programme

Technical and Economic Analysis of Bhaktapur Compost Plant – Nepal

Case-Study Report
Composting

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1997

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PREFACE

This study has been done in the framework of UWEP, the Urban Waste Expertise Programme, a six-year programme - 1995-2001 - of research and project execution in the field of urban waste management in the south. UWEP aims at: * generating knowledge on community and small and micro enterprise involvement in waste management * developing and mobilizing south expertise on urban waste issues The Urban Waste Expertise Programme covers a range of topics related to waste management in the context of the urban environment in the south - solid waste collection and transfer, waste minimization, recycling of various waste fractions, resource recovery and liquid waste treatment.

Waste management and its various stakeholders now form a rapidly growing area of interest. The role played by small and microenterprises and communities, however, is still much neglected. UWEP aims to generate, analyse, document and customize the information that is gathered during research and pilot projects, in order to enhance the expertise of the UWEP target groups, ultimately aiming at an improved integrated sustainable waste management system. This will in the long run lead to an improved environment, create more employment and offer improved urban services for everyone.

One of the UWEP research topics was composting. This report, *"Technical and Economic Analysis of Bhaktapur Compost Plant - Nepal ",* reflects the results of a case-study research done by Bhushan Tuladhar and Anish Bania, commissioned by WASTE, the executing agency of the UWEP programme. Similar researches on the topic of composting were undertaken in the Philippines, Egypt and Nepal. By publishing these case-study reports, we explicitly aim at divulging the data gathered during the researches. UWEP sees this report as one of the ways of focusing attention on small and microenterprises, community involvement and their invaluable role in urban waste management.

Hopefully this publication helps you to form a picture of the role the various stakeholders play in urban waste management. More information and an overview of the other UWEP reports and books can be obtained from WASTE.

The *UWEP Case-study Report* series are published informally by WASTE. In order that the information contained in them can be presented with the least possible delay, the typescript has not been prepared in accordance with the procedures normally adhered to. WASTE accepts no responsibility for errors.

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During the course of the study, Mr. Dilip Suwal, Sanitation Officer at Bhaktapur Municipality was a great help in showing us around and providing us valuable information. The authors express their deep gratitude towards the interest shown by Mr. Suwal and the time and information he provided for this study. Also deserving thanks are all the staff at the Bhaktapur Compost Plant.

At NIES, Mr. Kedar Kelambu assisted us with the research and Mrs. H. D. Ranjeetkar reviewed the report for us. The authors are grateful for their contributions to this study.

The lab analysis required for this study, was conducted by Agricultural Technology Centre and Environmental and Public Health Organisation.

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ABBREVIATIONS & GLOSSARY OF NEPALI WORDS

AIC	Agricultural Input Corporation
Ajima	Name of a Goddess
BCP	Bhaktapur Compost Plant
Byawasthapan	Management
Cbm	Cubic Meter
C:N	Carbon to Nitrogen Ratio
Chwaasa	A place where two lanes meets
Chhidi	Space under the stairways
Chyaame	Caste of people who were traditionally responsible for waste management
Doka	A place where one lane meets another forming a "T" junction.
EPC	Environmental Protection Council
Fohor Maila	Solid Waste
Hara-Huru	Caste of people who were traditionally responsible for waste management
HMG	His Majesty's Government of Nepal
IUCN	International Union for Conservation of Nature and Natural Resources
n.a.	Not Available
Mal	fertilizer
Nag raaja	Sepant king
NEPAP	Nepal Environmental Policy and Action Plan
NRA	Nepal Research Associates
Pore	Caste of people who were traditionally responsible for waste management
Punhi	Full moon
Rs.	Nepalese Rupees (US $ 1 = Rs. 57.3)
SWMRMC	Solid Waste Management and Resource Mobilisation Centre
Saa	compost
Saaga	Compost pit
UWEP	Urban Waste Expertise Programme

Chapter 1

INTRODUCTION

1.1 BACKGROUND

Although Nepal's urban waste is primarily organic in nature, only a small portion of it is composted or properly managed. While scavengers and waste buyers usually collect other recyclable materials, such as metal, paper and plastic, organic waste is usually dumped in the nearby streams or other public places. Only one city in Nepal, Bhaktapur Municipality, is currently operating a compost plant. This study has been conducted with the aim of examining, analysing, and documenting this composting operation in order to suggest improvements to the current operating practice at the plant and encourage the replication of this model.

This study is part of the Urban Waste Expertise Programme (UWEP), which is a six-year programme commissioned to WASTE by the Netherlands Development Cooperation. An important activity within UWEP is research on 'Composting of Organic Household Waste.' This case study of Bhaktapur Compost Plant (BCP) has been prepared as a part of this research effort.

Objectives of the Study

The main goal of this study is to evaluate the technical and economic aspects of the Bhaktapur Compost Plant and recommend measures to improve its efficiency and replicate such efforts in other municipalities of Nepal. The specific objectives of the study are as follows:

- Assess the effectiveness of the current waste management system in Bhaktapur.
- Assess the current problems faced by the waste management system and their impact on the compost production.
- Assess the quality of compost being produced by the compost plant.
- Recommend measures to improve the quality of compost and quantity of production.
- Conduct a complete financial analysis of the operation to determine its profitability and replicability.
- Analyse the market for compost in the Kathmandu Valley and the current marketing instruments used by BCP, and recommend measures to improve BCP's marketing strategy.
- Review the policy, legal and institutional framework within which the Bhaktapur waste management system is currently operating and recommend changes if necessary.

Methodology

As this study was part of UWEP, the terms or reference provided by WASTE was closely followed. The TOR provided detail procedures, especially for the financial and marketing analysis. Methods used to obtain relevant information included literature search, site observation, interviews with the staff of Bhaktapur Municipality and the compost plant, and a survey of farmers in the Bhaktapur and Thimi areas.

Scope and Limitations

The scope of the study was limited to technical, financial and marketing analysis of the Bhaktapur Compost Plant. The Terms of Reference for this study as provided by WASTE Consult is presented in Annex 1.

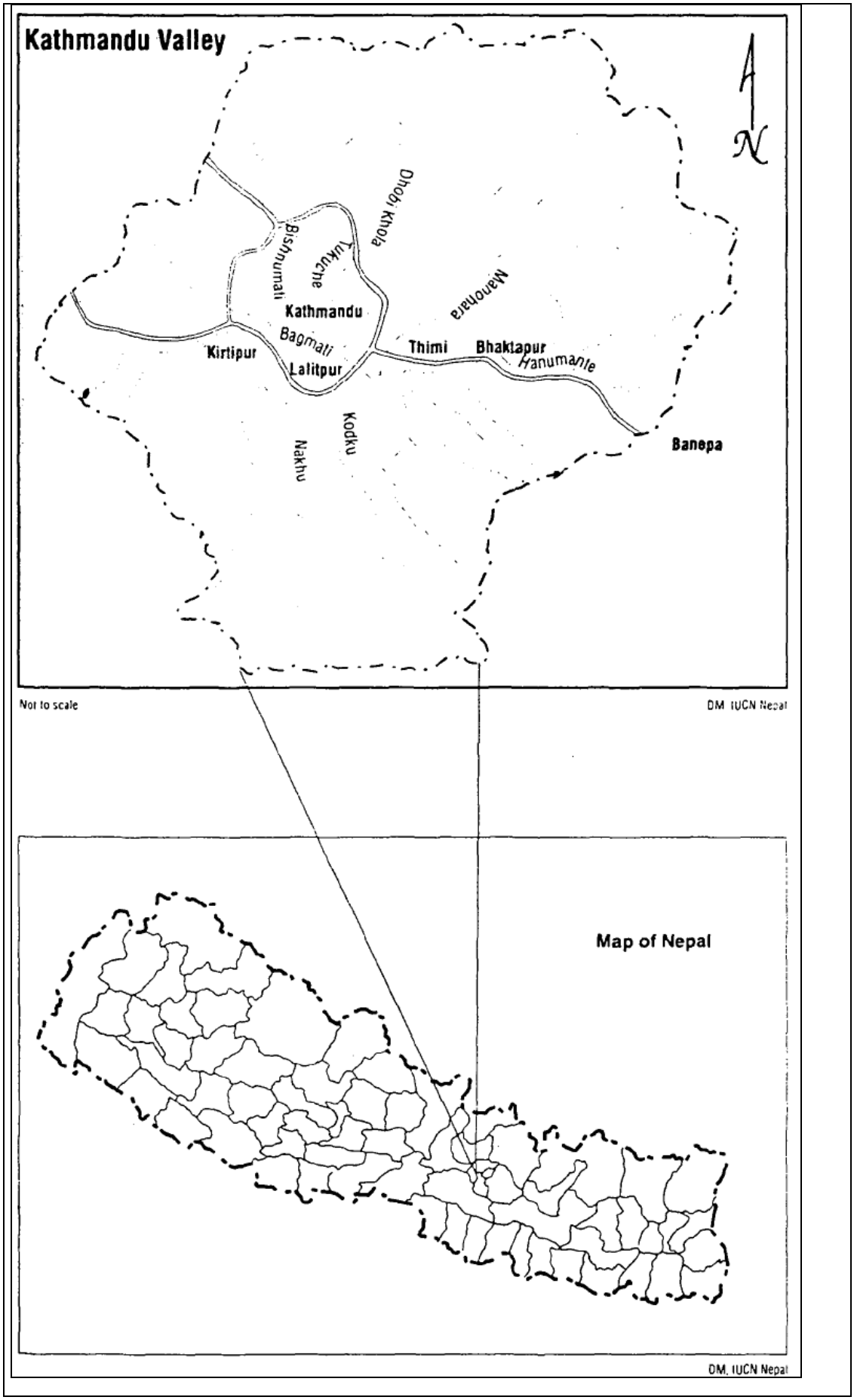
The main limitation of the study is the short time period (two months) in which it was conducted and the unavailability of accurate data on important parameters such as production levels, waste characteristics, compost quality, and sales, at the compost plant. Furthermore, the fact that the compost plant was not fully operating at the time of the study made acquisition of information difficult.

1.2 City of Bhaktapur

The ancient city of Bhaktapur is located in Kathmandu Valley approximately 15 km east of the city of Kathmandu (see Figure 1.1). The city is located on top of a small hill, which rises from the northern banks of the Hanumante River. The city is densely built with narrow lanes, row houses surrounding small courtyards, and many temples and shrines. Much of the city's magnificent architecture dates back the 17th century. The city is surrounded by agricultural fields. Many of the farmers who own and work in these fields live in the outskirts of the city.

According to the 1991 census the Bhaktapur Municipality had 9,187 households with a total population of 61,405. This made Bhaktapur the eighth largest municipality in Nepal. In comparison, Kathmandu, Nepal's biggest city had 81,139 households with 421,258 people. Between 1981 and 1991 Bhaktapur Municipality's population grew by 2.4 percent per year. Assuming the same growth rate, Bhaktapur Municipality's population in 1996 would be 68,787. The total population of Bhaktapur district, which includes the city of Bhaktapur and 21 other villages, was 172,952 in 1991.

While the neighbouring towns of Kathmandu and Lalitpur have experienced rapid growth and changes in social structure, Bhaktapur, for the most part, has retained its old character. Bhaktapur's population growth rate of 2.4 percent is low compared to Kathmandu city's 6.0 percent and Lalitpur's 3.8 percent. Furthermore, while Kathmandu and Lalitpur have had to deal with a large flow of migrants, very few migrants have moved into Bhaktapur. According to 1991 census, 84 percent of the migrants into Kathmandu Valley have settled in Kathmandu and 15 percent in Lalitpur, thus leaving Bhaktapur with only 1 percent.


Kathmandu Valley
N
Dhobi khola
Bisnumati
Tukuche
Manohara
Kathmandu
Bagmati
Kirtipur
Lalitpur
Thimi
Bhaktapur
Hanumante
Kodku
Nakhu
Banepa
Not to scale
DM IUCN Nepal
Map of Nepal
DM, IUCN Nepal

Along with retaining the original population, most Bhaktapur residents have also continued to hold on to their old life styles. In 1991, only 25 percent of the people in Kathmandu district were involved in agriculture, compared to 72 percent in 1981; whereas in Bhaktapur district 65 percent were still involved in agriculture in 1991, compared to 80 percent in 1981. Bhaktapur's relatively low literacy rate (58.9 percent) and large household sizes (6.63 persons per household) also demonstrate the low impact of modern culture on the lifestyle of Bhaktapur residents in the city.

The majority of Bhaktapur's population belong to the Newar ethnic group, who are the original inhabitants of Kathmandu Valley. Newars usually live in joint families and their houses form compact settlements with public courtyards. Newars have their own distinct language and culture and usually form tightly knit communities. Newars are also noted for the many festivals and feasts they celebrate which commemorate a large pantheon of deities. As a result, food waste dominates the waste stream during major festival seasons. In these respects, Bhaktapur is a typical Newar town.

1.3 Traditional System of Waste Management

Prior to the rapid urbanisation and modernisation that Kathmandu Valley witnessed in the latter half of this century, waste management was probably not a major problem in the towns of the Valley. This was mainly because (a) the amount of waste produced was not very significant, and (b) the society had developed its own system of managing the waste; a system which was an integral part of the culture and life style in the Valley. At that time, almost all the residents in the Valley were farmers and the waste they generated consisted of agricultural waste, kitchen waste, sewer, and waste from religious activities and festivals. Because of the absence of sophisticated materials and excess packaging, the volume of waste was probably minimal and the waste was primarily organic in nature. The communities in the Valley had developed a fairly effective system for managing this waste. Although many houses were not equipped with toilets, many people used the nearby rivers as their toilets and dumped their waste in an open pit, called *saaga*, near their houses to produce compost, which they applied in the fields. *Saagas* were built between houses or in courtyards. Although most people do not use *saagas* anymore, there are still a few functioning *saagas* in Bhaktapur, where changes have not occurred at the same rate as in Kathmandu and Lalitpur, the other major cities in the Valley.

Waste management is built into the culture and religion of Newars, the traditional inhabitants of the Valley. Waste from rituals such as child birth and death ceremonies are disposed at the *chwaasa* (a particular place in each locality where two lanes cross) or *doka* (place where one lane meets another, thus forming a "T" junction). There is a belief that demons reside at the *doka*, and the *chwaasa* is the place for the Goddess *Ajima*. Therefore, if anyone dumps waste that are to be disposed at *chwaasa* at the *doka* or elsewhere and vice versa, then the person will be troubled by the demons and the Goddess. Similarly, there is also a belief that if the *saagas* and other areas in the house are kept dirty then the owners will have to bear the wrath of *Naag Raja* (the serpent king). Waste from various feasts is also traditionally disposed at the *chwaasa*. Similarly, it is customary to throw old clay pots at the *chwaasa* on the day of

Chwaasala Punhi, the full moon in the month of December (Prajapati 1986). These superstitions and practices help keep houses and surrounding areas reasonably clean.

The tradition of cleaning private and public places during major festivals is another mechanism that has been built into the Newar culture to keep the urban areas clean. For example, during the festival of Bisket Jatra in Bhaktapur, there is a belief that Gods and Goddess reside in the *Chhidi* (space under the stairways) and in each courtyard. Therefore, in order to please the deities these areas are cleaned during the festival. Similarly, during the festival of *Sithi Nakha*, which takes place just before the monsoon season, there is a tradition of cleaning wells, ponds or other water bodies (Prajapati 1986; Prajapati 1990).

The Newar society has assigned the tasks of cleaning the city and disposing the waste to special castes called *Chyaame, Hara-Huru and Pore* (Nepali, 1963). While the women in the household, regardless of their caste, are responsible for keeping the house clean, once the garbage reaches the public domain, it is strictly the responsibility of the sweeper caste to manage the waste. The sweepers collected garbage from the streets, *chuka*, *chwaasa*, *doka* and any other waste piles in public places and dumped them in the river banks. In order to keep the town clean, sweepers were made to live in the outer edges of the town, near the rivers. Although the rivers in the valley are regarded as holy places and river banks are the sites of numerous shrines and temples, dumping of waste in the river was never considered to be an abnormal or unacceptable practice. Thus the sweepers either sold waste as compost to farmers or dumped them in the rivers.

1.4 Bhaktapur Compost Plant

The Bhaktapur Compost Plant was established in 1978 as part of the Bhaktapur Development Project, which was implemented with the assistance of Germany from 1976 to 1984. The compost plant was handed over the Bhaktapur Municipality in 1981. However, as the municipality did not have sufficient incentive to compost its waste, production gradually decreased until it came to a complete halt in 1984. In 1988, the compost plant was rehabilitated and some of the staff of the Bhaktapur Municipality were trained in compost plant operation with the assistance of the German funded Solid Waste Management and Resource Mobilisation Centre (SWMRMC). The plant restarted its operation in 1989. Since then the plant has been operated by the Bhaktapur Municipality with occasional technical assistance from SWMRMC.

The compost plant is located in Bhelukhel, which is a neighbourhood in the southern part of the city on the northern bank of Hanumante River (see Figure 1.2). The plant is situated in a community mostly inhabited by sweepers. This particular site was chosen for the plant because it is bit away from the city centre, while still being close enough to the source of waste. Although there are a few houses next to the plant, particularly towards the north and the west, because most of the people living around the plant are sweepers who are used to working with waste, there no complaints from the nearby residents. BCP is therefore located in a very suitable location.

BCP currently occupies an area of 2,640 sq. meters. However, it is now expanding its area to include an area of approximately 1,680 sq. meters immediately south of the current site.

The site has a boundary wall with two gates and a guardhouse. An unloading dock and conveyor is located in a paved area in the north. This is the only area in the compost plant with a corrugated metal roof. The rest of the area is not protected from rain. Three windrow platforms are located immediately south of the area with the conveyor. The layout of the plant is present in Figure 1.3.

BCP is the only compost plant which is being operated by a municipality to compost municipal solid waste. In 1982, a compost plant had been established at Teku, Kathmandu, by the German funded Solid Waste Management Project. Initially the Teku plant was manually operated and had a capacity of 5 tons per day. In 1985, a mechanised screening facility, with a capacity of 30 ton per day, was added at Teku. The Teku Compost Plant shut down in 1991 following complaints from neighbours regarding smells and littering. Besides BCP, compost is also being produced in Nepal by an NGO called *Unnati Aadhar Kendra* from domestic waste; a private company called Sher Bone Mill from slaughter house and various other types of waste; private and government owned nurseries from yard waste; and farmers from agricultural waste.

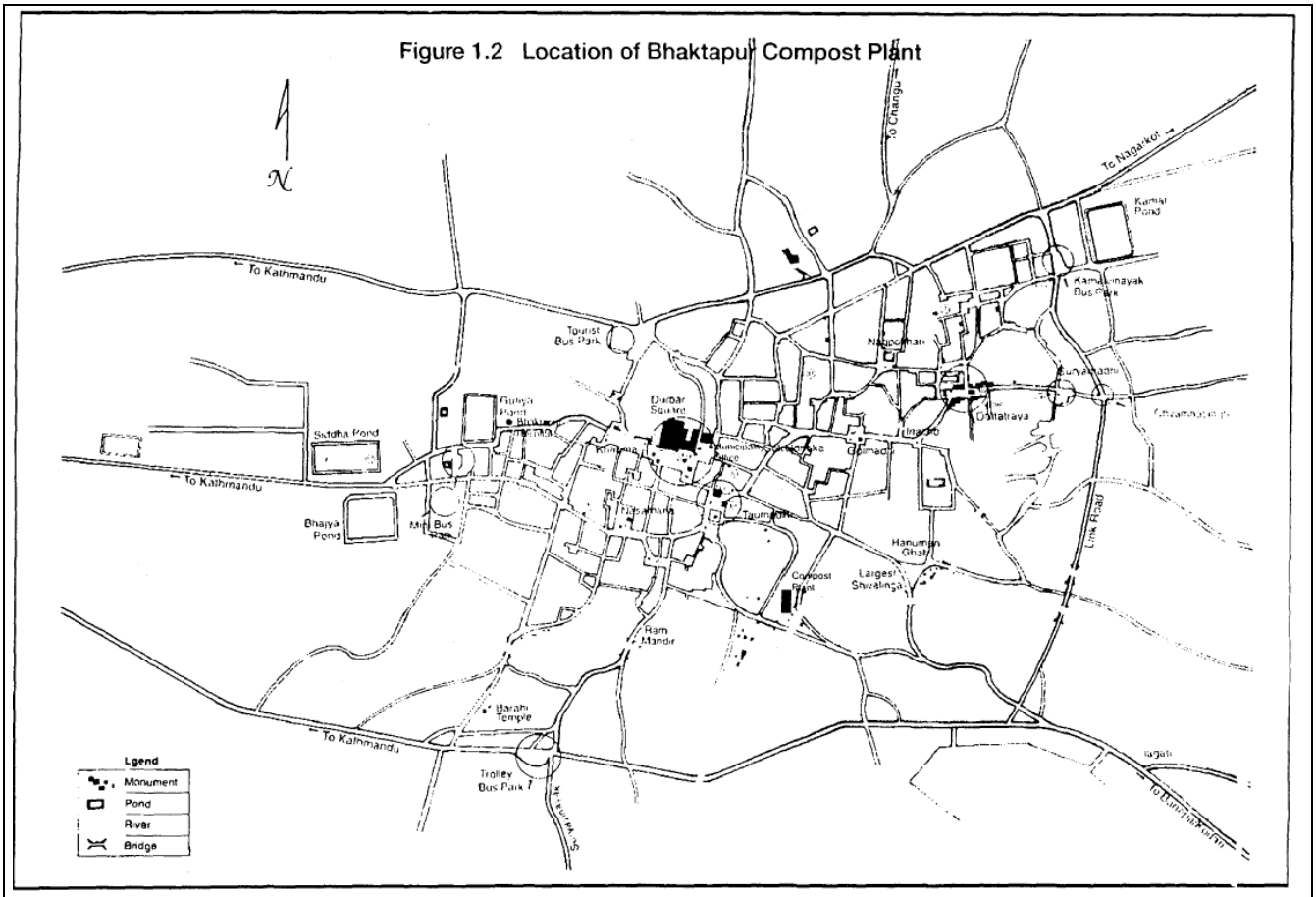
1.5 National Policies and Legislation Related to Solid Waste Management

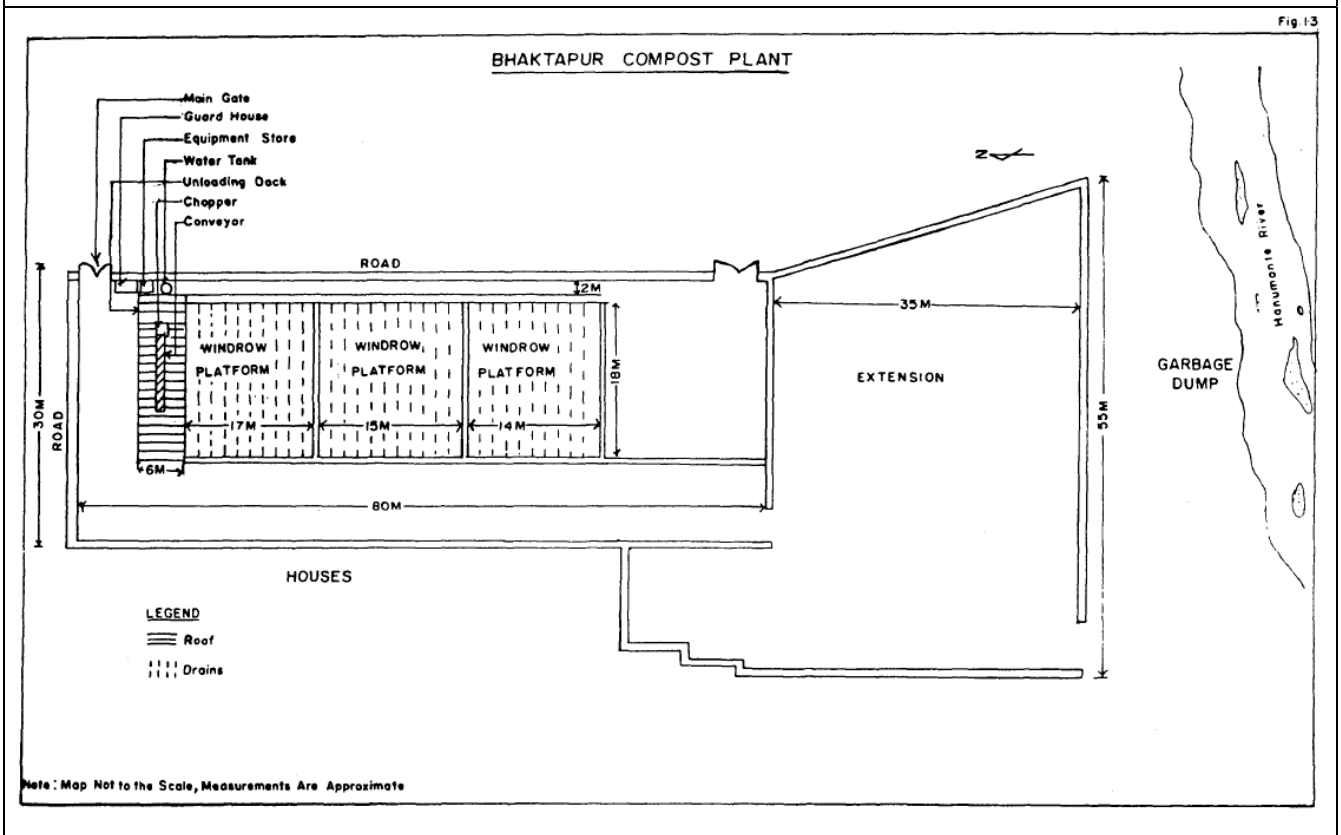
Although the National Conservation Strategy (HMG/IUCN, 1988), Nepal's first environmental policy, mentions that the government will develop and implement policy and legislation related to pollution; and the Constitution of Nepal, 1990 requires the State to prioritize prevention against environmental degradation from development activities, integrated solid waste management and recycling in particular have received very little attention by Nepal's policy makers in the past. Nepal Environmental Policy and Action Plan (NEPAP) is silent on the issues of solid waste management and recycling (EPC, 1993). The Eighth Five-Year Plan (1992-1997) does not specifically mention any plans regarding solid waste management or recycling. Only in 1996, HMG adopted a Solid Waste Management Policy for Nepal, which emphasizes the importance of composting and recycling. The main policies, legislation and regulations related to solid waste management and recycling in Nepal are reviewed in the sections below.

Solid Waste Management Policy, 1996

The government introduced a solid waste management policy in 1996 with the following objectives:

- Make waste management simple and effective.
- Minimize pollution and public health effects from waste.
- Mobilize waste as resource.
- Privatize waste management.
- Raise public awareness and people participation.





Although the policy clearly states the government will promote

composting and recycling activities, a framework or guidelines on how this is to be done has not yet been formulated. Similarly, the government wants to privatize solid waste management activities but procedures on 'how' to do this have not been set. Therefore, introducing strategies and programmes for translating these policy statements into action is the immediate challenge for the government.

Environmental Protection Act 1996 & Environmental Protection Regulations 1997

Nepal has recently promulgated Environmental Protection Act and Regulations, which are designed to be a broad umbrella legislation to protect the country's environment. The Act and Regulations include provisions for environmental impact assessment, pollution prevention and control, heritage conservation, and environmental conservation fund. Section 7 of the Act, which deals with pollution prevention and control, mentions that no one can cause pollution which will have significant adverse impact on environment or public health. Section 14 of the Regulations states that disposal of waste beyond the standards fixed by HMG will not be permitted. However, as of yet, the government does not have any environmental quality standards for disposal of solid waste or liquid effluent.

Municipality Act, 1992

Nepal's Municipality Act, 1992 was promulgated with the main aim of strengthening local institutions and decentralizing development activities by making the municipalities responsible for the economic, social and cultural development at the local level. Section 15, Subsection 1, of the Act makes all municipalities responsible for various local level activities, including the following:

- Protect water bodies such as rivers, ponds and wells.
- Conserve environment and cultural heritage.
- Public health and social development.
- Clean special areas as designated by the municipality.
- Remove hazardous substances.

Sub-section 2 of Section 15 mentions that municipalities may implement activities related to cleaning of the city and collection and disposal of solid waste. Therefore, the Act requires the municipalities to conserve the local environment but makes solid waste management an optional activity. At present, however, all municipalities in Nepal are involved in solid waste management activities in one form or other because it is an essential service for the people and no other government agency is fully responsible for it.

In the case of Metropolitan areas (at present, Kathmandu is the only metropolis in the country), Section 63 of the Act states that the Municipal Corporation is responsible for solid waste management and sanitation and it can issue directives to any polluting institution to stop polluting activities. Kathmandu Municipal Corporation, however, has not been able to implement this provision effectively. This is mainly because the Solid Waste Management and Resource Mobilisation Centre is also responsible for collection of waste from

some areas in the city and for landfilling of the waste, and there is a lack of proper coordination between these agencies. As a result, the responsibilities for solid waste management in Kathmandu are not clear.

Section 21 of the Act requires municipalities to give priority to the following programs:

- Provide employment to the local people.
- Utilize local resources and skills.
- Benefit needy and backward class.

An effective composting and recycling program will address all these priority issues. Additionally, Section 23 of the Act mentions that the municipality shall hold programs which will conserve the environment. Therefore, although the Municipality Act does not require municipalities to promote recycling, it is clear that municipalities can fulfill many of their responsibilities by implementing an effective system of waste recycling.

However, at present none of the municipalities have any formal recycling programs, with the exception of Bhaktapur Compost Plant. This is primarily because of the initial cost associated with the establishment of a recycling system and the lack of adequate knowledge among sanitation officers in the municipalities. Most municipalities do not consider recycling as a tool for solid waste management, as long as they can get away with dumping their waste in a nearby river, an obviously inexpensive but also inappropriate method for managing solid waste.

Recycling by municipalities can be promoted by either amending the Act so as to require municipalities to maximize recycling of waste or enforcing the clause of the existing Act related to conservation of environment including water bodies and cultural heritage. In either case, municipality officials must first realize the economic and environmental benefits of recycling and sanitation officers in municipalities must be trained in designing and implementing a recycling program.

The Municipality Act has also authorized municipalities to collect fees for cleaning services (Section 47 Sub-Section 2) but this is not practiced because the concerned authorities have not come up with an appropriate pricing mechanism.

Solid Waste Management and Resource Mobilization Act, 1987

The Act was promulgated to establish the Solid Waste Management and Resource Mobilisation Centre (SWMRMC) and manage Kathmandu Valley's solid waste. However, although the Act is valid for the cities of Kathmandu, Lalitpur and Bhaktapur, the SWMRMC has been mostly involved in Kathmandu and Lalitpur and its activities in Bhaktapur has been limited to occasional technical assistance. In spite of the Act, Bhaktapur Municipality continues to manage Bhaktapur's waste independent of the SWMRMC.

Section 2 of the Act establishes SWMRMC as an autonomous body with perpetual entity. The responsibilities of the Centre as defined by the Act includes the following:

- Designate areas and provide containers for disposal of waste.
- Make provisions for transferring and proper disposal of collected waste.
- Produce briquettes, compost and energy (biogas) from waste.
- Make provisions to collect recyclable materials from waste.
- Conduct research activities to manage waste.
- Provide waste management related technical assistance and training.

Although the Act clearly states that the Center will produce compost, briquettes and biogas, none of these have been done except for the establishment of a mechanised composting plant in Teku, Kathmandu which operated from 1985 to 1990.

The Act also authorizes SWMRMC to:

- Restrict disposal of waste from public space (Section 4, sub-section 4.3)
- Fine Rs. 100 to Rs. 1,000 for littering or disposing waste haphazardly in public places (Section 5.1). If fines are not paid individuals can be imprisoned up to 24 hours according to the instruction of inspection officer of SWMRMC. (Sub-section 5.2.3)
- Collect fees for cleaning services from individual and organizations (Sub-section 3.2.1.3)

The SWMRMC was very active while it was operating as part of the German-assisted Solid Waste Management Project. Today, however, due to institutional and financial problems within the Centre, and the lack of coordination between the Centre and the municipalities, the Centre is unable to fulfill its responsibilities and as a result the enforcement of the Waste Act is very weak. Under these circumstances and increasing felt need for a decentralised waste management system, it is high time that the Act be replaced by a more suitable legislation regarding solid waste management. The new legislation should clearly state that the municipalities are responsible for solid waste management and also promote environmentally sound and efficient waste management practices.

Scrap Tax

Many District Development Committees in Nepal levy tax on all recyclable scrap materials leaving their districts. The tax, which is collected from scrap dealers at exit points of all districts, has had an adverse effect on the recycling business because the amount of tax can be more than one-third the value of the scrap. For example, all old newspaper leaving Kathmandu Valley is taxed at the rate of Rs. 2 per kg, while the scrap value of old newspaper in Kathmandu is only about Rs. 5 per kg. Although composting is not directly affected by this tax because organic waste is rarely traded over long distances, the tax increases the level of contamination in organic waste because scavengers no longer collect recyclables with a low market value, such as broken glass and contaminated plastics.

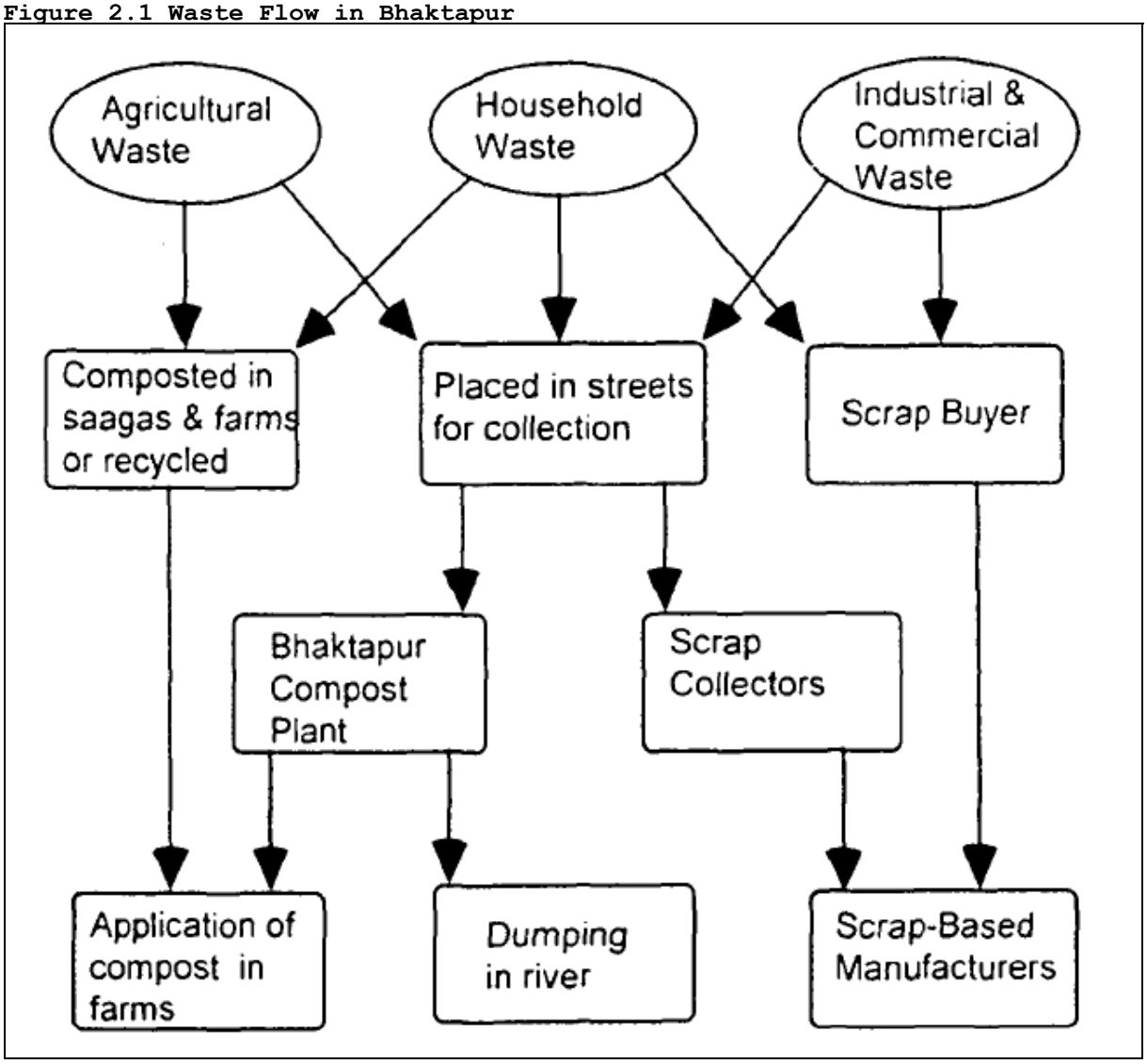
Chapter II

SOLID WASTE MANAGEMENT IN BHAKTAPUR

Bhaktapur is one of the most organised towns in Nepal in terms of solid waste management. Because most of the residents still practice the traditional way of life, the town as a whole generates very little waste. The compact nature of the town makes waste collection relatively easy. Waste generated by the residents is either composted by themselves, or put out in the streets for collection by the municipality or sold to waste buyers. Some people, however, still dump their waste on the banks of the Hanumante River or other public places. People who compost waste by themselves are generally farmers who either compost it in *saagas*, which are compost pits located in various parts of the city and are shared by several households or in farms which are located outside the city. Waste collected by the city is taken to its compost plant, which is the only municipal compost plant in the country. Waste sold to waste buyers mainly consists of bottles, pieces of metals, and paper, mainly old newspaper. These scrap items, along with the scrap collected from the streets or the composting plant, are sold to scrap-based manufacturers. Because of the efficiency of the system, the city is noticeably cleaner than most other Nepalese cities. The entire cost of solid waste management is borne by the municipality and the residents do not have to pay for waste management services.

The flow of waste in Bhaktapur, from cradle to grave, is presented in Figure 2.1 and described in the sections below.

Figure 2.1 Waste Flow in Bhaktapur



2.1 Waste Generation

The main sources of waste in Bhaktapur are households, agricultural activities and industrial/commercial establishments.

The contribution of industries and commercial establishments to the total waste stream is relatively low because Bhaktapur has few industrial or commercial units, compared to other major cities, and most the industries in the town are small handicraft industries, which produce very little waste. The town has an industrial district with 21 industrial units. However, none of these are heavy industries and the generation of waste by the small industries is minimal. Industrial waste is usually recycled. The town does not have many hotels because most tourists stay in Kathmandu or Lalitpur instead of Bhaktapur. There are a few small educational institutions, which mainly serve the local population. One of the largest schools in the town is the military school with about 800 students. Another major institution in town is the Bhaktapur Hospital, which serves the people of the district. Both the military school and the hospital are located in the eastern side of town.

The amount of agricultural waste generated varies seasonally. Because a significant percent of the residents are farmers who use open spaces in the town for drying and processing agricultural products, agricultural waste is a major contributor to the waste stream, specially during the harvest season in September/October. The main types of agricultural waste generated by the city are rice husk and straw. This waste is either

- composted by the farmers;
- recycled to make various products, such as mats, ropes, and baskets;
- used as fuel for nearby brick factories; or
- dumped at waste collection points on the streets.

As in most other cities, households are the most significant contributors to the waste stream. There have been no studies done to predict the amount of waste generated by the residents of Bhaktapur. A study done in 1989 indicated that Kathmandu residents generate approximately 0.4 kg of waste per person per day. By now, the waste generation rate among Kathmandu residents may have slightly increased because of changing consumption patterns. Bhaktapur residents, however, probably generate slightly less waste than people in Kathmandu because modernisation, which usually results in higher waste generation, has not affected this town as much as Kathmandu. Assuming that an average Bhaktapur resident generates 0.4 kg of waste per day, in 1996, 68,787 people of the town would generate approximately 27.5 tons of waste per day.

The waste generated by Bhaktapur is primarily organic in nature. Waste sampling done for this study indicated that 88 percent of the waste is organic. The characteristic of waste was determined by sorting and examining two tractor loads of waste, which were on their way to the Bhaktapur Compost Plant. The sampling was done at about 11:00 am on 9 December 1996. The waste examined represented a typical waste load that is transported to the compost plant. The result of the analysis is presented in table 2.1 along with results of a waste characterisation study done in Kathmandu in 1989.

The analysis shows that the amount of organic waste in Bhaktapur is unusually high and that the amount of metals and paper is insignificant. The high percentage of organic waste indicates that people in Bhaktapur primarily discard organic waste and that other waste materials are collected for recycling before the waste reaches the compost plant. Another reason for the high portion of organic waste is that the analysis was done in early December, which is after the harvest season. Thus, the waste probably contained more agricultural waste such as hay than in most other seasons. The amount of metal and paper in the waste is low because the town does not have large offices or industries. Most of the metal and paper scrap that is generated is probably sold to scrap buyers or picked by scrap collectors. As a result, their presence in the waste that is collected by the municipality is negligible.

Table 2.1 Characteristics of Waste

MATERIAL	BHAKTAPUR[1]		KATHMANDU[2]
	WEIGHT (KG)	PERCENTAGE	PERCENTAGE
Organics	540	87.9	58.4
Inert Material (bricks/broken clay pots)	55	9.0	28.9
Plastic	10	1.6	2.0
Glass	3.4	0.6	1.6
Textile	2.5	0.4	2.0
Paper	<1kg	negligible	6.2
Metal	<1kg	negligible	0.4
Rubber	1	0.16	0.4
Batteries	-	-	0.1
Total	614	100	100

Note:

1 average of two tractor loads on their way to compost plant analysed for this study on December 9, 1996.
2 SWMRMC, 1989.

2.2 Waste Collection and Transfer

Bhaktapur residents place their garbage at designated places in the streets either in the evening or morning. Sweepers employed by the Municipality clean the streets and other public places and collect the waste at the same designated places. The 93 waste collection points in the city have been designated in consent with the local people so that they are convenient for both the local people and the waste collectors, do not obstruct traffic and do not become aesthetically undesirable. Before 1990, the Municipality had placed waste containers at several locations but they were damaged during political disturbances. As a result, the Municipality now does not have any large waste containers. A few areas in town have small road-side trash cans.

Bhaktapur Municipality has 5 tractors and 2 small pick-up trucks to collect waste from the collection points and transfer it to the compost plant. Each vehicle has two helpers and one driver for waste pick up. The waste is picked up every day between 6 am to 9 am.

The Municipality does not keep any records on the amount of waste collected per day. Oeltzschner and Betts (1996: D9) report that the Municipality is collecting and transporting 35 tractor loads of waste per day. Observation made during this study, however, indicated that the municipality is collecting about 20 tractor loads of waste per day. Waste analysis done for this study indicated that a tractor load of waste weighs approximately 600 kg (see Table 2.1). The Municipality, therefore, collects and transports approximately 12 tons of waste per day.

Besides the Municipality, waste materials are also collected by scrap buyers, scrap collectors and farmers. Farmers collect organic waste, mostly from their own homes or their neighbours' homes for making compost. Scrap buyers go door-to-door and buy valuable scrap materials such as metal, glass bottles, paper and plastic. Scrap

collectors roam the streets and collect recyclable materials such as metal and plastic from the piles of garbage that have been placed by residents and sweepers at the various collection points in the city. According to the Sanitation Officer at Bhaktapur Municipality, waste is scavenged at least twice before it reaches the compost plant. The exact amount of waste collected through these means is unknown.

If one assumes that the city of Bhaktapur generates 27.5 tons of waste per day as mentioned in Section 2.1, then the observations of this study indicate that slightly less than half of the generated waste is collected by Municipality. This suggests that either the assumed waste generation rate (0.4 kg per person per day) is too high or that a significant amount of waste is recycled at source or dumped. Because Bhaktapur is a traditional community, which produces very little waste and recycles most of it, the cause for the difference between the figures for waste generation and waste collection is probably a combination of these reasons.

2.3 Waste Treatment and Disposal

The waste collected by the Municipality is either composted at BCP or used to fill low lying areas or dumped in the Hanumante River. Most of the waste is taken to BCP for composting. The other two options are mostly used during the rainy season when the compost plant does not operate or to dispose rejects from the compost plant. In November 1996, the municipality was dumping about half of the collected waste to fill up low-lying areas between the compost plant and the river. Bhaktapur municipality does not have a proper landfill site and does not use the landfill site at Gokarna in Kathmandu because of high transportation costs.

Waste collected by farmers is either composted in *Saagas* located within the city or in their farms outside the city. *Saagas* are compost pits built between houses or in small courtyards. Several families usually share the pits. Waste, usually from the kitchen, is dumped in these pits and is left there for four to six months. Two or three times a year, the *Saaga* is emptied and the compost is taken to the fields.

Waste collected by scrap buyers or scrap collectors is usually sold to scrap dealers or directly to scrap-based manufacturers. Most of the scrap dealers are located in Kathmandu. Bhaktapur has a few scrap-based industries, which use waste paper and metal. Waste paper is used by Bhaktapur Craft Printers, which is located in Bhaktapur Industrial District and by Himalayan Paper Works at Kamal Binayak. Scrap metal is usually recycled to make handicrafts or utensils. Scrap materials, which are not recycled in Bhaktapur, are either recycled by industries in Kathmandu and Lalitpur or taken outside the Kathmandu Valley for recycling.

2.4 Organisational Structure of Bhaktapur Municipality

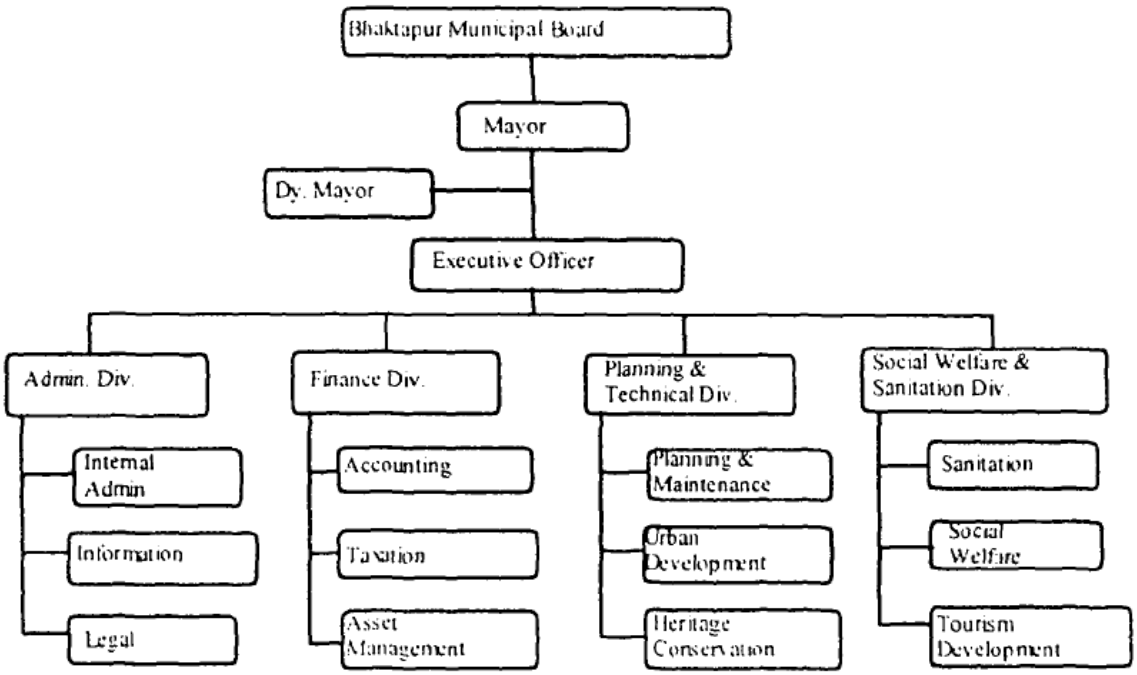
Bhaktapur Municipality is divided into 17 wards. Each ward elects five representatives, including a ward chairman and a woman representative, to the Municipal Council. The Mayor who is also an elected representative heads the office of the Municipality. The Municipal Board, which consists of the Mayor, Deputy Mayor and 17

ward chairmen, provides guidance to the Mayor. The administrative work of the Municipality is carried out by the Executive Officer, an employee of HMG, under the direction of the Mayor.

The office of Bhaktapur Municipality has four divisions: Administration, Finance, Planning & Technical; and Social Welfare and Sanitation. Each Division is further divided into sub-division. The sanitation sub-division of the Social Welfare & Sanitation Division has the responsibility for solid waste management in Bhaktapur. The sub-division has one Sanitation Officer.

The Sanitation Officer is the main person in charge of solid waste management in Bhaktapur. Because waste water collection and treatment is the responsibility of the Nepal Water Supply Corporation, and not the Municipality, the main job of the Sanitation Officer is oversee the solid waste management activities. The Municipality has 30 sweepers working on a salary basis and an additional 30 sweepers work on a contract basis. Eight of the 17 wards of Bhaktapur are cleaned by the sweepers employed by the Municipality, while cleaning and waste collection in nine of the wards have been contracted out. Additionally, the Municipality has six people employed at the compost plant. All the people involved in waste management report directly to the Sanitation Officer.

Figure 2.2 Organisational Structure of Bhaktapur Municipality



Chapter III

TECHNICAL ANALYSIS OF BCP

3.1 Feed Stock

The only feed stock used by BCP is Bhaktapur's municipal waste. Although most farmers who compost waste also use other organic waste such as animal manure and rice husk to improve the quality of compost, BCP does not use any other materials in its operation. As almost 90 percent of the incoming waste is organic in nature, almost all the incoming waste is suitable for composting. The amount of waste composted depends on the demand for finished compost and the availability of space and labour at the compost plant. During November-December 1996, the compost plant was accepting only about 4 tractor loads of waste per day. The rest of the waste was being dumped on the banks of the Hanumante River. Furthermore, the waste was not being piled in windrows but rather being dumped in a newly extended area of the plant in order to level the surface. The characteristics of the incoming waste have been described in section 2.1.

3.2 Process

The compost plant has a concrete paved unloading dock where the tractor loads of incoming waste is dumped before being shoveled into the hopper which leads to a conveyor belt. The unloading dock has an area of 20 sq. m. At the front of the belt there is a chopper which reduces the size of the waste as it moves on to the belt. The 10 m long and 0.5 m wide belt is meant for assisting in sorting of the waste. The entire area comprising of the unloading dock and the conveyor is under a metal shed. The total area covered by the shed is 110 sq. m.

Once the waste is sorted it is to be placed on the windrows in long rows. At present, however, because the conveyor belt is not being used, the waste is unloaded directly on to the windrows. Some sorting is done once the waste is placed onto the windrows but this only removes large contaminants. As a result, the waste that is being placed on the windrows still contains contaminants, mainly plastics, rocks, and some pieces of glass.

According to the Sanitation Officer, the main reason for not using the conveyor is the lack of manpower at the compost plant. At present, there are only 6 people working at the plant. Although six people are clearly insufficient to run the plant, the number of workers has not been increased because of budgetary constraints. The Sanitary Officer believes that he would require 20 additional people to operate the compost plant in full swing. In 1989, when the compost plant started its operation following rehabilitation, the plant had 3 supervisors and 8 sweepers. Additionally, the SWMRMC had seconded an advisor to assist in the operation of the plant. The production of the plant at that time was approximately 1.5 tons per day (SWMRMC, 1989).

The windrows are built on three brick paved platforms and on empty spaces towards the south of the plant. The windrow platforms have drains separating each windrow. Each of the three platforms can accommodate six windrows, which are 2 m wide at the base, 1 m high and 18 m long. The area south of the third platform can accommodate 8 additional windrows.

BCP has recently acquired a large piece of land immediately south of the existing plant, which will allow it to build several more rows of windrows. If the new extension area is fully utilised the compost plant will have the capacity to build at least 40 windrows, while leaving enough space for maturation and storage of finished product. Assuming that the windrows are triangular in cross-section and have the dimensions of 2 m width at the base, 1 m height, and 18 m length, then at any given time, there would be 720 cbm of windrow space. SWMRMC's experience from Teku indicates that the density of waste in a new windrow is approximately 1.4 times higher than fresh incoming waste (SWMRMC, 1989). Furthermore, if we assume that 15 percent of incoming waste is rejected, then a total of 1,185 cbm of fresh waste will be required for the 40 windrows. If the average time required for composting, including maturation, is 2 months, then each windrow can be replaced at least 4 times a year, even if no composting is done during the monsoon season. Therefore, if the new space is fully utilised, the compost plant will have the capacity to utilise 4,740 cbm of waste per year.

In November 1996, the plant had 8 windrows which were approximately 15 m long and another about 40 m long windrow along the northern wall. Each windrow is approximately 3 m wide at the base and 1.5 m tall. Therefore, at that time the compost plant had a total of 360 cbm of material in the process of composting.

The only method for aeration used at the plant is turning of the windrows. Turning of the compost pile is done manually by moving the windrows longitudinally. Although the windrows are supposed to be turned once every week or at least once a month, because of the lack of manpower and inefficient use of the existing manpower, windrows are not turned at regular intervals. At the time of this study, one of the windrows had not been turned for 8 months, and another was being turned only after 6 months. Two or three people are required to turn a window. One person digs the pile and the others shovel the waste and remove large contaminants. Currently, three workers working on one window turn approximately two cubic meters of waste per day.

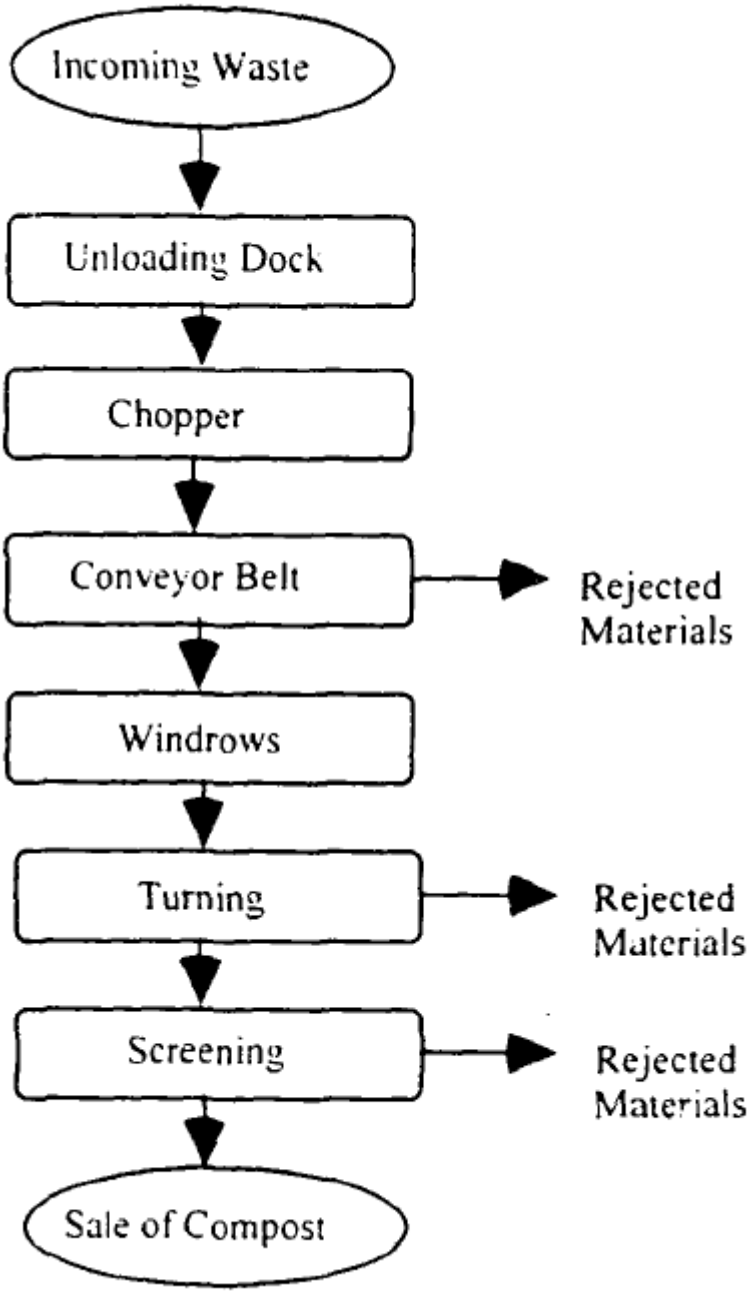
Because the incoming waste is not properly sorted before it is placed on the windrows, it contains a lot of contaminants and some sorting is done while turning the pile. This level of sorting is, however, clearly not enough as large amounts of contaminants were visible on the piles even after turning. This system is not efficient because the reject materials continue to occupy valuable space at the compost plant and the need for sorting the waste also slows down the workers.

During the wet season (June-August) water is not added to the windrows. In the dry season, water is sometimes sprinkled on the windrows, however not at a regular interval. The temperature and moisture content of the decaying material is never checked.

Once the workers feel the compost is ready or when there is demand

for compost, the compost is screened through an inclined static screen with a mesh size of 0.25 inch. There is no set period for maturation. Although the maturation time recommended by SWMRMC is 5 weeks, at BCP, the maturation time depends on the demand for compost. The screened compost is piled near the centre of the plant before it is sold to farmers.

Figure 3.1 Process Flow Chart



The rejected materials from the sorting and sieving process are either thrown in to the river or used to fill up low lying areas. Some recyclables such as metal and plastic are sold to scrap buyers.

The compost plant currently has the following equipment: 1 conveyor belt with chopper; 6 shovels; 7 rakes; 6 handcarts; and 3 screens.

3.3 Product

BCP only produces one type of compost. However, the plant sells its old compost for a lower price than recently made compost. Therefore, from marketing point of view the compost plant is selling two products.

BCP's production capacity depends on the amount of composting space available and the number of workers employed, assuming that the method of composting remains the same. According to SWMRMC (1989), the current space available is enough to produce 4 tons per day, if the same manual process is used. BCP is currently extending the area occupied by the compost plant. With this extension, the capacity will increase to about 6 tons per day. According to a FAO survey one person can manually produce and market approximately 300 kg of compost per day (SWMRMC, 1989). This figure is derived from experiences, mainly in India. Assuming this same figure, the six workers at BCP should be able to produce 1.8 tons of compost per day. To reach its capacity of 6 tons per day, the plant would require 20 workers.

At present, however, the plant is operating below capacity mainly because of inefficiencies in operations and management. As there are no records kept regarding the amount of incoming waste or the production of compost, it is impossible to say the exact rate of production. However, workers at the plant say that BCP currently produces only about 1 ton of compost per day. This indicates a capacity utilisation factor of approximately 25 percent. Because the plant does not operate for about three months during the monsoon, annually, the plant produces approximately 200 tons. According to the Municipality the total revenue earned from the sale of compost in 1995 was Rs. 22,004. The old compost at the plant is sold at Rs. 100 per tractor load and the new compost is sold at Rs. 200 per load. Each tractor load of compost weighs approximately 475 kg. There are no records as to the amount of compost sold. Assuming that 75 percent of the sale was done at Rs. 200 per tractor, the total amount of compost sold from BCP in 1995 is only 60 tons. This indicates that either the estimated production of 1 ton per day and 200 tons per year is too high or that much of the compost sold is not recorded.

BCP does not regularly analyse the quality of its compost. The last analysis was done in May 1989 by SWMRMC. That analysis indicated that although compost made at BCP has low nitrogen and organic content, it was still possible to make reasonably good quality of compost from Bhaktapur's waste. The quality of the compost is also reflected by the demand for the compost by local farmers. According to the farmers, the BCP compost is of reasonably good quality but the main problem is the glass particles in the compost and the high transportation cost.

Results of an analysis done for this study on a sample of 5 months old compost and a sample of 1 year old compost produced by BCP is

presented in Table 3.1. The table also presents results of the analysis of BCP's compost done in 1989, and compost quality standards recommended by SWMRMC. BCP compost is dark brown in colour and has a density of 820 kg per cubic meters.

Table 3.1 Compost Quality

PARAMETER	BCP (5 MONTHS)[1]	BCP (1 YEAR)[2]	BCP (1989)[3]	PROPOSED STANDARD QUALITY[4]
pH	4.95	5.15	na	na
Total Nitrogen %	0.45	0.39	0.71	min. 0.8
Phosphorus (P_2O_5) %	0.59	0.56	0.65	min. 0.4
Potassium (K_2O) %	0.95	0.89	0.85	min. 0.3
Organic Matter %	8.11	7.05	15	min 18
Organic Carbon % (calc.)	4.71	4.10	8.8	min. 8.5
Moisture %	66.3	67.6	26	max 30
C:N Ratio	10.51	10.51	12.4	min 12; max 20
Calcium %	0.95	0.89	1.50	min 2
Magnesium %	0.49	0.46	0.53	min 0.4
Boron (mg/kg)	10 - 16	na	5.4	max 25
Zinc (mg/kg)	140 - 208	na	270	max. 300
Copper (mg/kg)	117 - 121	na	120	max. 150
Nickel (mg/kg)	32 - 41	na	25	max. 50
Cadmium (mg/kg)	0.7 - 0.8	na	<0.4	max. 5
Lead (mg/kg)	73 - 76	na	110	max. 100
Chromium (mg/kg)	30 - 36	na	94	max. 100
Mercury (mg/kg)	3.6 - 4.7	na	0.2	max. 5
Silver (mg/kg)	0.7 - 0.9	na	3.6	-
Iron (mg/kg)	8,600 - 12,400	na	17,000	-
Manganese (mg/kg)	263 - 290	na	500	-
Arsenic	1.7 - 2.4	na	na	-

Note

1: 5 month old BCP Compost analysed for this study. The results of the metal content analysis are range of three replicate tests. The nutrient analysis was done at Agricultural Technology Centre, Lalitpur. The metal analysis was done at Environmental and Public Health Organisation, Kathmandu.

2: 1 year old BCP Compost analysed for this study. Metal content analysis was not done for this sample.

3: Results of analysis of BCP Compost in May 1989. The analysis was conducted in Germany (SWMRMC, 1989)

4: Proposed Compost Standards in Sammelband "Muell-und Abfallbeseitigung" by Kumpf/Maas/Straub MuA 45.Lfg. VIII 1977 code (Kennzahl) 6856, pg 13-14 (SWMRMC, 1989)

The following conclusions can be drawn from the analysis of BCP's compost:

1 The compost is slightly acidic. This is not desirable because the soil of Kathmandu Valley also has a slightly low pH.

Compost with a pH of a little over 7 would be more suitable for Kathmandu Valley

2 The organic and nitrogen content of the compost is low. Although BCP's 1989 compost was also deficient in organic matter and nitrogen, the samples analysed for this study had significantly lower levels of organic matter and nitrogen than BCP's compost in 1989. One possible reason for this difference could be different composition of incoming waste. Because a significant portion of waste coming to the compost plant is agricultural waste, the type of waste being composted varies seasonally. Another reason could be the loss of organic matter and nitrogen from the compost due to leaching and conversion of nitrogen into gaseous products. Although the age of the compost sample analysed in 1989 is not known, it is possible that it was not as old as the samples analysed for this study. However, even if there were losses, this alone would not explain the huge difference.

3 The C:N ration is also slightly low.

4 The levels of other macro-nutrients — phosphorus and potassium — are acceptable.

5 Among the trace minerals, while magnesium content is acceptable, the calcium content is slightly low. The calcium content was higher when measured in 1989.

6 Concentrations of all heavy metals are in the acceptable range. The concentration of mercury is, however, fairly high. The reason for the high mercury content in the waste is not known. Because Bhaktapur has no major known source of mercury waste and because the level of mercury measured in 1989 was significantly low, the high level of mercury observed is very unusual. Potential reasons for this could be experimental error or error due to one time sampling.

This study also conducted analysis of compost made by farmers in Bhaktapur, by Sher Bone Mill, a private company in Lalitpur which makes compost (brand name: Kisan Mal) from animal manure, and by Unnati Adhar Kendra, an NGO which makes compost (brand name: "Unnat Mal") from household waste in Teku area of Kathmandu. Comparison of various types of compost made in Kathmandu Valley is presented in Table 3.2. For comparison purposes, the table also contains the results of an analysis done in 1988 on compost made from Kathmandu's waste by SWMRMC. The raw materials and processes used to make Unnat Mal and the SWMRMC compost is not much different from the raw material and process used by BCP.

Table 3.2 Comparison of Various Types of Compost

PARAMETER	BCP COMPOST[1]	FARMER COMPOST[2]	UNNATI MAL[3]	KISAN MAL[4]	SWMRMC[5]
pH	4.95	5.2	7.3	8.05	7.0
Total Nitrogen %	0.45	0.67	1.04	3.02	0.93
Phosphorus % (P_2O_5)	0.59	0.45	0.88	9.50	0.83
Potassium (K_2O)	0.95	0.8	2.4	1.50	0.61
Organic Matter	8.11	12.26	7.22	68.20	17.9
Organic Carbon %	4.71	7.12	na	57.4	na
Moisture %	66.3	70.0	na	26.1	na
Calcium %	0.95	0.8	na	14.0	5.9
Magnesium	0.49	0.3	na	4.59	0.44
C:N	10.51	10.62	na	19	na

Note:

1 5 month old BCP Compost

2 Compost made by a Bhaktapur farmer. Raw materials used to make the compost mainly consisted of various types of agriculture waste, mustard oil cake and buffalo manure.

3 Compost made by Unnati Aadhar Kendra, an NGO, from domestic waste

4 Compost made by Sher Bone Mill Industry, a private company, from buffalo manure; bone , oil cake and various other waste.

5 Average of results of analysis done on five samples of SWMRMC compost (MASS, 1990:44)

The table shows that the quality of BCP compost is not as good as most of the other compost used in the Valley. The table also shows the possibilities for improving the quality of BCP's product.

A survey conducted during this study indicated that farmers of Thimi and Bhaktapur realize that using compost fertilizer is much more beneficial for the soil than other chemical fertilizers. Farmers who use BCP compost usually mix it with chicken or animal manure and small percentage of chemical fertilizers such as Urea and Complex. Based on our survey, the following are the general attitudes of farmers towards BCP compost:

- The compost has high contamination in the form of broken glass, plastic and old textile.
- Quality of the compost is acceptable.
- Price of compost is reasonable. Currently, BCP compost sells for Rs. 100 per tractor load (approximately 475 kg) for one year old compost and Rs. 200 per tractor load for compost produced this year (i.e. Rs. 0.21 and Rs. 0.42 per kg respectively). Farmers from Thimi, however, consider the transportation cost, which is about Rs. 250 per tractor to be too high.

The analysis of BCP's compost, its comparison with other compost available in Kathmandu Valley, and the attitude of the farmers who use BCP compost indicates that there is room for improving the quality of the compost.

3.4 Occupational Health, Safety and Environmental Issues

For the most part, the operational procedure of BCP is safe and environmentally sound. The waste does not have hazardous materials. Bhaktapur residents in general generate negligible amount of hazardous waste and whatever is generated rarely ends up at the compost site. Potential hazardous materials such as hospital waste and carcasses of dead animals are not brought to the compost plant; they are buried separately. The analysis of the compost (see Table 3.1) also shows that the concentrations of heavy metals are within acceptable range. The workers at the compost plant have been given protective clothing such as masks and boots, although these are not used all the time because some workers feel uncomfortable working in protective clothing and BCP does not strictly mandate their use.

Two main health and safety concerns at BCP are:

- presence of glass in the compost which can cut the workers as well as the users of the compost; and
- release of hazardous gasses such as ammonia, H_2S and methane during the turning of windrows, due to anaerobic conditions inside the windrows.

The first problem can be minimised by carefully sorting the waste before placing it in the windrows. The second problem can be tackled by frequently turning the piles or by putting perforated pipes inside the windrows in order to ensure aerobic conditions.

The main environmental problem associated with BCP is the occasional disposal of waste in the Hanumante River. During rainy season and when there is more waste than the handling capacity of BCP, the waste is dumped on the banks of the Hanumante River or in low-lying areas in the outskirts of the city. This waste is either eaten by pigs, or washed away by the river if it is not covered by soil. Because the local people use the river for many purposes, and because it flows through heavily populated areas, pollution of the river is a major environmental problem. Dumping of the waste in the river should therefore be stopped in order to minimise the adverse environmental impacts on the river system and the associated health risks.

3.5 Strengths and Weaknesses of the System

Strengths

The main strength of BCP is the interest and commitment shown by Bhaktapur Municipality towards composting. The municipality's efforts in composting its waste, in spite of the fact that waste can be freely dumped in the river at no cost to the municipality, is indeed commendable. No other municipality or government body in Nepal is composting its waste. Most are content dumping their waste in a river or some other public place. One or two municipalities, such as Banepa, have expressed their desire to compost their waste, but have not dared to do so yet. A few private companies and community groups are composting their waste, but these are very few and scattered. A large composting plant used to operate in Teku, Kathmandu, but it closed down in 1990. BCP is by far the biggest compost plant operating in the country. In this context, the support

of Bhaktapur Municipality and the local people is BCP's greatest strength.

Another positive point of BCP is the composition of Bhaktapur's waste. The fact that the waste is 88 percent organic with negligible amount of hazardous contaminants makes it ideal for composting. The amount of sorting that needs to be done is minimal and size reduction is also only seldom necessary. Furthermore, the amount of waste generated by Bhaktapur residents is small compared to other urban residents. Therefore, the waste is easily manageable.

Bhaktapur's waste collection system is another major strength for BCP. The waste collection system is regular and efficient, thus ensuring the plant a regular supply of raw material.

The location of BCP is another positive aspect of the system. It is very close to the city centre, and the nearby agricultural fields, thus minimising cost associated with waste hauling as well as transporting the product to the market. There is sufficient land area for composting and if needed there is also some space remaining for future expansion. Although houses surround the compost plant, it is located in a community of sweepers and thus its presence does not offend or disturb the local community. There has been no opposition from the local community regarding the operation of the compost plant at that location.

Another strength of BCP is its simple operating procedures and low operation/maintenance cost. Because Nepalese people understand the manual composting system, the system does not seem out of place or "foreign" in Bhaktapur. The lack of sophisticated equipment, together with inexpensive labour, keeps the operating cost low and reduces chances of process failure. In comparison, a large mechanical system built in by a German project in Kathmandu in 1985 ceased to operate in 1990 because of frequent break-downs, complex operating procedures, complaints from neighbours, and lack of political support. Comparison of this system with BCP has shown that labour intensive processes are cheaper and more suitable for Nepal than mechanical processes (SWMRMC, 1989).

Weaknesses

The workers do not have sufficient incentives to improve the system. Although the workers are aware of some of the improvements that can be done in the system, they are reluctant to introduce any new changes and do not see how improving the system will benefit them. The introduction of performance oriented incentive packages would motivate the staff to deliver better results.

The current work force of 6 people is not enough to fully operate the plant. The municipality has realized this, but so far it has been unable to hire additional people due to budget constraints. Recently, Bhaktapur Municipality has started an innovative fund raising mechanism by charging every tourist US $ 5 for entering the historic city. The funds raised will go primarily towards conservation efforts. Bhaktapur is the only city in the country which has such a fee. With the introduction of this fee, there is a possibility that Bhaktapur can allocate some more money towards waste management.

Waste is not properly sorted at the compost plant. As a result, the end product has contaminants such as glass. The presence of glass in the compost is a major problem, because most farmers work bare feet in their fields. This is also the most commonly heard complaint from the farmers using the compost. Improper sorting at the beginning also results in inefficient use of the available space for composting as much of the space is being used by rejects which should have been removed before putting the waste in the windrows. There is space at the compost plant for sorting and it is even equipped with a conveyor. Therefore proper sorting should be strictly enforced.

The windrows are not regularly turned. This results in anaerobic conditions inside the windrows. It causes odour problems and increases the time required for composting. Therefore, a schedule needs to be fixed regarding the turning of the windrows and it should be strictly followed.

Another problem associated with BCP is the long time required for compost production. This is mainly because the windrows are not turned regularly and favourable conditions are not maintained inside the windrows. The time required for compost production can be reduced by regularly turning the windrows, ensuring that the C:N ratio of the feed stock is between 25 to 30, maintaining moisture content at 50 to 60 percent and using activators such as effective microorganisms.

The quality of compost is not good enough. In order to improve the organic and nitrogen content of the compost, the incoming waste can be mixed with other materials such as animal manure, saw dust and ash. Chicken manure can be bought from nearby poultry farms; saw dust is available from nearby saw mills and ash is available from near by brick factories or from pottery makers.

There is no system of quality control. The quality of the final compost is not regularly checked and records of production and sale of compost are not kept. As a result, the performance of the composting plant is not known and customers do not have enough confidence in the product. BCP should, therefore, maintain proper records of its operations and check the quality of its compost at least once a year.

Compost is not produced during the rainy season. Putting shed over the composting platform would solve this problem. This, however, requires initial capital cost, which may not be readily available. Covering the windrows with plastic sheets and constructing drainage channels would be a temporary and inexpensive solution to this problem.

Chapter IV

FINANCIAL ANALYSIS

4.1 Introduction

The financial analysis of BCP attempts to determine the profitability of the enterprise by calculating actual cost, including hidden costs, of producing one kg of compost and comparing with the revenue earned. Cost of production has been calculated by adding various cost components including costs for labour, materials, bought-in services, rent, investment costs and financing costs.

The financial analysis of BCP includes all costs calculated on a per kilogram of compost basis. The average actual production level of BCP is assumed to be 200 tons for a twelve-month period. One tractor load of compost, the unit in which BCP sells its compost, is assumed weigh 475 kg. All figures are in local currency and its equivalent in US dollars. The current exchange rate is US $ 1 = Rs 57.30.

Running (operating) cost is calculated on a yearly basis for the total yearly output. Cost of production will strictly concentrate on costs of operation at BCP facility only and will exclude costs associated with waste collection in Bhaktapur municipality. However, partial costs for waste transfer (labor, fuel and depreciation of vehicles) are included as hidden costs in calculating cost of raw materials and labor.

Waste recovery is done first by scavengers who pick the recyclables such as metal pieces, plastic, and glass from the waste piles in the streets before the Municipality workers collect it. According to the BCP's supervisor waste would have been scavenged at least twice before it reaches BCP facility. BCP workers also collect and sell the remaining recyclables. Income generated from this activity is negligible and is not included as BCP's source of revenues.

4.2 Cost of Production

4.2.1 Cost of Labor

Actual cost of labor includes salaries for 6 full-time persons and 1 full-time supervisor (Sanitation Officer) for a one-year period. Salaries of a full-time staff at BCP are Rs. 2,050 per month ($35.78) for the labourers, and Rs. 3,200 per month ($55.85) for the supervisor. The total actual cost of labour per kg of compost is calculated as:

[(Rs. 2,050*12*6) + (Rs. 3,200*12)]/200,000 kg = Rs. 0.93/kg

The hidden cost for labour includes one fourth of the cost of salaries for 21 full-time workers who work as drivers and loaders for the waste collection and transfer vehicles (2 loaders and 1 driver per vehicle for 5 tractors and 2 pick-ups) as they spend approximately one-fourth of their daily time to transfer the waste to the BCP facility. The full-time salary of a driver is Rs. 2,350 ($ 41.01) and the assistant(loader) is Rs. 2,150 ($37.52) per month.

One fourth the cost of 14 labourers per kg of compost is included as hidden cost and calculated as:

[{(Rs. 2,350*7*12) + (Rs. 2,150*14*12)}/200,000 kg]/4 = Rs. 0.70/kg

4.2.2 Cost of Materials

There is no actual cost for raw materials but hidden cost for raw materials include one fourth of the yearly cost for fuel and depreciation of vehicles. Fuel costs are for 7 vehicles, which include 5 diesel tractors and 2 petrol mini-vans. According to the supervisor, 10 liters of petrol and 10 liters of diesel are allocated per vehicle for 10 days, or 1 liter per day. Diesel is Rs. 14 per liter ($ 0.24) and petrol is Rs. 39 ($ 0.68) per liter. The fuel cost per vehicle is calculated as:

[{Rs. (5*1*365*14)+ Rs.(2*1*365*39)}/200,000 kg]/4 = Rs. 0.07/kg.

There is no cost of any additives or packing materials as BCP does not use any additives to make compost and packaging of compost is not done. Since the whole process of making (sorting, turning the windrows, screening etc.) compost is manual and the conveyor is not used the demand for electricity is negligible. Cost of electricity and water is estimated to be Rs. 6,000 ($104.71) per year. Cost of tools is Rs. 15,000 ($261.78) per year and includes cost for sieve, shovels, rakes, brooms, aprons, gloves, boots, and masks.

The actual cost of spare parts and maintenance of waste collection vehicles is approximately Rs. 4,000 ($69.81) per year and the hidden cost includes one-fourth of this cost which is Rs. 1,000 ($ 17.45) for maintenance and spares for the vehicles used for collection and transfer.

4.2.3 Bought-in services

This refers to services provided to the enterprise by other people or companies. Since BCP does not separate the cost for bought-in services for machinery repair and maintenance, this cost is included in the cost of spare parts and maintenance. There are not other bought-in services involved in producing compost at BCP.

4.2.4 Rent

There is no actual cost for rent as the Municipality owns the land. Hidden cost includes a yearly rent of Rs. 120,000 ($2,094.24), which is the approximate market rate for the rent of land equivalent to that occupied by BCP. Hidden cost for rent per kg of compost is calculated as:

Rs. 120,000/200,000 kg = Rs. 0.60/kg

4.2.5 Investment Cost

Investment cost refers to the distribution of expenditures in assets owned by the enterprise. The actual investment cost for BCP includes cost of depreciation for building and machinery (conveyor). Historical purchase price for the building is the cost of construction at the time it was built and the purchasing price for

the conveyor. Life time use for the conveyor is estimated to be 10 years and 15 years for the building.

The hidden cost for depreciation will include one-fourth the cost of depreciation of transportation vehicles, which are 5 tractors, and 2 mini-vans, which are used for collection, and transfer of waste.

The price of a tractor is Rs 125,000 ($2,181.50) each and the life time is estimated for 5 years, the price for mini-van is Rs. 500,000 ($8,726) and life time is estimated for 8 years.

Depreciation = [(purchase price-residual value)/life time]/200,000 kg.

Depreciation for each tractor is therefore equal to [(Rs. 125,000 - Rs. 10,000)/5]/200,000 kg = Rs. 0.12 per kg. For 5 tractors, depreciation cost is Rs. 0.60.

Depreciation cost for each mini-van is [(Rs. 500,000 - Rs. 50,000)/8]/200,000 kg = Rs 0.28 per kg. For 2 mini-vans, depreciation cost is Rs. 0.56 per kg.

Table 4.1: Fixed Assets Register

NAME OF ASSET	YEAR OF PURCHASE	EST. TOT LIFE (YR)	PRICE AND VALUE OF THE ASSET				AVG. ANNUAL OCCUP. RATE	DEPRECIATION COST PER KG	
			HIST. PURCHASE PRICE	REPLACEMENT VALUE	HIDDEN VALUE	RESID. VALUE	KG OF COMPOST	ACTUAL COST	HIDDEN COST
1	2	3	4	5	6=5-4	7	8	9=[(4-7)/3]/8	10=[6/3]/ 8
Machinery	'95	10	300,000	330,000	30,000	50,000	200,000	0.13	0.02
Building & other facility	'89	15	100,000	194,871*	94,871	40,000	2000,00	0.02	0.03
Total								.15	.05

*the initial cost of building is adjusted for inflation at 10 percent per annum

Machinery, building and facility are the main fixed assets of BCP. Depreciation for building and machinery per kg of compost is Rs. 0.15.

4.2.6 Financing Cost

Financing cost refers to costs that has to be paid for those who have provided capital for the enterprise. Working capital to cover BCP's operational expenses is provided by the municipality through its own resources. BCP does not receive any other form of funding in the form of grant or loans.

The Municipality provided BCP with the necessary investment for acquiring the building and machinery. Because the Municipality is covering all fixed and running costs, there is no financial cost involved. However, the hidden cost of financing is equal to the interest that would have to be paid on the amount of subsidy received from Bhaktapur Municipality, if the money had been borrowed from a commercial financial institution. The operating cost provided by Bhaktapur Municipality to the plant is equal to the total operating cost minus the revenue earned by the plant. In 1995, this would equal to:

(Rs. 1.04/kg x 200,000 kg) - Rs. 22,004 = Rs. 185,996 (see Table 4.2).

The current interest rate on priority sector investment is 16 percent. Therefore the annual hidden cost for financing is equal to:

Rs. (185,996 x 0.16)/200,000 kg = Rs. 0.15 per kg.

4.2.7 Average Cost Price of Product

Table 4.2: Cost Price of Compost

COST ITEM	AVERAGE UNIT COST PER KILOGRAM OF COMPOST	
	ACTUAL COST (RS.)	HIDDEN COST (RS.)
Cost of labor		
6 persons (f-time @ 2,050/month)	0.74	
1 supervisor (f-time @ 3,200/month)	0.19	
7 drivers(@2350/month)	0	0.25
14 loaders(@2150/month)	0	0.45
Total labor cost	0.93	0.70
Cost of materials:		
cost of raw materials	0	0.07
cost of additives and packing materials	0	0
cost of energy and water	0.03	0
cost of spare parts and maintenance	0	.01
cost of tools (shovels, brooms, rakes, aprons, boots, gloves, sieve)	.08	0
Total materials cost	.11	0.08
Cost of bought-in services	0	0
Cost of rent	0	0.60
Sub-total of operating cost	**1.04**	**1.38**
Cost of depreciation		
Cost of interest	0	0.15
Subtotal of capital cost	**.15**	**0.49**
Total cost price	**1.18**	**1.87**

The actual cost price of the compost includes cost of labour, cost of materials, depreciation and the hidden costs include one fourth the

labour cost for waste transfer, fuel costs of vehicles, depreciation of vehicles and rent. All available costs are tabulated in Table 4.2.

The actual cost of producing one kg of compost is Rs. 1.18 (US $ 0.02) and the hidden cost is Rs 1.87 (US $ 0.03). The total cost of production for the compost is, therefore, Rs. 3.05 (US $ 0.05) per kg. When considering only the actual cost of production, labour comprises 79 percent, materials comprises 9 percent and the capital cost comprise 12 percent of the cost. However, when considering the total cost of production, labour comprises 53 percent, materials comprise 6 percent and capital costs comprise 21 percent of total cost.

4.2.8 Cost of Taxes

There is no actual cost for taxes as BCP is owned by the municipality.

4.3 Revenue from Product Sales

The four potential sources of revenue for a composting enterprise are: sale of compost; a tipping fee for handling the waste; sale of recyclable scrap and subsidy from supporting agencies. In the case of BCP, the main sources of revenue are the sale of compost and subsidy from Bhaktapur municipality.

Revenue generated from the sale of compost in 1995 was only Rs. 22,004 ($ 384), whereas the total production was approximately 200 tons . The old compost at the plant is sold at Rs. 100 per tractor load and the new compost is sold at Rs. 200 per load. Each tractor load of compost weighs approximately 475 kg. There are no records as to the amount of compost sold. Assuming that 75 percent of the sale was done at Rs. 200 per tractor, the total amount of compost sold from BCP in 1995 is only 60 tons. This indicates that either the estimated production of 1 ton per day and 200 tons per year is too high or that much of the compost sold is not recorded. As the municipality office, which is located away from the compost plant, handles the revenue receipts and there are no mechanisms for monitoring the sale of compost from the compost plant, it is most likely that much of the compost sold is not recorded.

Since, Bhaktapur’s waste comprises of 88 percent biodegradable materials and scavengers collect recyclable materials from the waste before it reaches BCP, revenue from selling of recyclable scrap would be negligible. Furthermore, because the small amount of revenue generated from selling scrap goes directly to BCP workers, it cannot be regarded as income for BCP.

Because Bhaktapur Municipality incurs all the operating expenses, this subsidy can be regarded as source of revenue for BCP. For operating expenses the municipality provided Rs 208,000 ($3,630.02) in 1995.

4.4 Profitability Statement

Based on the revenue calculated in Section 4.3 and the total cost of production calculated in Section 4.2, a profitability statement for BCP has been prepared (Table 4.3)

Because this analysis is only of BCP as an independent unit, it does not include the avoided cost of managing the waste through other means such as landfilling if it were not composted by BCP. The avoided cost results in cost saving in transporting the waste to the landfill site and sanitary landfill cost saving. Although the avoided cost is probably a significant amount, the cost savings benefit Bhaktapur Municipality, and not BCP, and is therefore not taken into account in this analysis.

Table 4.3 Actual Profitability Statement of BCP

ITEM	PER KILOGRAM OF COMPOST	PER TIME PERIOD (1995)
Revenue:		
Revenue from subsidies	1.04	208000
Revenue from recorded sale of compost*	0.11	22004
Revenue from waste recovery sales	0	0
Total Revenues	1.15	233004
Actual running cost	1.04	208000
Gross Profit (loss)	0.11	22004
Actual capital cost	0.15	30000
Net profit(loss) before tax	(0.04)	(8000)
Cost of taxes	n.a.	n.a.
Net profit/Loss after tax	(0.04)	(8000)
Hidden cost	1.87	374000
Net Profit (loss)	(1.91)	(382000)

* This is the revenue from sale as it was recorded by the Municipality. However, as mentioned in Section 4.3 of this report, much of the compost sold is probably not recorded. Assuming that average price of compost is Rs. 175 per tractor load (475 kg), then only 60 tons, out of the 200 tons sold was recorded. As a result, per kg revenue from the sale of compost is shown to be 0.11 only instead of 0.37.

This financial analysis indicates that BCP is currently operating at an annual loss of Rs. 386,000 ($6,736.47), or in other words, BCP looses Rs. 1.91 per kg of compost produced, even when Bhaktapur Municipality is subsidising all of the operating cost. This is mainly due to the high hidden costs involved and very low revenue earned from the sale of compost. Because of the low price of BCP's compost (Rs. 0.37 per kg) and the large amount of unrecorded sales (only about 30 percent of sale is recorded), the actual revenue earned per kg of compost sold is only Rs. 0.11, whereas nurseries and private companies in Kathmandu sell their compost for between Rs. 4 to Rs. 15 per kg. Assuming that all the compost sold by BCP was recorded, the plant would still be running at loss after taking into account the hidden cost as indicated in Table 4.4.

Table 4.4 Adjusted Profitability Statement of BCP

ITEM	PER KILOGRAM OF COMPOST	PER TIME PERIOD (1995)
Revenue:		
Revenue from subsidies	1.04	208000
Revenue from sale of compost*	0.37	74,000
Total Revenues	1.41	282,000
Actual running cost	1.04	208000
Gross Profit (loss)	0.37	74,000
Actual capital cost	0.15	30,000
Net profit(loss) before tax	0.22	44,000
Cost of taxes	n.a.	n.a.
Net profit/Loss after tax	0.22	44,000
Hidden cost	1.87	374,000
Net Profit (loss)	(1.65)	(330,000)

* Assuming that 200,000 kg of compost is sold and all sale is recorded

Table 4.4 indicates that after taking into consideration all the unrecorded sale of compost, which amounts to 140 tons per year, BCP lost Rs. 1.65 per kg of compost or Rs. 330,000 in 1995.

Chapter V

MARKETING ANALYSIS

5.1 Introduction

Effective marketing is a vital element for any successful enterprise. This involves a clear understanding of market segments, prediction of the demand for each segment, and development and utilisation of an appropriate mix of tools to meet this demand. The marketing instruments most often used can be divided into the following groups: product, pricing, promotion, and place or distribution system. Although there is a huge potential market for compost within Bhaktapur, Thimi and other nearby villages, this has not yet been exploited by BCP. The lack of a proper marketing strategy is one of the main factors responsible for this situation.

This chapter evaluates the current marketing system of BCP and analyses the potential market to recommend measures to improve the current system.

5.2 Market Segments

A market segment is defined as a homogenous group of customers. Members of each segment belong to the same social group, have similar attitude towards compost and use the compost for the same purpose. In the case of BCP, the potential customers can be divided into the following groups:

Vegetable farmers

This is the most obvious market segment for BCP's compost. In the past 8 years of operation of BCP, almost all users of BCP compost have been vegetable farmers of Bhaktapur and Thimi, which is a town about 6 kilometers west of Bhaktapur. The main reason for this is that (a) vegetable farms are located very close to Bhaktapur, thus decreasing transportation cost, and (b) farmers realize the benefits of compost in improving their vegetable production. In our survey, which included 10 farmers from Thimi, only one farmer was not aware about BCP compost. BCP's compost is locally known as German *Mal* (fertilizer), as this plant was started with technical assistance of GTZ.

Cereal crop farmers

Besides vegetables, the farmers around Bhaktapur also grow rice, maize, wheat, and millet. Tests done by SWMRMC have demonstrated that the use of compost, along with chemical fertilizers, in growing these crops, can significantly increase yields. However, at present, only a few crop farmers use BCP compost in their fields. The main reason for this is the presence of glass in the compost. Most farmers make their own compost for their fields.

Home gardeners

Very few houses in Bhaktapur have their own gardens. Although many houses, do have a few flower pots in their balcony, this will not generate any noticeable demand for BCP compost in the near future. In Kathmandu and Lalitpur, however, the demand for compost by home gardeners is increasing and some nurseries and Sher Bone Mill sell compost in small 1 kg and 5 kg packets. Therefore, there is a possibility of selling BCP compost in small quantities if it is attractively packaged and sold through nurseries or department stores in Kathmandu, Lalitpur and may be even Bhaktapur.

Private nurseries

Recently there has been a rapid growth in the number of nurseries, especially in Kathmandu and Lalitpur. Most private nurseries, however, make their own compost to meet their needs. Out of the five nurseries in Bhaktapur, which were surveyed for this study, only one had used BCP compost in the past year. It is important to note that these nursery owners are primarily farmers who have allocated some space in their fields for nursery purposes. Although three of the five nurseries were aware of BCP, they had not purchased any BCP compost because of excessive contamination in the form of broken glass.

Government nurseries

There is a government owned forestry nursery in Bhaktapur, which distributes saplings of fruit and fodder trees to local villagers. Officials at this nursery were not aware of BCP compost and were making their own compost to meet their needs.

Bhaktapur municipality

Unlike Kathmandu and Lalitpur municipalities, there are very few parks or gardens where the municipality may be able to use its own compost. There are some gardens inside the Bhaktapur Durbar Square, but the municipality is not responsible for managing these gardens. Therefore at present the municipality is not using any of BCP's compost. In the future, however, if the municipality constructs parks and gardens for its citizens, it could be a potential customer for BCP.

Institutions such as schools and colleges

There are several schools, colleges and hotels in Bhaktapur which may use some compost. At present, however, BCP does not supply to any of these institutions.

5.3 Demand per Market Segment

As mentioned above, the main market segment for compost is vegetable markets. Because of high cost associated with transporting compost, vegetable markets outside Bhaktapur district will probably not qualify as potential markets in this segment. According to Nepal District Profile, Bhaktapur district has approximately 700 ha. of

vegetable farms (NRA, 1997). If the vegetable farms are applied with medium dose of compost, one ropani (0.05 ha) of vegetable farm will require 750 kg of compost per year (MASS, 1989). This means that the total demand for compost among vegetable farmers in Bhaktapur district is approximately , the total demand for compost will be approximately 10,500 tons per year.

Many of the vegetable farmers, however, make their own compost. Assuming that 75 percent of the compost requirement is met by the farmers themselves, the demand for compost by vegetable farmers will be 2,625 tons per year. A study done in 1989 estimated that the demand for SWMRMC compost in Bhaktapur area may reach in the range of 1,000 to 2,000 tons per year (MASS, 1989). The study, however assumed that Bhaktapur had 250 ha of vegetable farms and that 50 percent of the farmers need for compost was met by themselves. Sales figures from the SWMRMC's Thimi depot, which catered mainly to vegetable farmers in the Bhaktapur/Thimi area, shows that 428 tons of compost was sold during the year 1987-88. The estimated order for 1989-90 was 750 tons.

Non-vegetable farmers are another major potential market for compost. Bhaktapur district has 8,076 ha of cultivated area. Of this, paddy is grown in 5,000 ha, wheat in 7,317 ha, maize in 2,200 ha and millet in 250 ha (NRA, 1997). The total is more than 8,076 ha because of multi-crop systems. Assuming that 7,300 ha of land is available for crop production and 10 tons of compost is required per ha, the total demand for compost by crop farmers in Bhaktapur district becomes 73,000 tons. Most of this demand is met by the farmers themselves as BCP does not supply to crop farmers and there are no other major compost producers.

The demand from other segments is very small and uncertain at present. Therefore the demand from these segments are not included in the market segment analysis presented in Table 5.1.

Table 5.1: Market-Segments and Demand in 1995

MARKET SEG.	MARKET FOR COMPOST			MARKET FOR COMPETING PRODUCTS			TOTAL FERTILIZER MARKET	
	TOTAL DEMAND[1] (T/YR)	SALES BCP (T/YR)	MKT SHARE (%)	CHEM. FERT.[2] (T/YR)	ANIMAL MANURE[3] (T/YR)	COMPOST EQUIV.[4] (T/YR)	TOTAL DEMAND (T/YR)	MARKET SHARE COMPOST (%)
1	2	3	4=3/2*100	5	6	7=5*fc+6*fm	8=2+7	9=2/8*100
Veg. farmers	10,500	200	1.9	262	2639	18,428	28,928	0.69
Crop farmers	73,000	0	0	2363	27,521	177,366	250,366	0
Total	83,500	200	0.24	2626	30,160	195,794	279,294	0.07

1 The demand per market segment was calculated assuming that (a) vegetable is grown in 700 ha and crop in 7,300 ha in Bhaktapur District and (b) one ha of vegetable farm requires 15 ton of compost and one ha of crop farm requires 10 tons of compost per year.

2 Chemical fertilizers used in Bhaktapur include Urea = 2072 m. ton; Ammonium Sulphate = 3 m. ton; Di-ammonium phosphorous (DAP)= 547 m. ton; Potash 2 m. ton; Triple-Super Phosphate (TSP)= 2 m. ton (Source: Agriculture Input Corporation; distribution of chemical fertilizers for Bhaktapur district). Please note that this figure does not represent the total nutrients required by the crops nor does it represent the total nutrients desired by the farmers. This is the amount sold in Bhaktapur. As the availability of chemical fertilizers is irregular, the actual demand of the farmers may be higher than this amount. This analysis assumes that of the total chemical fertilizer sold in Bhaktapur, 10 percent is used by vegetable farmers and 90 percent is used by crop farmers.

3 Animal manure includes fertilizer made from chicken waste made by poultry farms and animal waste produced by households. The total amount used in 1995 was estimated by making the following assumptions: (a) Animal manure required for average holding size was calculated using the ratio obtained from our survey (a farmer owning 0.331 hectares used approximately 1,250 kg of animal manure, which is equal to 3.77 tons per ha); and (b) in Bhaktapur district, vegetable is grown in 700 ha and crop is grown in 7,300 ha.

4 For the purpose of calculating compost equivalent, the following assumptions have been made: Urea is 46 % nitrogen; ammonium sulphate is 21% nitrogen; and DAP is 18% nitrogen. Compost equivalent is calculated by only comparing the nitrogen content of fertilizer and compost. In the case of compost nitrogen content is assumed to be 1%. Therefore fc is 46 for Urea; 21 for ammonium sulphate; and 18 for DAP. Similarly, manure is assumed to have 3% nitrogen. Therefore fm is 3.

Contamination and high transportation cost are the primary reasons for the decline in popularity of BCP compost. Till now, the target group for BCP compost consists of farmers only as there are many farmers in the area and the market is far from being saturated. Other potential groups such as nurseries are mostly located in Kathmandu and Lalitpur districts and horticulture farmers are located in Dhading district. High transportation costs is most likely to make BCP compost not as attractive as it needs to be used in bigger volumes compared to animal manure or chemical fertilizers. The main competition faced by BCP is compost made locally by individual households. Since farming has been a way of life for centuries in these areas almost all farmers know how to make compost and claim that their compost is of better quality than BCP compost as our survey showed.

5.4 Marketing-mix

Marketing mix is a combination of various marketing instruments used to approach the market segments that the enterprise wishes to serve. In the case of BCP, the current marketing mix is far from being adequate to meet the needs of the plant. With the exception of occasional advertising in the municipality's newsletter, and word of mouth advertising within the farmers' community, BCP does not use any other marketing instrument.

5.4.1 Product

At present BCP products are not designed to meet the needs of the various potential market segments, but rather to suit BCP's own convenience. BCP only produces one type of compost (i.e. BCP compost which is known locally as German *mal;* the compost does not have a

brand name). Proper sorting is not done to remove contaminants. The quality of the compost, in terms of nutrients, is also not altered to meet the specific needs of customer. Packaging is not done to make handling and transportation easier. Instead the compost is produced and put in the open for the farmers to come and get it. At the time of this study, however, BCP was selling its old stock at a 50 percent discount. Therefore, because of the price difference, it can be said that BCP was selling two products: one year old compost; and new compost. This again was not done to meet the needs of the farmers but rather to get rid of BCP's old stock. An analysis of these two products is summarized in Table 5.2.

Table 5.2: Product Range

PRODUCT NO	BRAND NAME	QUALITY[1]	PACKING	SIZE PER UNIT	1995 PRODUCTION	MARKET SEGMENTS SERVED
1	2	3	4	5	6	7
Product 1	BCP compost (last year)	N=0.39%; P=0.56%; K=0.89%	tractor -load	475 kg	50 tons	farmers in Thimi and Bhaktapur
Product 2	BCP compost (this year)	N=0.45%; P=0.59%; K=0.95%	tractor -load	475 kg	150 tons	farmers in Thimi and Bhaktapur

1 See Table 3.2 for details.

According to our survey, the farmers were satisfied with the nutrient quality of BCP compost. In terms of physical quality, however, contamination due to glass particles and plastic is the single most important deterrent for farmers to use this product. The price of BCP compost is reasonable and affordable. The reasonably good quality of the compost and its low cost is main strengths of the product. On the other hand, the main weaknesses are contamination with glass particles and high transportation cost.

In Thimi and Bhaktapur, the main competing products are compost made by individual farmers, and chemical fertilizers.

In order to address the problem of contamination, BCP has stopped using a sieve of 1/2 inch (12.2 mm) and started using a sieve of 1/4 inch (6.4 mm). BCP staff hopes that this change will significantly reduce contamination. BCP has not initiated, nor does it have any immediate plans to introduce any other measures for improving the existing product or introducing new products.

5.4.2 Distribution

All of BCP compost sales is done directly to farmers who come to the BCP plant to purchase the compost. Farmers first pay at the Municipality office (which is about 5-7 minutes walking distance from BCP) and then show the receipt of payment to workers at the compost site.

According to the supervisor of waste collection and management, BCP

used to provide tractor-transportation facility to farmers but as the waste collection load increased the Municipality could not spare an extra tractor for transporting compost. However, realizing the demand for compost and the complaints from farmers about having to pay high transportation costs for hiring a tractor, the Municipality intends to add tractor transportation facility at BCP by purchasing an additional tractor for the next fiscal year, if the proposal passes the budgeting committee.

Table 5.3: Distribution Channels

PRODUCT	DISTRIBUTION CHANNEL	ANNUAL SALES (1995)
BCP Compost	Direct from BCP	Rs. 22,004

BCP, so far, has only used the direct sales method. As the plant is a government enterprise it does not function as a profit center or a privately owned company. This probably explains the lack of initiatives and incentives within the municipality to apply more aggressive marketing techniques including other distribution channels to increase the annual sale of compost.

The problems with the current distribution system can be assessed as:

- Direct sale can only fulfill the demand of a limited number of target customers.
- Cannot provide transportation facilities when required.
- Sales is wholly dependent on customers who are expected to come directly to the plant rather than BCP making efforts to deliver the product to the customers.

In order to solve these problems, BCP can take the following initiatives:

- Open a sales depot in Thimi, because many of BCP's customers are from Thimi. This would lower transportation cost for the farmers and make the compost more accessible to them. In 1989, SWMRMC used to operate a depot at Thimi and it was doing well.
- Sell the compost through other retailers.

5.4.3 Pricing

Price for BCP compost has been fixed for Rs. 200 per tractor-load for this year's compost and Rs. 100/tractor-load for last year's production. Assuming that a tractor-load is approximately 475 kg, the cost per kg would be Rs. 0.42 and Rs. 0.21 respectively. Assuming that 75 percent of the compost sold is new compost and 25 percent is from the previous year, then the average price of compost is Rs. 175 per tractor or Rs. 37 per kg. The cost of transportation is approximately Rs. 75 per tractor per km.

Table 5.4: Pricing of Products (in local currency in 1995)

Dist. Channel	direct	direct	coops* retail shops	coops retail shops	direct	direct	direct	direct; retail shops	direct; retail shops

*all chemical fertilizers are imported by AIC and distributed through cooperatives.

Prices are usually set by taking into consideration financial requirements of the enterprise, the demand of the customers, and the willingness to pay on the part of the customers. The price set by BCP was, however, not determined by taking into account market forces or any of the principles mentioned above, but rather it was decided by the Municipality board. It is likely that this price was set on the basis of selling price of compost produced by Solid Waste Management Resource Mobilization Center (SWMRMC) in Teku in Kathmandu, which has been closed since 1990. In 1990, the price for SWMRMC's compost was Rs. 250 per ton, which means that a tractor load of SWMRMC compost would cost Rs. 120. The price structure for BCP compost has been revised for compost produced last year, which at Rs. 100 per tractor is half the price of compost produced this year.

BCP's price is very low compared to price of other competing products. Sher Bone Mill sells its compost made from animal manure at Rs. 4,000 per ton. Unnati Aadhar sells its compost made from waste at Rs. 5,000 per ton. Private nurseries sell their compost for as much as Rs. 15,000 per ton. Chemical fertilizers are subsidized by the central government and the selling prices of these fertilizers are fixed by the government. The level of subsidy varies according to the fertilizer and could reach up to 50 percent.

BCP's prices are not adjusted for inflation and compost production does not receive any form of subsidies from the central government.

5.4.4 Promotion of the Product

In the early stages of production, Bhaktapur Municipality used to advertise its BCP compost via radio and in cooperation with Agriculture Development Office. (SWMRMC, 1989)

But in the last two years Bhaktapur Municipality has been running advertisements in its monthly newsletter, *Bhaktapur*. The advertisement reads "Contact Bhaktapur Municipality for Compost Mal produced from Bhaktapur Compost Plant." In a recent advertisement of September issue of *Bhaktapur* the advertisement read "Compost Mal at 50 percent reduced rates" (translated from Nepali). The supervisor responsible for waste collection and BCP mentioned that they also advertised in a local weekly newsletter, *Shramik Weekly* but we could not find any such advertisement in the back issues of this publication.

The image of BCP compost or *German mal* has not been very positive because of high degree of contamination and inferior quality. Most farmers are aware that the compost they make is of better quality.

However, they would still purchase BCP compost if transportation facilities were provided and contamination was removed. Since most farmers work with bare hand and feet on at the fields they complained about glass contamination as it posed health hazards.

Table 5.5: Promotional Activities

PRODUCT	TYPE OF PROMOTION	MEDIA	TARGET-GROUPS	GOALS	COST
BCP compost	advertisement	monthly newsletter	farmers	inform farmers of BCP compost increase demand among farmers	none- as this newsletter is published by the municipality

BCP's marketing efforts through advertising in its monthly newsletter is not adequate as the circulation of this newsletter is very limited and not available in the town of Thimi. The most powerful and effective media in these towns would be personal selling, radio, programs in cooperation with Agriculture Development Office and distribution of simple pamphlets to farmers. Regular advertisements in media such as local newsletters would also be effective.

Since most of the farmers are aware of BCP compost or *German mal*, BCP has to make efforts to improve the tarred image of their product.

5.5 Market-Positioning and Marketing-Strategy

The market-positioning of an enterprise is defined as the way it profiles itself and its products on the market. It shows how each group of customers is approached by the enterprise by the mix of the various marketing instruments. The market-strategy is defined as the rationale and policy behind the set of marketing mixes applied to each market segment. In the case of BCP, the enterprise is catering to only one market segment and even in this segment, optimization of market-positioning and market-strategy has never been considered to improve the sale of its product. Table 5.6 presents the existing marketing strategy and performance for BCP, within the market segment it is currently serving.

Table 5.6: Existing Marketing Strategy and Performance

MARKET-SEGMENT : FARMERS IN BHAKTAPUR AND THIMI		
MARKET-MIX INSTRUMENTS	BCP POLICY	PERCEPTION OF THE CUSTOMERS
Product	Only one product, except when there is old stock.	Quality is satisfactory, except for the high level of contamination
Place/Distribution	Direct sales	transportation cost too high not readily accessible

Pricing	Rs. 200 and Rs. 100/ tractor	reasonable
Promotion	Advertise in municipality's magazine	not enough
Overall performance of BCP in this segment	So far BCP's performance is less than optimal. - Quality of compost is poor - Distribution channels is limited - Promotion of product is limited - Image of BCP compost is not very favorable	
Opportunities/constraints for improvement	Opportunities: - Quality of compost can be improved - Improve accessibility to customer by increasing distribution channels - Demand for compost is very high - Constraints: - Manpower shortage - Lack of incentives to increase production and sales - Know-how within BCP personnel of appropriate marketing techniques	
Performance of competitors in this market-segment	Product Quality - Quality of compost produced from animal manure and chicken manure is high - Price - Price per kg is higher for competing products but customers are willing to pay Marketing - chemical fertilizers are available from cooperatives and are generally more accessible than BCP compost although they are not always readily available. These products are promoted by radio and government agricultural offices. - animal manure and chicken waste is readily available from numerous households and poultry farms	

Chapter VI

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The following are some of the main conclusions that can be drawn from this study:

1 Despite the many weaknesses in HMG's policies and legislation related to waste management, the solid waste management system in Bhaktapur is quite efficient and may be regarded as the best among all municipalities of Nepal.

2 Bhaktapur compost plant is the largest compost plant operating in Nepal and the only one being operated by a municipality.

3 Waste generated by Bhaktapur residents is primarily organic in nature and contains very little, if any, hazardous materials. Bhaktapur's waste is, therefore, suitable for the production of compost.

4 The manual composting process utilised at BCP is appropriate for the existing conditions.

5 Due to insufficient manpower and poor management, BCP is unable to utilise its full production capacity of 4 tons of compost per day. As a result, a significant portion of the waste that can be composted is currently not being composted. The compost plant is currently producing approximately 200 tons of compost per year.

6 Poor sorting of waste and irregular turning of the windrows are the main technical problems at BCP.

7 Compost produced by BCP has low organic and nitrogen content. Additionally, the compost is usually contaminated with small pieces of broken glass, which can be dangerous for the users.

8 Actual cost of compost production in Bhaktapur is Rs. 1.18 per kg and the hidden cost amounts to Rs. 1.87 per kg.

9 BCP is currently operating at a loss. When considering all the actual and hidden costs, the loss amounted to Rs. 1.91 per kg of compost in 1995, even when the operating expenses provided by Bhaktapur Municipality is taken as a source of revenue. The main reason for this loss is the low revenue generated from the sale of compost. According to the records of the municipality, the total amount of revenue generated from compost sale in 1995 was only Rs. 22,004. The low figure is because of the low price at which the compost is sold (Rs. 0.37 per kg) and the high amount of unrecorded sales (estimated to be 70 percent of the total sales). As a result, assuming that the plant produced 200 tons of compost in 1995, the revenue generated per

kg of compost is only Rs. 0.11. In comparison, compost made by some nurseries sells for as much as Rs. 15 per kg in Kathmandu.

10 BCP does not have a proper marketing strategy. It produces only one product and caters to only one market segment — vegetable farmers in Bhaktapur/Thimi area. The only distribution channel BCP utilises is direct sales from the compost plant itself and the only promotional activity of BCP is occasional advertisement in the municipality's own magazine. As a result, even though there is a large market for compost and several potential market segments remain unexplored, BCP is having a difficult time selling its product and continues to operate at a loss.

6.2 Major Recommendations

Based on the findings of this study the following recommendations have been made to improve the technical and economic performance of BCP and promote composting of municipal waste in Nepal:

1 BCP should consider introducing performance oriented incentive package, in addition to the existing base salary, in order to motivate the staff to be more productive. The incentive may be in the form of a percentage of the total sale.

2 The production of compost at BCP should be increased through more efficient utilisation of existing space and better management of the plant. The current rate of 1 ton per day, which is less than what the plant was producing in 1989, is very low considering the amount of space available and the vast demand for compost. The production should be gradually increased with the goal of reaching the capacity of 4 tons per day, which is the current maximum capacity, and then 6 tons per day, which will be the maximum capacity following expansion of the plant.

3 If BCP wishes to operate at full capacity, the number of workers at BCP should be increased to 20 from the present level of 6. The increase should be gradual but steady.

4 The staff of BCP should be given proper training on compost production and marketing.

5 The windrows should be turned once a week in order to ensure aerobic conditions in the windrows and minimise the time of production. Additionally, perforated pipes should be inserted into the windrows to ensure the flow of oxygen inside the windrows.

6 Incoming waste should be properly sorted before it is placed on the windrows. Unsorted waste takes up more space, reduces the quality of the final product and makes the place look untidy. As the volume of waste processed by the plant increases, the conveyor should be used for sorting. While sorting the waste, special care should be taken to remove glass pieces.

7 In order to increase the nitrogen and organic content of the compost, BCP should mix the incoming waste with animal or chicken manure and saw dust or ash. If available, sludge from

the nearby waste water treatment plant should also be used.

8 In order to increase the pH of the compost, the windrows should be sprinkled with some agricultural lime.

9 BCP should try using effective microorganisms (EM) to activate the composting process. This is being used by Sher Bone Mill, the maker of Kisan Mal, to reduce undesirable odour and speed up the composting process. Initially, EM should be used on one of the windrows as a trial.

10 In order to ensure quality control, the nutrient content of the compost should be checked once a year and the temperature and moisture of the windrows should be checked regularly.

11 The compost plant should be covered with a shed to continue compost production during the monsoon season. If budget limitations do not allow the construction of the shed, plastic sheets should be used to protect the compost from rain.

12 The current price of compost is very low compared to its competing products and is not enough to cover BCP's operating expenses. Because there is a large demand for compost, and farmers and gardeners are willing to pay a higher price for good quality compost, the price of BCP compost should be increased. The price of BCP compost should be gradually increased together with the improvement in quality. The price can be increased by 50 percent in the first year and then at the rate of approximately 25 percent per year until an equilibrium point is reached in the market.

13 BCP should maintain good records of production and sale of compost in order to ensure that there is no leakage in incoming revenue.

14 Although BCP should continue to focus on selling its product to local farmers, where there is a very large demand, it should also explore other potential market segments. Home gardeners in Kathmandu and Lalitpur may be an attractive segment because they will be willing to pay a higher price if the compost is of good quality and has an attractive packaging. The sale of nursery compost for as much as Rs. 15 per kg is an indication of this possibility.

15 BCP should pack the compost in bags of different sizes in order to suit different market segments it intends to serve. For farmers, BCP should pack the compost in 50 kg bags. This can then be transported by bicycles or other forms of local transport. For home gardeners, BCP should pack the compost in attractive 5 and 10 kg bags.

16 BCP should provide the services of its tractors and mini pick-ups for transporting compost to its major customers.

17 Because Thimi is a major market for BCP, it should either establish a sale depot in Thimi or sell thorough an existing dealer there. Additionally, BCP should sell its product through various retailers, and government cooperatives in Bhaktapur, Thimi and possibly even in Kathmandu. The small packages of compost for home gardeners can be sold thorough

various retail stores, nurseries, and departmental stores in Kathmandu at a slightly higher rate.

18 BCP should increase its promotional activities by having programmes and advertisements aired during the Agricultural Programme of Radio Nepal, producing and distributing pamphlets to potential customers, and conducting demonstrations for farmers.

19 Despite its shortcomings, BCP is an excellent example of a municipality managing its waste locally in an environmentally sound way. HMG should, therefore, promote Bhaktapur's waste management system as a model for other municipalities. However, in order to avoid some of the problems faced by BCP, municipalities should consider allowing the private sector to manage composting units.

20 Municipalities should consider encouraging private sector involvement in composting of municipal waste by providing a tipping fee, which is equivalent to the avoided cost of landfilling.

21 HMG should amend the Municipality Act and the Solid Waste Management and Resource Mobilisation Act, in order to discourage municipalities from dumping their waste and promote composting and other forms of recycling.

22 The scrap tax charged by the District Development Committees should be abolished.

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Annex 1

Terms of Reference '**Compostinq** of organic household waste' (UWEP 5)

A. Introduction to the Urban Waste Expertise Programme (UWEP)

Background
The consultancy requested in this ToR is part of the Urban Waste Expertise Programme (UWEP). UWEP is a six-year programme commissioned to WASTE by The Netherlands Development Cooperation (DGIS). The programme consists of two parts:

- an Inception Phase (May 1995 - December 1996) for which the policy and the activities are set by WASTE, and
- a Project Execution Phase (January 1997 - April 2001) of which the policy and the themes are determined by the partners from the South which are selected during the Inception Phase.

A Programme Policy Committee, consisting of three persons from the South, is responsible for safeguarding the policy of UWEP. WASTE will run the secretariat of the programme and will provide thematic support.

Aims

The programme aims at:

- enabling organizations from the South to develop and initiate activities to improve waste management in low-income areas and to improve waste collection and recycling by small and micro enterprises
- providing information to government authorities and development agencies about small and micro enterprise and community involvement in waste collection and recycling to improve municipal waste management systems.

Target groups and Beneficiaries

Dissemination of the generated and documented knowledge will be targeted at local professionals, intermediary organizations for communities and small and micro enterprises, and policy makers (government authorities as well as.donor agencies). The affiliate beneficiaries will be the communities and the small and micro enterprises to improve their working and living conditions.

Activities

During the programme a wide variety of activities will take place in order to fulfil the aims mentioned above:

- professionals from the South will do research into experiences and knowledge on collection and recycling of waste materials in various cities in the South. Pilot projects will be carried out to generate innovative techniques and approaches. The findings from the research and pilot projects will be analysed, documented and disseminated through public and scientific media.
- resource centres in the South will be provided with the documentation to facilitate access to gained knowledge and expertise.

Research

The research project 'Composting of organic household waste' is part of one of the most important activities of the Inception Phase: *'documentation of existing activities in solid and liquid waste collection and recycling in the South'.*

The research on 'Composting of organic household waste' is one of the eleven research projects identified for 1995/1996. The general objectives of the research projects are as follows:

- to generate information about so-called informal, small-scale initiatives of enterprises and communities
- to identify the 'lessons learnt' and other interesting elements in order to transfer the knowledge and experience gained to other areas
- to identify problems and potentials for improvement.

B. Introduction to composting of organic household waste

Background and rationale

In 1989 WASTE started a research on the potentials of recycling to become a source of income for people in the low-income areas of Nairobi, Kenya on request of the Undugu Society of Kenya (USK), a Kenyan NGO. Rather than 'reinvent the wheel' and try to develop recycling activities, WASTE decided to involve local consultants from six other cities where resource recovery activities efforts are better developed than in Nairobi. The consultants investigated the technologies used, the products made and the markets covered by micro-entrepreneurs who recover urban solid waste materials in Cairo, Bamako, Accra, Manila and Calcutta.

Ten waste materials were identified: rubber, plastic, motor oil, cooking oil, tin cans, photochemicals, broken gla^s, bone and horn, household batteries and organic (biodegradable) waste. Attention was also paid to issues such as the size of the workforce and type of labour within enterprises, skills, government policies on recycling, and environmental legislation affecting resource recovery. These issues form the context within which resource recovery may form the basis of viable enterprises, and determine the extent to which recycling activities can be introduced in other cities'.

The research generated an abundance of local knowledge and expertise on recycling waste materials. Based on the consultants reports four publications were made to transfer the gained knowledge to other interested parties, such as intermediate organizations or policy and decision makers in government departments. The books are published in an Urban Solid Waste Series. Their topics are: Organic Waste, Plastics, Rubber and Hazardous Wastes (Motor oil, Household batteries and Photochemicals).

The main conclusions on recovery of organic materials, that can be drawn fox the WAREN research, are the following:
- 50-70% of municipal waste in economically less developed countries consists of organic material, and thus, composting is an interesting option to minimize amounts of waste to be transported and disposed of in landfills
- in the past, many municipalities have opted for large-scale mechanical composting plants; some have been closed down and many operate well below their planned capacities, mainly because of lack of marketing studies and because of lack of technical knowledge of operating over-sophisticated, inappropriate equipment
- also small-scale composting enterprises often face financial problems or have been subsidized either by the municipality or by donor agencies
- the only financially feasible composting enterprises that have been identified in the WAREN research are the micro-entrepreneurs in Bamako, Mali, using a simple methodology with simple tools, whereby farmers come to the composting site to buy the compost
- often the market for compost is a constraint in compost production; distances to the rural markets are large and consequently, transport costs are high
- another constraint is that chemical fertilizers are often cheaper than compost because of government subsidies
- although small-scale composting activities contribute to waste removal, at the moment their scale is too small to treat the total amount of municipal waste quality of the compost made from municipal waste is sometimes a problem due to among others the presence of heavy metals and the large amount of inert material in the garbage.

Since the WAREN research dealt with ten waste materials, in depth research was not possible. Therefor, this research project deals specifically with technical (i.e. process of composting, scale of technology, quality of compost) and financial-economic (i.e. marketing of compost and financial feasibility) aspects of existing composting enterprises in various countries.

*Although the main motivation of composting is not always a financial one - social and environmental motivations may be of equal importance - in these Terms of Reference the term 'composting enterprise' will be used to refer to all kind of different composting systems (in terms of scale, processing technique, management etc.). Researcher(s) are requested to use their own terminology (with clear explanations).

Objective of the consultancy

The objective is to examine, analyse and document existing composting enterprises.

The general research questions are:
- How do the composting enterprises function (with particular reference to technical and financial/economic aspects)?
- What are the key factors that determine the efficiency and effectiveness of the enterprise?
- What are the obstacles they face and what are opportunities for improvement?
- What are the key factors that determine the replicability of the enterprise?

The specific research questions are:
- What is the appropriate scale for composting enterprises?
- What are possible markets for compost?

The results of this research project should ultimately contribute to improved composting of (urban) organic waste and should ultimately lead to policy adjustments to facilitate the establishment of composting enterprises.

Working methodology

Case-studies in several countries will be investigated, which focus on the composting enterprise, however, relevant linkages with other actors should be taken into account as well. Case-studies will be selected using the following criteria.
Composting enterprises
- should have left the experimental stage behind
- should operate more or less successfully for more than two years
- should have a production capacity between 1 and 50 tonnes compost per day(preferably less than 10 tonnes)should have reached some level of commercialization (and not operate only because of environmental or social objectives).

The research should analyse the success as well as the existing problems and constraints of the enterprises.

Recommended research methods are:
- observation during working hours
- analysis of the records and documents of the enterprise
- interviews with key persons and institutions
- SWOP (Strengths, Weaknesses, Obstacles, Potentials)-analysis in group meeting(s).

The research should be carried out as much as possible in consultation and in discussion with employees involved in composting. Also, the research should build as much as possible on already existing literature and research.

It is assumed (but this depends among others on the number and complexity of the enterprises studied and the amount of information already existing) that each research will last around 2 months.

C. Scope of work

This section describes the actual work that needs to be done by the researcher(s). All items mentioned should be covered to the extent that they are applicable to the case study, although they might not be applicable to every research. If an item is not relevant or cannot be covered, it should be explained why not. The description of the points mentioned below should be to the point and concise, rather than presenting.general overviews. Issues that are essential for understanding the case study, that are not listed here, should be included as well.

Waste management system

This topic refers to the waste management system at city level and national level (if relevant, for example when describing laws):

- the responsible agencies for solid waste management and an indication of their performance
- an overview of all the other actors (private (formal and informal) and community (NGOs and CBOs) involved, their tasks, responsibilities and activities, and how they are interrelated
- the main national and local laws, regulations and ordinances regarding solid waste management in general and composting of municipal waste in particular (e.g. regarding maximum allowed amounts of heavy metals in compost) and the way these facilitate or obstruct composting activities
- the policy, attitude and type of intervention of the government authorities regarding involvement of communities and the private (formal and informal) sector in composting enterprises
- a general historical overview of the existence and growth of composting enterprises

Waste flow

This topic should describe the place of composting enterprises in the waste management system at cky level:

- a (cradle-to-grave) flow chart which visualizes the flow of waste materials throughout the economy and the environment and which quantifies, if possible, the total volume of urban waste and the volume of the various waste components (e.g. organic material, plastics, paper) collected
- a description of the sources) of the (organic) waste materials to be composted (such as household (mention number of households, type of area served (low-, middle-, high-income)), industrial and commercial (such as restaurants and hotels); separated/non-separated), mention quantities, type of organic material and distances

Organization of the enterprise

- a specification of the persons involved (gender, age, religion,*class, status, origin, ethnicity / minority)
- a general description of the type(s) of activities of the enterprise (make a clear distinction between collection of waste materials, composting and (if applicable) sorting and selling or recycling recyclables, such as paper, glass or plastics
- an explanation of leadership roles and processes of decision-making within the enterprise
- an explanation of the organizational structure and the legal status of the enterprise
- a description of the location and the working area of the enterprise and an evaluation of the siting criteria that have been used to determine the location
- a historical overview explaining the motivations for starting the enterprise, specifying the persons or organizations that took the initiative, and analysing the problems encountered, the solutions found and the development and growth of the enterprise in general

- an evaluation of the strengths and weaknesses of the enterprise and the reasons for success of the enterprise, including recommendations for possible or necessary (internal and external) improvements in the future

Technology and the composting process

- a description of the type(s) of technology or equipment used for composting (and other activities if applicable, such as collection or recycling), the way the equipment was acquired or developed, the actual ownership, maintenance, and availability of spare parts
- a detailed description of the composting process (sorting, mixing with other organic materials (e.g. animal manure, sawdust etc.) pile formation, watering, aeration (e.g. turning), maturing, screening etc.) and the techniques used for monitoring and controlling the composting process (such as temperature, pH value, moisture content)
- a list of technical data and a flow chart of the enterprise: amount and type of organic material processed per day, production capacity per day, amount of recyclables sold per day, amount of rest materials per day, etc. (describe seasonal variations)
- an assessment of limitations and possibilities for increase of production capacity: expansion (i.e. within the enterprise) and/or extension (i.e. setting up more enterprises)
- an evaluation of problems encountered and solutions found regarding the technology and the process

Occupational health and environmental pollution

- a description of the environmental impacts (air, water and/or soil pollution) of the composting enterprise
- an inventory of actual health problems of the employees, which may be linked to the composting process
- an analysis of the perception and the attitude of all the employees regarding environmental and health problems
- a description of the quality of the compost in terms of nutrient value, heavy metal content, undesired elements (such as small pieces of glass) etc.; if available, data should be given on the nutrient contents (organic material (in % dry matter), N, P, K (in mg/kg dry matter)), heavy metal content (Cd, Cr, Cu, Hg. Ni, Pb, Zn, As (in mg/kg dry matter)
- a description of the measures that were taken:
    - to improve working conditions
    - to minimize environmental pollution
    - to improve the quality of the compost

Financial and marketing analysis

- financial analysis
    - a calculation of the cost price per kilo compost and the total cost per month/year
    - a calculation of the average revenue per source and the total revenue per source per month/year
    - a computation of the profitability of composting
- financing aspects
    - an assessment of the capital funds and the value of assets, resulting in a balance sheet
- marketing analysis, regarding
    - the market segments
    - the marketing-mix
    - the market-positioning and marketing-strategy of the composting enterprise

A methodology for the financial (Appendix 1) and marketing (Appendix 2) analysis is enclosed.

Cooperation with other actors

- a description and analysis of outside technical and Financial support received (from government agencies, donor agencies, universities, large

industries, political parties, trade unions, other non-governmental organizations etc.)

- a description and analysis of the benefits and problems concerning cooperation with the government agencies (such as the rights and the duties of the enterprise, for example concerning final disposal of rest materials) and in particular with the municipality in terms of contracts, agreements and so on
- an analysis of the various roles of the residents, neighbourhood leaders and neighbourhood committees related to the composting enterprises: i.e. ability and willingness to pay the delivered collection services (only applicable if the composting enterprise collects (organic) waste materials door-to-<Joor), necessary cooperation of the residents (for example, the way in which waste materials are to be collected: separated or not), influence on the performance of the enterprise (e.g. in the case of a bad smell caused by the composting process), participation in decision-making processes at neighbourhood level (for example, involvement in selecting the location of the composting enterprise), etc.
- an analysis of the benefits and problems concerning cooperation with the buyers of collected waste materials, such as wholesalers, shops, tree nurseries, farmers, municipality (if possible include examples or copies of the contracts used, otherwise explain the content of the contracts)
- a description of types of cooperation with other composting enterprises.

3.. *General*

- an explanation and definition of used terms
- in the cost computations, all the prices are to be given in *local currency;* the prevailing exchange rate to the US dollar should also be given, both the official rate and the 'street' rate for the sake of reference
- a list of references of documents used
- a list of abbreviations
- do include slides of the composting enterprise described above (the employees the technology, the geographical working area (i.e. where the organic material is being collected), the location and lay-out of the enterprise, the different uses of compost etc.).

D. Reporting

All reporting is to be done in English. The researcher(s) should provide a Draft Report and a Final Report to WASTE:

1. Draft Report
The Draft Report should contain all the aspects required according to this ToR. The draft should also indicate which aspects of the tasks have not been dealt with to the full extent. The report should be received by WASTE not later than 1996.

2. Final Report
The researcher(s) is requested to incorporate the comments on the draft made by WASTE. The Final Report should be received by WASTE not later than 1996.

3. Conditions for presentation
The draft as well as the final report should be presented on DOS formatted and virus *free* diskette in WordPerfect 5.1 or WordPerfect 6.x format. Besides the diskette WASTE is to receive 1 (one) printed copy of the draft report as well as 1 (one) printed copy of the final report. Within the text of the report references are made to the slides by specifying the number of the slide. The photography should consist of a series of numbered slides (originals). A separate list specifies each slide by describing its contents and using the same number as mentioned on the slide. This list should be presented printed as well as on diskette.

E. Procedure

1. WASTE sends Terms of Reference to the participating researcher(s)
2. These researcher(s) react with a short outline, including the contents of the case-study they propose, the team of researchers (including their CVs) and the budget
3. Signing of the Lump Sum Agreement
4. The researcher(s) carry out the research following the Terms of Reference
5. WASTE reviews the Draft Report
6. The researcher(s) incorporates the comments and sends the Final Report to WASTE

F. Support provided by WASTE

WASTE acts as the general coordinator of the research and elaborates the Terms of Reference. It is assumed that the work can be done on the basis of the Terms of Reference. If requested by the researcher(s), specific assistance by WASTE can be provided. The researcher(s) are responsible for the quality of the research.

Annex 2

Photographs

Photo 1. City of Bhaktapur

Photo 2. Bhaktapur's narrow streets.

Photo 3. Utilisation of City's open spaces to process agricultural products.

Photo 4. Bhaktapur's waste collection tractors.

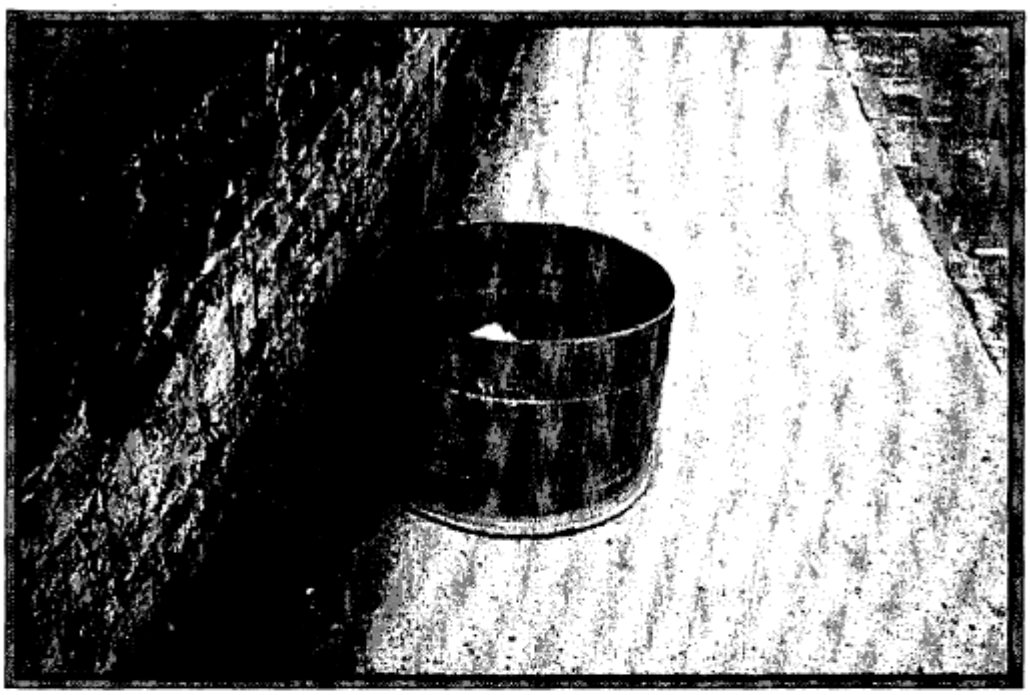

Photo 5. A trash can put by Bhaktapur Municipality.

Photo 6. Street cleaning in Bhaktapur.

Photo 7. Garbage collection in Bhaktapur.

Photo 8. Bhaktapur Compost Plant.

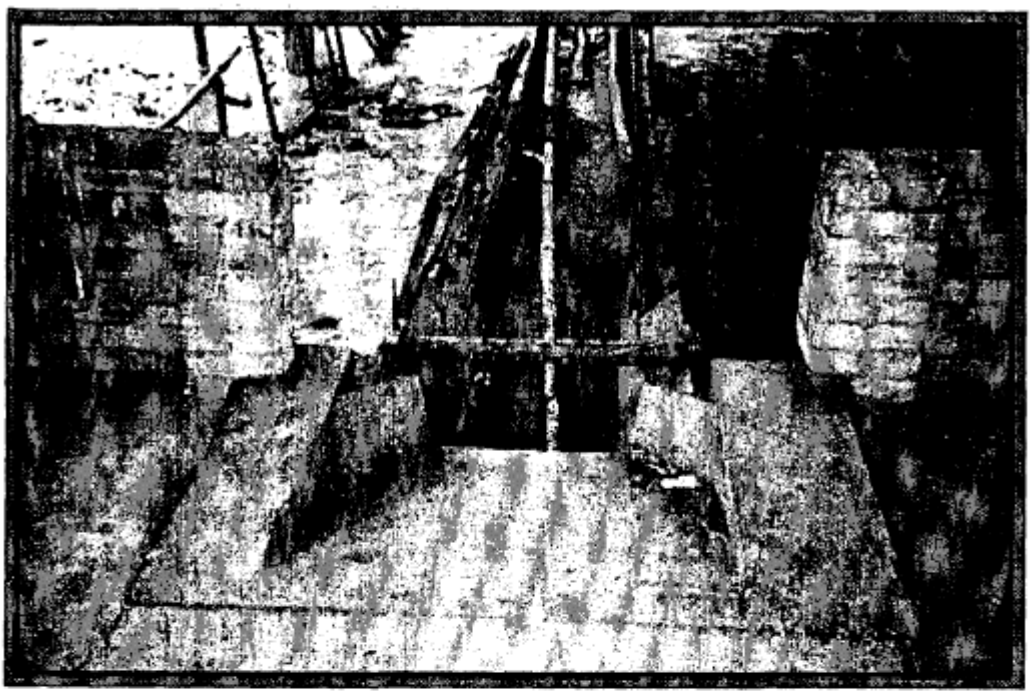

Photo 9. Unloading dock, chopper and conveyor at Bhaktapur Compost Plant.

Photo 10. Unloading garbage at Bhaktapur Compost Plant.

Photo 11. Pigs feeding on garbage at Bhaktapur Compost Plant.

Photo 12. Windrows at Bhaktapur Compost Plant.

Photo 13. Turning of windrows at Bhaktapur Compost Plant.

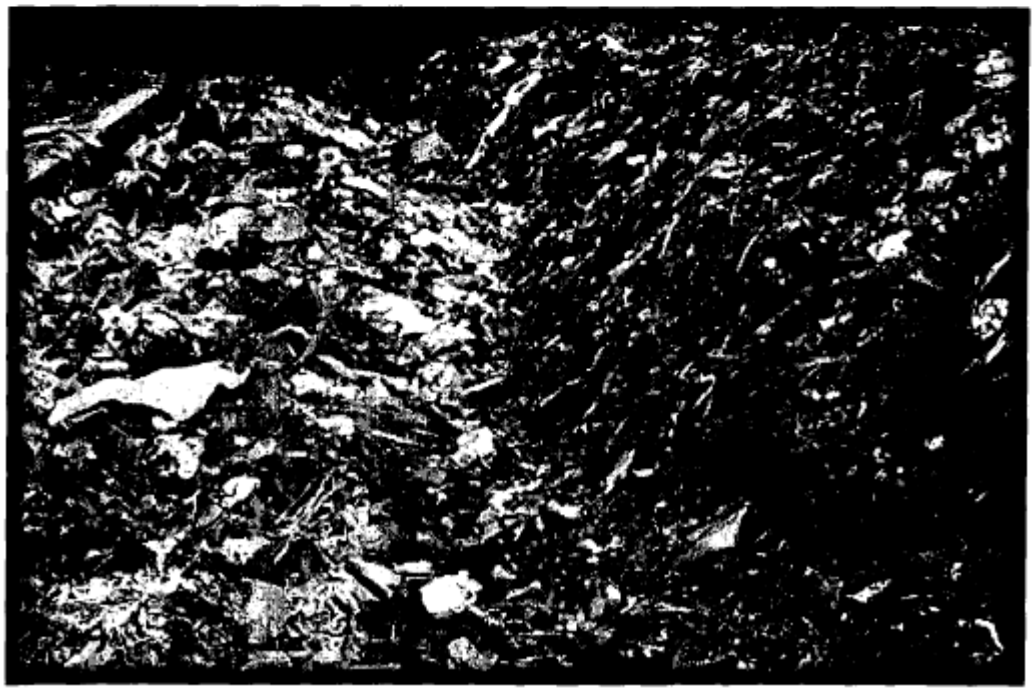

Photo 14. Windrows and reject materials at Bhaktapur Compost Plant.

Photo 15. Screening compost at Bhaktapur Compost Plant.

Photo 16. Hanumante river, waste dump and Bhaktapur Compost Plant.