

*Capacity Building for the Urban Environment:
A Comparative Research, Training and Experience Exchange*

Project Paper No.12

**City Wide Best Practices in Solid Waste
Management in Collection, Transportation and
Disposal**

by

HSMI/WMC of UIFW, New Delhi

*David J. Edelman, Series Editor
Ed Frank, Project Manager*

Yvonne Verdonk, Production



**Institute for Housing and Urban Development Studies
Rotterdam, The Netherlands
September 1997**

***Capacity Building for the Urban Environment:
A Comparative Research, Training and Experience Exchange***

A project implemented by the

**Institute for Housing and Urban Development Studies (IHS),
Rotterdam**

In co-operation with the

**Instituto de Desarrollo Urbano (CIUDAD), Lima
Institut Africain de Gestion Urbaine (IAGU), Dakar
Instituto para la Democracia Local (IPADEL), Lima
Human Settlements Management Institute (HSMI), New Delhi
Centro de Servicios para el Desarrollo Urbano (PROA), La Paz**

Sponsored by

**Directorate General for International Co-operation (DGIS),
Netherlands Ministry of Foreign Affairs, The Hague**

and

**Swiss Development Co-operation, Federal Department of Foreign
Affairs, Bern**

Introduction to the Project

Focus and Outline of the Project

Capacity Building for the Urban Environment is a comparative research, training and experience exchange project that was launched in October 1994 with the support of the Dutch government. It provides an inventory and review of the experiences of relevant bilateral and multilateral organisations and of Best Practices in urban environmental management. For the countries of India, Peru and Bolivia, it identifies, communicates and extends the application of Best Practices in environmental management for cities. In May 1995, the project was expanded to include Senegal/West Africa with the support of the Swiss government.

The focus of the project is on learning from experiences in urban environmental management at the city level and on developing strategies for capacity building in order to replicate and scale up the best of these experiences elsewhere. The overall co-ordination of the project is the responsibility of the Institute for Housing and Urban Development Studies in Rotterdam, while co-ordination in the participating countries is the responsibility of the following partner organisations:

- Human Settlements Management Institute (HSMI), New Delhi, India;
- Instituto para la Democracia Local (IPADEL), Lima, Peru;
- Instituto de Desarrollo Urbano (CIUDAD), Lima, Peru (since January 1997);
- Centro de Servicios para el Desarrollo Urbano, (PROA), La Paz, Bolivia, and
- Institut Africain de Gestion Urbaine, (IAGU), Dakar, Senegal.

Project Activities

Support to cities in the form of applied research and development activities in the area of urban environmental management has been, and continues to be, provided by the co-ordinating partner organisations through the following set of activities:

Research

Within the applied research programme undertaken in the project, Best Practices in urban environmental management in Bolivia, India, Peru and, to some extent, Senegal were identified, and their lessons and experiences reviewed. An analysis and review of the identified Best Practices then took place involving a large number of individual research groups and professionals. In a process of on-going monitoring and review, guidance and support were provided by IHS and its partner organisations. The results of both the individual studies of Best Practices and their review are being published in several books and papers in both English and Spanish. These and their publication dates are listed in the *Introduction to the Project Papers*, which follows this note.

Networking

In identifying the research priorities of the project, during the conduct of the research studies, and throughout the review of research findings, a structure was developed and utilised to ensure the participation of all interested and concerned individuals and institutions through a consultative process. Expert group meetings and consultative seminars were organised for this purpose.

Capacity Building Strategies

After the Best Practices research, analysis and review were completed for all countries, outline capacity building strategies were developed for each based on what was learned from these local experiences and practices. These strategies were developed through a broad-based consultation process involving a large number of research institutions, individual professionals and academics, city representatives, NGOs and local representatives. They are currently being modified based on the outcome and findings

of Habitat II, which was held in Istanbul in June 1996, and the emphasis has now shifted to applying a number of Best Practices to selected cities.

Best Practices Documentation

Concurrent to and co-ordinated with this project, IHS served as the secretariat of and contributed to the review of the Best Practices that were submitted to the United Nations Centre for Human Settlements (UNCHS) for the *Global Best Practice Initiative for Improving the Living Environment* in preparation for Habitat II. HSMI, PROA, IAGU and IPADEL were also involved and contributed to the national preparatory processes that took place in their own countries. An overview of the Best Practice submissions to UNCHS, as well as summaries of the additional case studies received by IHS, are being made available on the Internet through the IHS Home Page.

Databases

Two databases are also under preparation: an institutional database and a literature database. The institutional database is being developed in co-operation with the International Institute for Environment and Development (IIED) in London. It contains entries on relevant organisations, some of which are documented in extensive profiles, while others are included as shorter reference information entries. IHS is developing the second database, which provides references in the literature on experiences with urban environmental management.

Rotterdam Seminar

The Rotterdam Seminar, which took place in May 1996 during the two weeks preceding Habitat II, brought together all principal researchers, as well as city representatives and other professionals involved in the project for a period of intensive discussions. The seminar resulted in a document that provided a comparative analysis of practices and experiences in the field of urban environmental management. This analysis included the project process and network building, governance, job creation and poverty alleviation and gender. This was published as a book in February 1997 and is listed later in the *Introduction to the Project Papers*.

The Rotterdam seminar also discussed *city-level capacity building strategies* for the cities of Calcutta, India; Ilo, Peru; Santa Cruz, Bolivia and Dakar, Senegal. Experiences in *urban environmental management* were reviewed for the cities of Tilburg, The Netherlands and Nairobi, Kenya.

Habitat II

At Habitat II the project was presented in the Special Meeting on Implementing the Urban Environment, organised by UNEP and UNCHS, as well as in other fora.

Capacity Building Strategies for Peru, Bolivia, India and Senegal

The outline capacity building strategies which were developed in preparation for Habitat II (i.e., by CIUDAD, PROA, HSMI and IAGU with the support of IHS). They are being modified for implementation, which is expected to begin late in 1997.

Outline Training Program for Local Officials, CBO Workers, and other Partners for Peru, Bolivia and India

These training materials are to be developed over the next few months and will comprise curricula for short courses related to the most directly applicable Best Practices identified for each country in view of its national strategy for capacity building in urban environmental management.

The Development of a Medium-Term Capacity Building Strategy for Senegal and West Africa

This activity is in progress and addresses the building of individual and institutional capacities at the local level for urban environmental management in both Senegal and throughout West Africa.

Introduction to the Project Papers

A number of publications have appeared under the Capacity Building for the Urban Environment project. These are listed below and can be ordered from IHS or its partner organisations respectively:

- *Capacity Building for the Urban Environment*, edited by David J. Edelman and Harry Mengers, summarises the research findings of the project and the conclusions of the Rotterdam Seminar. It was published by the Institute for Housing and Urban Development Studies (IHS) in Rotterdam in February 1997;
- *Urban Environmental Management: The Indian Experience*, edited by B.N. Singh, Shipa Maitra and Rajiv Sharma, reviews the Indian experience in urban environmental management and presents all the Indian Best Practices of the project in detail. It was published by the Human Settlements Management Institute (HSMI) and (IHS) in New Delhi in May 1996;
- *Problems and Issues in Urban Environmental Management: Experiences of Ten Best Practices*, also edited by B.N. Singh, Shipa Maitra and Rajiv Sharma reports on the Indian Best Practices of the project in an abridged form. It was published by HSMI and IHS in New Delhi in May 1996, and
- *Ciudades para la Vida: Experiencias exitosas y propuestas para la acción*, edited by Liliana Miranda Sara, presents the Best Practices and outline capacity building strategies for Peru and Bolivia for a Spanish speaking audience. It was published as Volume 6 in the Urban Management Series of the joint UNCHS/UNDP/World Bank Urban Management Programme in Quito in May 1996.

The objective of this series of *Project Papers*, then, is to bring to an English speaking audience the results of the project research in Peru and Bolivia appearing in the Miranda book. In addition, the Indian research, while documented in English in the second and fourth references listed above, has not appeared as complete, individual studies. Consequently, a selection of these will also be chosen for this series. Finally, the first reference in the above list covers aspects of the research undertaken in all four countries of the project.

As a result, the selection of work appearing in the *Project Papers* includes the following:

Bolivia

- 'Urban and Environmental Reality Workshops' by Zoila Acebey;
- 'Urban Agriculture in Community Gardens' by Julio Prudencio Böhr, and
- 'Institutional and Development Framework for Urban Environmental Management in Bolivia' edited by Gastón Mejía.

Peru

- 'Defence and Conservation of the Natural Swamp Area Pantanos de Villa, Lima' by Arnold Millet Luna, Eduardo Calvo, Elsie Guerrero Bedoya and Manuel Glave;
- 'Consultation in Urban Environmental Management: The Case of Ilo' by José Luis López Follegatti, Walter Melgar Paz and Doris Balvín Díaz;
- 'Promotion of Employment, Health and the Environment, Lima' by César Zela Fierro and Cecilia Castro Nureña
- 'Environmental Sanitation and Infrastructure: The Case of the Marginal Urban Areas of the Southern Cone of Lima' by Silvia Meléndez Kohatsu, Víctor Carrasco Cortez and Ana Granados Soldevilla, and
- 'Inter-institutional Consultation and Urban Environmental Management in San Marcos Cajamarca' by Marina Irigoyen and Russeles Machuca.

**City Wide Best Practices in Solid Waste Management in
Collection, Transportation and Disposal**

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HSMI/WMC of UIFW, New Delhi

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City Wide Best Practices in Solid Waste Management in Collection, Transportation and Disposal

HSMI/WMC of UIFW, New Delhi

INTRODUCTION

'Garbage' is the waste generally thrown out of our homes, offices, shops, restaurants and small commercial establishments. In our country almost half of it consists of rotting vegetable and food matter. Besides, it also contains paper, plastic, glass, rubber, leather, coal, porcelain, metal, rags, toxic material (such as batteries, pesticides, paints, broken tubelights, and chemicals), building material and soil.

Materials are considered 'waste' when they exhaust their utility and they cause nuisance due to aesthetic and environmental reasons. Improper disposal of trash material may cause and spread disease by harbouring pathogenic microbes and disease vectors such as fly, mosquito, rodents and animals and even by attracting destitutes and rag pickers. They can also contaminate land or water and emit foul odour.

On the other hand, solid waste can be a potential resource. Some components of garbage can be processed into compost or bio-fertilizer or biogas can be produced. Some items of trash can be salvaged, recycled and reused.

In our country, most cities and towns have retailers and wholesalers and relatively large number of petty traders called 'rahdiwalas' who trade in different kinds of recyclable waste material. The ragpickers are often the primary agents of salvaging the recyclable waste. These materials are then sorted and sent to various small and large industries which use them in varying proportions to substitute for virgin material in the manufacture of articles.

Solid Waste Management involves managing activities associated with generation, storage, collection, transfer and transport, processing and disposal of solid wastes in an environmentally compatible manner with due considerations of the principles of economy, aesthetics, energy and conservation.

Over the last couple of years, there has been a growing concern about the problems associated with garbage management and the country woke up with a jolt to realize and face the dire consequences when the plague broke out in Surat in 1994. The

publicity and wide coverage of the event has been able to attract considerable attention to the issue of solid waste management. In spite of this, the problem seems to be insurmountable due to resource constraints, lack of awareness and a number of other factors.

The primary responsibility of solid waste management rests with the local bodies. But due to the reasons mentioned above and rapid urban growth, the municipal services have become either partly or wholly inadequate. No thought seems to have been given to integrated environmental planning for the whole town or city. Some of the conventional systems and arrangements seem to have lost their relevance under changed circumstances.

This calls for a review of the situation at present, proper planning and introduction of suitable innovative ideas.

ISSUES AND CONSTRAINTS

The prominent *issues* in waste management are :

- 1) Various types of wastes, each requiring a different type of handling and treatment are mixed and disposed together;
- 2) Both the formal and the informal sectors consisting of the municipal services on the one hand and the ragpickers and others in recycling trade on the other are operating without any coordination;
- 3) The quality and efficiency of waste management has direct impact on the environment and the health of the citizens; and
- 4) Both, the organic as well as inorganic wastes are a valuable resource.

The system also has a number of *constraints* such as :

1) INABILITY OF EXISTING INSTITUTIONS TO PROVIDE EFFECTIVE SOLID WASTE MANAGEMENT

Municipal solid waste management service is usually limited to



SOME FACTS

According to WHO, every year 50 lakh people die due to diseases related to improper disposal of waste.

India produces about 75 million tonnes of waste every year out of which in urban areas, only 50-70% is collected.

The plague outbreak in Surat was aggravated further by the uncollected garbage just lying around on the streets.

There are many potential infernos like Jwalapur Market, Delhi, which was gutted due to unsafe and improper waste plastic management.

Since, 1987 Bangalore has no official dumping sites for its 2000 tons a day of garbage.

only a part of the population and, moreover, has considerable operational deficiencies. The root cause of these problems is inefficient institutional arrangements. Most agencies responsible for solid waste management do not have the organizational structure with qualified staff for proper planning and operational management of solid waste. There is also poor coordination within municipal or local authority departments which are involved in various aspects of planning and implementation of solid waste activities.

2) LACK OF SUFFICIENT FINANCIAL RESOURCES AND THEIR MANAGEMENT

Although solid waste management activities take a large share of the municipal budget, financing is insufficient and charges, if any, do not cover the cost of even the inadequate services provided. The low priority accorded to solid waste management is shown by the inadequate budgetary provisions for operations and the lack of mechanisms for financing capital investments and for effectively recovering costs of services from the beneficiaries.

3) INAPPROPRIATE TECHNOLOGIES

Often there have been lapses in proper planning and judicious selection of appropriate technologies. The concept of proper treatment and sanitary disposal of solid waste has been more or less absent. As a result there has been lack of efficiency in collection and transportation with wastage of manpower, equipment and funds. The insanitary landfills, rather garbage dumps have become point sources of pollution.

4) LACK OF HEALTH PROTECTION AND COMMUNITY PARTICIPATION

The health risks to solid waste workers and waste pickers as well as the general public have largely been overlooked by the agencies. Consequently adequate measures to prevent adverse health impacts of handling hazardous and infectious hospital wastes have not been established.

Community participation has usually been confined to short awareness and local clean-up campaigns. Public education for participatory activities by the community has generally been inadequate.

5) PROBLEMS FACED BY WASTE PICKERS AND THOSE CREATED BY THEM

The wastepickers have a very low social as well as financial status in the society. Those involved in this job, most of whom are women and children are looked upon with doubt and dissent, though they work in most hazardous conditions.

On the other hand, the waste pickers are responsible for spread of waste around the bins causing more nuisance and spread of disease.

THE STUDY CONTEXT

The focus of the study is on capacity building at the local level. The study attempts to consolidate examples of innovative practices "best practice" having potential for scaling up and wider replication at the city level.

There is no town or city in our country where proper solid waste management is actually being practiced on a town/city wide scale. The situation in general is far from satisfactory. Even component wise total coverage of solid waste management, for example, collection or transportation is not to be found in any urban area. At the same time, it is also being realised that most of the conventional systems, which were designed long back, have become much less effective because the situations (ground conditions) have changed significantly.

On the other hand, there have been many instances of positive interventions, either in terms of technology or community action which seem to have greater relevance to the current situations. None of these, however, have been taken up at a city wide scale so far. But some of them appear to have great potential for wider replication, especially in a decentralised manner.



For this study, six cities have been chosen across the length and breadth of the country where such instances have come to light.

The study provides insight into waste management practices. Identification of the key practices that can be implemented in other cities would be useful in designing a capacity building programme.

The present study identifies the most important city level issues of urban environment management and of the "best practices". Based on local experiences and best practices, national capacity building strategies have been formulated and developed under the project.

IDENTIFICATION OF BEST PRACTICES

'Best Practices' are actions, initiatives or projects which have resulted in tangible improvements in the quality of life and in the living environments of people, in a sustainable way. A 'Best Practice' may be the improvement in the efficiency of management systems for the delivery of basic services; it could also be the forging of new partnerships between public and private sectors for more effective investments; or it could be the harnessing of new technology to improve productivity, employment and income.

They represent up-to-date solutions to common problems faced by many cities and communities and demonstrate how some of the pressing problems can be solved.

The scaling up and wider replication of "best practices" have been considered with due regard to the critical conditions for their success in terms of the required institutional framework, financial management capability, municipal autonomy and decentralization, public participation and community linkages and other related aspects through a research agenda.

THE OBJECTIVES

The main objectives of the study are as follows:

- i) To document the innovative practices in collection, transportation, disposal and recycling aspects of solid waste management in selected cities, namely, Ahmedabad, Bangalore, Bombay, Madras, Pune and Rajkot;
- ii) To analyze operational features of each "successful practice" vis-a-vis its scale of operation and acceptance by the community; and
- iii) To understand the partnership developed between NGOs/CBOs community groups and local agencies in operationalising the system under consideration.

THE FRAMEWORK OF STUDY

Various significant aspects of the 'best practices' in the cities have been duly covered with proper emphasis on each of the following aspects :

TECHNICAL ASPECTS

The technical details of storage, collection, transportation and disposal of waste for domestic, institutional, commercial, construction, hospital and industrial wastes have been covered.

INSTITUTIONAL SET UP

This includes and evaluates various current institutional arrangements in terms of delegation of powers, decision-making process, intra-organizational relationship, strategic and operational planning and monitoring at different levels.

FINANCIAL ARRANGEMENTS

The Financial set up constitutes the estimation of financial requirements of the system options, the scale of tariff for cost recovery and the role of beneficiaries.

SOCIAL ASPECTS

Social aspects in terms of profile of the area, people's perception about the present practices of handling the waste and their understanding of the health and hygiene aspects of waste disposal have been taken into consideration.

HUMAN RESOURCE DEVELOPMENT ASPECT

The human resource development aspect includes the changes and recommendations for training for better planning and functioning of the 'best practices'.

LEGAL ASPECTS

These include the laws and regulations on SWM, their adequacy and effectiveness and an analysis of the amendments required to sustain the improved practices in solid waste management.

METHODOLOGY

In order to identify the practices, which have a wider acceptability and sustainability, an inventory of the organisations and individuals involved in solid waste management was prepared. The inventory contained a general outline of the agency/individual, their activities, objectives, scale of operation, etc.

This information was further analysed in terms of sustainability, replicability and effective utilisation. Few prominent practices



were selected for detailed documentation. These were studied in terms of the institutional, technical, financial and managerial linkages with formal agencies and community. Their linkage with formal solid waste management system was looked into and the role of various stake holders involved in the practice was studied. View points of the agency and other actors involved in the practice, were taken to consolidate the opinion about the success of the practice. The report helped in assimilating the issues and shortcomings, which were further elaborated to formulate strategies which would overcome these shortcomings.

THE COMPONENTS OF SOLID WASTE MANAGEMENT

TYPES OF SOLID WASTE

The quantities and characteristics of solid waste vary from region to region, from city to city and from country to country. The factors that influence the quantities and composition are, the average level of income, the sources, the population, social behaviour, climate, industrial production and the market for waste materials. As economic prosperity increases, the amount of solid waste produced increases in weight and volume and a proportionally larger part will consist of luxury waste, such as paper, cardboard, and plastic and heavier organic materials. There are also differences in solid waste composition due to season and location, for example, coconut hulls are more prevalent in spring and paper after festivals.

Solid waste is usually categorized according to the sources from which it emanates. A common classification is as follows:

1. Municipal Solid Waste (MSW)

It includes domestic waste, street/kerb side waste, commercial/institutional waste, market waste, and hospital wastes.

2. Industrial Solid Waste

Includes scrap metals, alloys, ores, glass, paper, plastic, chemicals and other industry specific items.

3. Agricultural and animal waste

Includes biodegradables (also known as compostables), combustibles, inerts and hazardous material.

THE CHARACTERISTICS OF WASTE IN INDIA

Being a developing country, the characteristics of solid waste in India are drastically different from those in the developed countries. Indian waste has very high density compared to its western counterpart.

The main reasons for it are, *firstly*, the content of paper, newspapers, plastics, bottles, aluminum foils and other packaging materials in the garbage is much less than in the western countries. As these recyclable materials fetch a price in the market, most of them are segregated at source by the households and sold separately. Besides, the culture of packaging, tinned foods and disposables has yet not fully invaded the country. *Secondly*, the organic content such as kitchen waste, vegetable market waste, etc. and street sweepings is very high.

A few aspects of solid waste in India at a glance have been shown in Table 5.1 and Table 5.2.

TABLE 5.1 SOLID WASTE GENERATED AND BUDGET ALLOTTED TO IT IN MAJOR CITIES OF INDIA

Solid Waste Details	Ahmedabad	Bangalore	Bombay	Madras	Pune
S.W. Generated (TPD)	1,683	2,130	5,800	2,675	1,000
SW cleared (TPD)	1,200 (71.3%)	1,800 (84.5%)	5,000 (86.2%)	2,140 (80%)	700 (70%)
Municipal Budget (Rs million)	2,700	2,370	24,360	1,450	2 (for disposal)

Source : Annual reports of the cities.



TABLE 5.2 COMPOSITION OF CITY REFUSE

(percentage by weight)

Contents of Solid Waste	Ahmedabad	Bangalore	Bombay	Madras	Typical European City
Paper	3.0	1.5	3.2	7.85	27
Putrescible matter	49.0	75.2	59.4	48.0	30
Dust, Ash	34.0	12.0	59.4	28.0	16
Metals	0.4	0.1	15.9	0.95	7
Glass	0.2	0.2	0.5	0.96	11
Textiles	-3.1	3.3	-3		
Plastics, Leather, Rubber	0.8	0.9	-	0.9	3
Other (stones, wooden matter)	-	18.9	16.4	-	3
Density (kg/m ³)	535	578	-	529	132
HCV (K Cal/kg)	990	-	-	1070	-
Per Capita per day	0.33	-	-	0.37	-

Source : Bhide A.D and Sundaresam B.B., *Managing Solid Wastes in Developing Countries*, Ed Holmes, John R.Wiley & Sons, Norwich, 1984

It can be seen from the Table 5.2, that the average paper content in the refuse of Indian cities is about 2 to 3 percent as compared to about 27 percent in a typical European city. On the other hand, the putrescible matter content is as high as 60 to 70 percent in India, as against about 30 percent in Europe. This is an indicator of the difference in densities in the two wastes. The amount of refuse collected from urban areas in India is of the order of 0.3 kg to 0.5 kg per person per day excluding night soil.

PHASES OF WASTE MANAGEMENT

The basic problems in solid waste management in India, which take up maximum resources and manpower from the local bodies, are administrative, financial as well as technical. They are discussed below, categorized under four fundamental aspects of solid waste such as collection, transportation, disposal, and recycling and resource recovery.

STORAGE AND COLLECTION

- 1) There is an adhoc system for storage of waste at

source. Proper storage facilities for segregating waste at source for households, commercial establishments, and institutions needs to be worked out.

- 2) The community waste storage facilities are not conveniently accessible due to long distances, are open and are unhygienic as well as inadequate. They are an open invitation to ragpickers, animals, birds and parasites.
- 3) Due to lack of proper collection system, the garbage is unnecessarily handled several times and even put on ground before being finally put on the transport vehicle.
- 4) Streets and public places are often treated as receptacles of waste by general public, as places of defecation by the slum dwellers and as dumps for infectious wastes by nursing homes. Almost two thirds of the waste from hospitals in all the cities goes to community bins, some to sewerage system whereas very little gets properly incinerated. (Annex I)



- 5) The general public attitude is to blame the city government for its inefficient and unsatisfactory functioning. Neither the public wants to assume any responsibility in its operation, nor are institutions coming forward to rope them in.
- 6) The people are not aware of their contribution in the huge quantities of solid waste generated, the immense mechanism, money and manpower involved in its clearance and disposal and the hardships faced by the local bodies to execute these functions.

TRANSPORTATION

- 1) The waste is generally loaded manually into the trucks and lorries for transporting to the dump sites or transfer stations. This poses a great degree of health risks to the workers handling it.
- 2) It is transported to dumping sites mostly in open flat-bed trucks, which spread foul smell and drop garbage on the way.
- 3) Due to lack of a systematic study on the quantity and quality of garbage generated at the neighbourhood level, monitoring is ineffective, thereby leading to malpractices and un-satisfactory lifting of garbage from dumps and roads.
- 4) Lack of route optimisation leads to wasted mileage and manpower.

DISPOSAL

- 1) Disposal of waste is invariably done by land filling or dumping it at the dump sites, without observing scientific norms and assessment of environmental parameters.
- 2) Resource recovery from organic waste, which is an important and major component of Indian waste is seldom done in an organised manner. The recyclable dry waste is wasted too by mixing it with wet waste.
- 3) Toxic and hazardous wastes are dumped, quite often, alongwith other city wastes in landfill sites. No special provisions are made to segregate them from biodegradable and recyclable waste.

RESOURCE UTILISATION, RECOVERY AND RECYCLING

- 1) People do not understand the importance of ragpickers, their role in recycling trade and the amount of gar-

bage reduced from the streets by them, and so treat them shabbily and look upon them with doubt.

- 2) They do not fully realize the value of waste, its recycling prospects, the importance of segregation, and innumerable environmental hazards created if it is handled wrongly.
- 3) Due to mixing of garbage, valuable recyclable material gets wasted as it gets soiled besides the fact that lot of time and money are sacrificed in its segregation.

THE EXPERIENCES OF "BEST PRACTICES" IN SWM

THE SIX CITIES IN RETROSPECT¹

The six cities are spread over four Indian states and vary widely as far as population characteristics, political situation, geo-physical condition and socio-economic status is concerned. These cities also show a variety of solutions to the solid waste management problem. The solutions in these cities are different in approach, technology and community involvement.

All six cities selected have different characteristics with respect to innovative practices. In a couple of cases, the municipal corporation itself has shown awareness and managed and coordinated such activities in the city. The demographic data and the comparative SWM details of the six cities has been described in Annex II and Annex III respectively.

AHMEDABAD

The city of Ahmedabad founded in the year 1411 A.D. has grown into a metropolis with nearly three million people in 1991. The city today is humming with several industrial, commercial and economic activities. Apart from being the capital, it is undoubtedly the premier city of Gujarat.

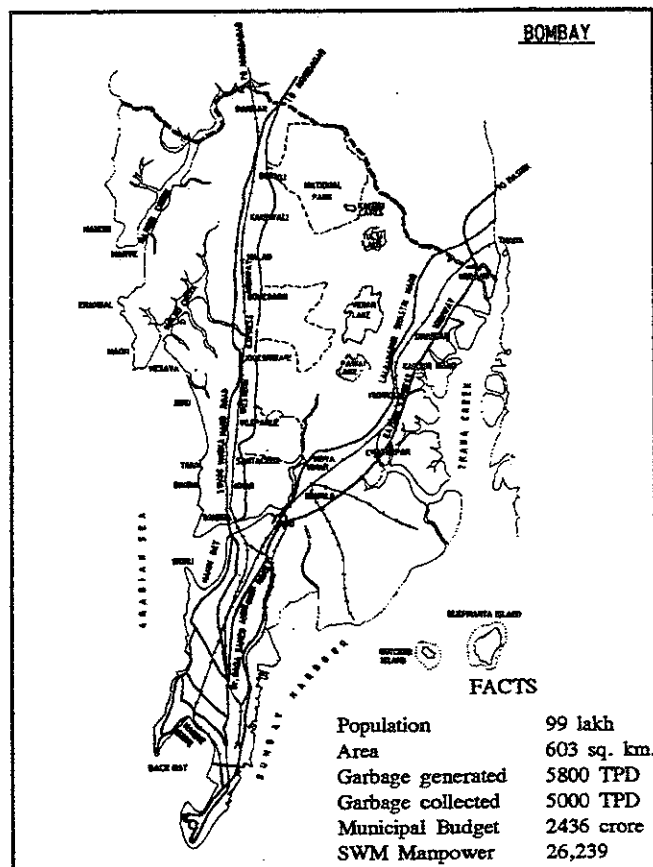
The Department of Health in the Corporation is responsible for carrying out this obligatory function of sanitation and conservancy including solid waste management. The entire city has been subdivided into five zones for better performance of the institution in management of the solid waste in the city. The service in each zone is under the supervision of a Zonal Dy. Commissioner/Health Officer/Additional Health Officer (one in each zone).

The city has an elected body comprising 127 councillors who have constituted a special committee for Solid Waste Management for improving solid waste management practices in the city.

¹ The statistics used in this section are based on the articles published in India Today, 1994; The Hindu Survey of the Environment, 1995 and Census of India, 1991.



BOMBAY



Bombay

The city of Bombay is the financial capital of our country where tremendous population growth and urbanisation has led to over-stretched services which are totally inadequate to look after good health and hygiene of the citizens.

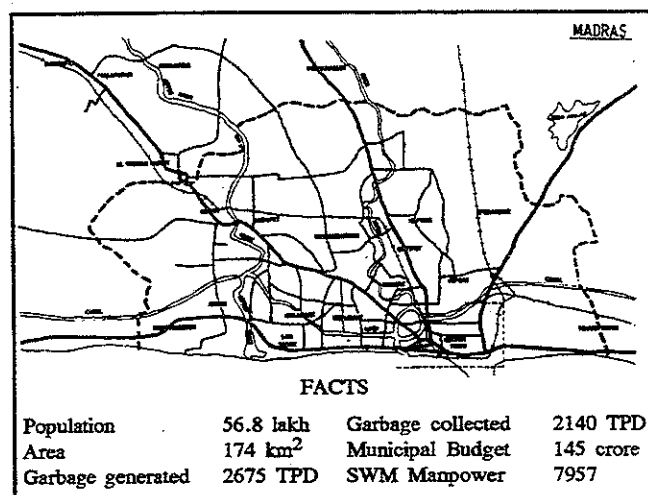
Solid waste management in Bombay is one of the services which is grossly overburdened and if continued in the same vein, will lead to disastrous results. This service is looked after by a separate Solid Waste Management Department of MCGB. It is under dual control of Chief Engineer who provides technical supervision and the Ward Officer who exercises administrative control. About one third of the total municipal staff is employed in SWM Department. The municipal budget in 1992-93 for SWM was Rs. 1,230 million. Continuously for a decade now, the percentage of SWM budget to total MCGB budget has been around 5.7% to 6.0%. In 1995-96, it proposes to spend Rs. 1,785 million on the service, that is 31.1% increase in three years.

Transportation of 60% of garbage is done through hired vehicles. The MCGB does it with the help of compactors, trucks, lorries, etc. For the year 1994 :

Average daily trips for transportation by municipal vehicles	= 161
by hired vehicles	= 389
by hired debris vehicles	= 418
Total trips	= 968

The city has four disposal sites, at Deonar (111 ha), Malad (19.2 ha), Gorai (14.5 ha) and Mulund (25.2 ha).

With increase in environmental awareness and realisation of money involved in waste, many NGOs and industries have ventured into the field of solid waste disposal. Bombay presents one such example where recycling of waste through anaerobic composting, aerobic composting and pelletisation is done on partnership basis.



Madras

MADRAS

The city of Madras in 1668 comprised of Chennapatna and the Fort St. George. Today the urban agglomeration of Madras Municipal Corporation (MMC) has grown into a huge city with ten zones. During the years 1971-81, the growth of the population in the

MMA is said to have been more than that of the city.

The Solid Waste Management (SWM) department was set up in the year 1993. It acts like an umbrella organisation uniting the three main aspects of SWM, namely, conservancy, transport of garbage, and disposal of garbage. The annual budget for SWM is Rs.400 million and major portion of it is spent on wages.

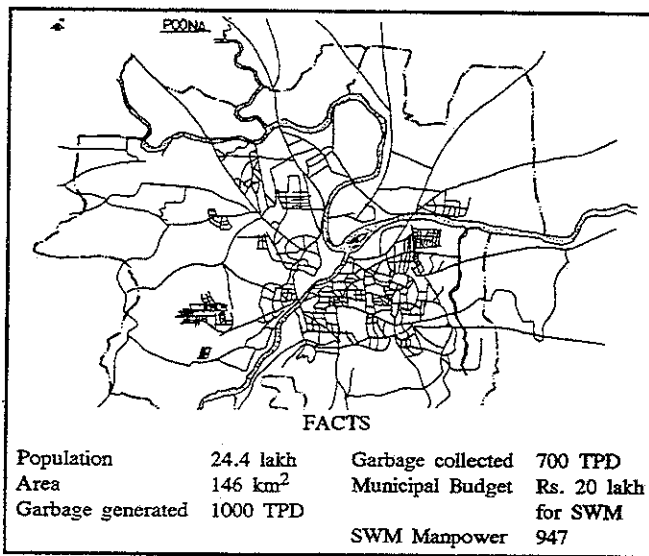
There are two dumping grounds in the northern and southern



parts of the city with the weigh bridge facility. One is at Kodungayur (18 ha) and other is at Perungudi (384 ha). Besides, there is 40 ha of surplus unauthorised area where dumping is done. The dump pickers are a problem that cannot be wished away by the Corporation. Though dump picking is illegal the Corporation is not able to stop it. The most dangerous activity they indulge in is burning the garbage.

Keeping in mind the welfare of the society, the Corporation introduced the 'Clean and Green Project' in June 1993. The conservancy work of different divisions has been handed over to four NGOs. This programme is sponsored by the Corporation of Madras. The important feature of this city has been the work done by NGOs in improving the social status of street children, ragpickers and abandoned youth by educating them and involving them in city cleaning, greening and waste management.

PUNE



Pune

Pune is one of the most important cities of Maharashtra, and it has developed at an alarmingly fast rate. It is a city with lateral spread, increasing the cost of infrastructure. The population outgrows the installation of services. In solid waste management, there being a centralised system, all refuse of the city is collected and dumped at the two dumpyards.

In Pune, the solid waste management (SWM) department is under the Medical Officer of Health (MOH). In addition, he also has the responsibility of the National Health Programmes, medical units, hospitals and dispensaries and so, practically, the working of the solid waste management department is looked after by the Deputy Medical Officer of Health (DMOH).

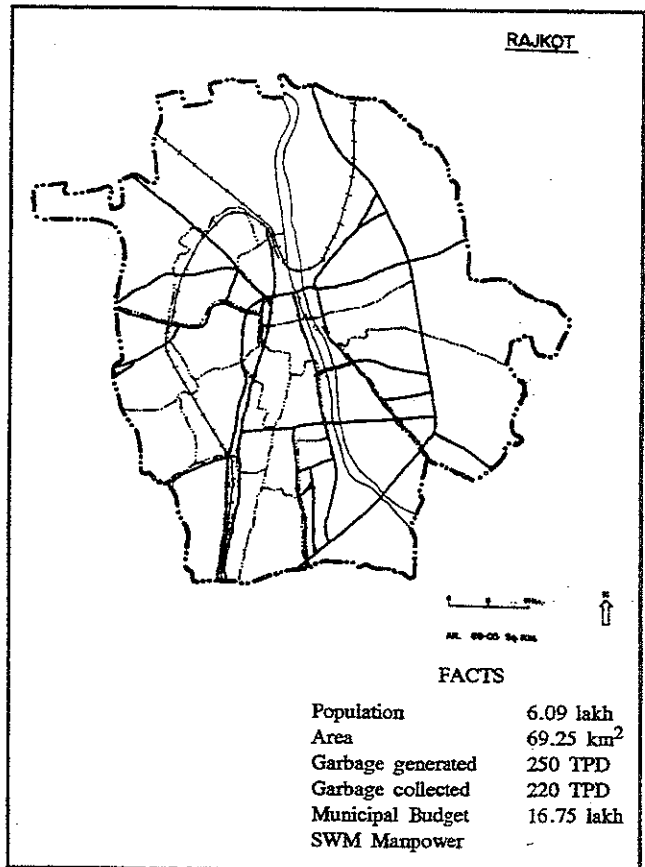
PMC gets much of the transportation work done through hired vehicles, but there is no privatisation of the service anywhere.

It has 29, ten to twelve ton tippers, 15 dumpers, five three ton tippers and 20 premier road masters, that is, a total fleet of 69 vehicles.

Disposal of the garbage is done by the ordinary landfill and dumping methods, there being two landfill sites at Rantekdi and Yeravda and two dumping sites at Paud (12 ha) and Devachi Urali (18 ha).

The overall awareness towards waste and hygiene is quite high in Pune compared to other cities of Maharashtra. But the efforts towards cleanliness are at a very small and local or society level. The earthworm technology for decomposition of organic waste has been successfully demonstrated in Pune. Many individuals and societies have started adopting it successfully.

RAJKOT



Rajkot

The city of Rajkot is the largest and the main city of Saurashtra region in Gujarat. The primary civic needs of the city are being attended to efficiently and effectively by the civic administration, namely, the Rajkot Municipal Corporation.

In recent years the horizontal and vertical growth in and around



the city has led to speedier urban agglomeration. This has also caused severe pressure on the existing civic services and financial management. The RMC spends Rs.1.7 million (approx) on collection of waste alone.

To take care of this scenario, which got worse every year, the city administration started thinking of newer ways to provide the services in a much more efficient and effective fashion. The assessment of the potential of private sector to take a more active role in provision of public services and physical infrastructure drew considerable attention. Rajkot Municipal Corporation, now successfully demonstrates the successfully models of public-private participation in solid waste management.

CATEGORIZATION OF BEST PRACTICES

As stated before, Best Practices are the actions, initiatives or projects which have resulted in tangible improvements in the quality of life and in the living environments of people in a sustainable way. They are actions which could be adapted by the others to their own situation.

The best practice is either an improvement in the efficiency of management systems for the delivery of the service, or it is a forging of new partnership between public and private sectors for more effective investments or it is the harnessing of new technology to improve productivity, employment and income.

The categorization of the best practices identified from the six cities based on above specifications has been done into the four main aspects of solid waste management, namely, collection, transportation, disposal and resource utilisation, recovery and recycling. It has been observed that out of these four main activities of solid waste management, most interest is shown in collection and disposal by non-governmental organizations. Hardly, any innovation has been made in transportation of solid waste in the selected cities, except for propagating partnerships. Private involvement is mainly restricted to giving out vehicles to the local authority on hire basis.

The major heads under which the best practices have been studied, are as follows :

1) DOOR TO DOOR COLLECTION AND PUBLIC AWARENESS

These practices have proved to be very successful and they operate on a small scale, restricting the operation to collection of waste and its local transportation to the municipal collection points. They have good scope of expanding further, as they are single in operation and also cost-effective.

2) COLLECTION AND NEIGHBOURHOOD DISPOSAL

There are various practices in which waste collection and its disposal is done in the same neighbourhood. In most of the cases, these practices have been launched by voluntary organizations, NGOs or CBOs, with the help of or in partnership with the local body, the informal sector and the private sector.

These practices have made an impact in the form of clean environment for the neighbourhood, efficient use of manpower such as ragpickers, decrease in solid waste to be transported due to the local disposal system, training of the workers in disposal techniques and change in habits of the people.

The only problem sometimes faced by such organizations is of funding. Otherwise, they are sustainable practices, with a simple operational frame work.

3) TRANSPORTATION

Very few private organizations are concerned with long distance transportation of solid waste. It is predominantly the local body's domain and so the practices mentioned are resorted to by the corporation only. These practices are cases of partnership between the local body and private sector.

4) DISPOSAL

The private sector, the NGOs and the academic and scientific community have come up with new technologies and mechanized plants for large scale disposal of waste which requires large capital. The entry of private sector into this sector is a clear indicator that this venture could also yield profits. This practice has made a direct impact on the rate of accumulation of waste in the city dumpyards and/or at landfill sites.

5) RESOURCE UTILISATION, RECOVERY AND RECYCLING

The principle objective of some of the voluntary organisations is public awareness, motivation of youth and welfare of the exploited women and street children or ragpickers. Their involvement in SWM practice is with the objective of giving job and a social status to the downtrodden people by associating them formally in waste management at neighbourhood level. They have made a discernible difference for these exploited workers, have helped in changing the attitude of the public and in increasing the general awareness about solid waste thereby ensuring better resource utilisation and recovery.

A brief introduction of various 'best practices' in the six cities based on the above categorization has been given in the succeeding sections. A brief sum-up of these practices taken up for study is as follows:



TABLE 5.3 LISTING OF BEST PRACTICES /ORGANIZATIONS IN SWM

Ahmedabad	Bangalore	Bombay	Madras	Pune	Rajkot
Collection					
World Bank Aided Project	Sadashivnagar welfare forum	Mr. George Bhopali	Civic Exnoras	Mr. PA Deshpande	Primary removal of solid waste, RMC
Zero Garbage on Roads Project	Ragpickers Education & Development Scheme	Clean Bombay Foundation Committee		Save Pune Citizens	Primary cleaning of housing societies, RMC.
Clean Ahmedabad Abhiyan	Civic Amenities and Cultural Association, Acts Trust	Vasundhra			
Collection and Neighbourhood Disposal					
	Centre for Environmental Education		IIT		
	Mythri Sarva Sewa Samithi				
	Suchi				
Transportation					
World Bank Aided Project					Secondary Solid waste removal
Disposal					
Excel Industries India Ltd.	Karnataka Compost Development Corporation Ltd.	Excel Industries India Ltd.		Western Paques India Ltd.	
	Terraforma Biotechnologies	DST/CMC		Bhavaikar Earthworm Research Institute	
		MCGB/IIT		Institute of Natural Organic Agriculture	
		Green Cross Society			
Resource Utilisation, Recovery and Recycling					
Self Employed Women's Association (SEWA)	Bangalore Oniyavara Seva Coota (BOSCO)		Don Bosco	National Society for Clean city	Pujit Roopani Memorial Trust
			Madras Clean and Green City Project	SNDT Women's University	

Source : Six City Based Studies.

OPERATIONAL AND INSTITUTIONAL FRAMEWORK OF THE 'BEST PRACTICES' IN COLLECTION

In the preceding section various solid waste collection, transportation and disposal options in the preidentified cities were

discussed. Each practice has its unique characteristic of operation based on the legal and institutional support, and citizens' initiative. The approach towards better garbage collection has been mainly because of the initiatives of citizens or non-governmental organizations. Initiative of municipal functionaries and privatisation of some services have also shown impressive results at some places. Inspite of all these ventures in different



regions or cities, there are considerable overlaps and similarities in the work styles, technologies and methodologies of their operations. With a view to understand and study their operations, the common denominators of institutional, legal and financial framework have been examined.

This section will look into the operational models of solid waste management in terms of

- door to door collection as well as public awareness and
- door to door collection and local disposal

in the six selected six cities of Ahmedabad, Bangalore, Bombay, Madras, Pune and Rajkot.

PRACTICES / ORGANIZATIONS INVOLVED IN DOOR-TO-DOOR COLLECTION AND PUBLIC AWARENESS

CONCEPT

The solution, to residents' haphazard discarding of waste on streets, a bad/irregular municipal collection system and the nuisance of the ragpickers is, door-to-door collection of waste, sweeping and dumping it at a common municipal collection point by the ragpickers. And a step further than this is, collection of segregated garbage. This way, all three purposes are solved; the waste gets cleared from the locality as well as the houses, the residents don't have to go out to dispose the waste, and the ragpickers get employment as well as self respect. On the other hand, such schemes have been started by a few local authorities too whereby they give a grant to housing societies for cleaning their area or they contract out selected wards/localities to private contractors.

This system has government's full support and works well. Those involved are generally new voluntary organizations or



Door to door collection of solid waste in Bombay

those which have been formed by a group of local sensitive and environmentally aware people for cleaning their own area. Such organizations involve themselves in waste disposal only after establishment of their roots. In such an arrangement, the clearance of debris, garden waste and street sweeping or disposal of night soil remains the responsibility of the local body.

OPERATIONAL FEATURES AND ECONOMICS

This system operates at a small neighbourhood level. To initiate such a system, an awareness has to be created amongst the residents so that they agree to join it. After that a residents association or a CBO is formed. Every member contributes Rs. 10 to 20 towards purchase of equipments, materials, vehicles and payment of workers' salaries. A soft loan is also often taken for this purpose. One or two ragpickers are contacted to collect the waste from door-to-door. In cases where the residents themselves segregate the waste, the collectors are given two baskets, one for dry and the other for wet waste.

The ragpickers are given a bicycle or a tricycle to collect and transport all the waste to the municipal collection points. That point onwards, it is the local body's responsibility to clear the waste. These workers usually work in two shifts, in morning and evening and sweep the streets too. The remuneration given to them ranges from Rs. 1200 to 3500 per month, depending upon the area covered, number of households, etc.

In case of municipal bodies, or other larger associations, tempos are used for waste collection. They have a bell, on ringing of which the households or their servants come and deposit their day old stored waste in the mini truck. But for obvious reasons, the door-to-door collection system is more popular.

INSTITUTIONAL / LEGAL REQUIREMENTS

Such a venture generally needs one president, one treasurer and one joint secretary. They operate together, the bank account for all financial transactions, employment of workers monitoring, attend to residents complaints, etc. Examples of organisations practicing this system have been detailed below.

AMC'S WORLD BANK AIDED PROJECT, AHMEDABAD

Municipal Corporation has undertaken a World Bank aided Solid Waste Management Project of Rs. 38 million for modernising its SWM practices. On analysing the improved practices in collection, transportation and disposal of solid waste it has been observed that these can serve well as a replicable model for the other cities also, if adapted wisely depending on the scale of activity and on the composition of the waste.

The best practices in primary collection and storage of waste in the city of Ahmedabad include the following:



SHOWING THE WAY

At Exnora International's modest office in T. Nagar, Madras, the postman is delivering more letters than usual. After the Surat tragedy, concerned residents are writing to ask if they, too, can become members of this five-year-old voluntary organisation's garbage clearance system. Civic Exnora, which organizes garbage collection in 1,300 streets of Madras - that is 20 per cent of the City.

Civic Exnora is an example of what people can do if they want to help themselves. "When there's a power cut, you light a candle. That's what I did," said M.B. Nirmal, a retired banker who founded Exnora, because he was appalled by the fifth.

The system is simple. In its member streets, residents place the waste in bamboo baskets inside the compounds of their buildings and houses. Every morning, a 'street beautifier' pushing a cycle cart collects the baskets and takes them to the nearest corporation transfer station.

It costs the residents of member streets Rs. 10 a month for the services. The minimum number of households for one unit is 120. The subscription per head goes up if the number is lower. Exnora equips the 'beautifier' with the necessary implements and assists him in getting a bank loan for the cart. He is paid out of the monthly subscription. "Earlier, servants would just dump the garbage outside the compound to save on the trip to the corporation bin. Now, my street is a member of Exnora and looks really clean," says Meenakshi Shankar, a resident of T. Nagar.

Exnora has also transformed Navalar nagar, one of the dirtiest slums on the banks of the Buckingham Canal, into a showpiece. The low-lying part, on level with the canal, has been raised with rubble and a park designed on it. Sixty volunteers now sweep the roads and maintain plants in the colony. Says S.S. Kannan, one of the volunteers: "We want to tell people that the broom is not a lowly object, that it helps to keep us free from fifth and disease."

But despite the good work, Nirmal believes the only permanent solution is to privatize garbage collection and disposal. "The corporation has too much on its hands. It cannot give top priority to all its duties," he says.

Source: India Today, October 31, 1994

1) Introduction of house-to-house collection system

House-to-house collection system has been introduced in posh residential areas for collection of domestic waste. At present this is being tried out on an experimental basis in nearly 2000 households in a few colonies only but it is intended to cover up larger percentage of population. A primary survey of a small 'sample' of this user group indicates that the results are positive with a high level of satisfaction from the users. Together with the Corporation there are volunteers and NGOs too who are actively involved in making this practice a success.

2) Special scheme for cleansing the hutments, private chawls and housing societies

For ensuring hygienic conditions and preventing the recurrence of epidemics in the hutments/ chawls etc. the Corporation has decided to give grants to those who shall arrange for the primary cleaning of their area with the help of part time or full time paid

workers. It gives about Rs.150 per month per 3000 sq.m. of open area.

Litter bins have been placed in the hospitals, public parks, theatres, important bus-stands and on important roads. The waste from these bins is collected on day-to-day basis by the sweepers in their hand carts during the street sweeping. Collection of trade waste is done by the refuse collectors on day-to-day basis in the newly introduced one cu.m. bins.

3) Introduction of litter bins and metallic containers for storage

All the open communal waste storage sites have been abolished and instead roll-off roll-on containers of three to six tonne capacity with four to six lids have been introduced. For transferring the waste from the handcart to the container and keeping the area around the container clean. Sweepers at the rate of one person per container were posted. The bins will be placed on asphalted land to facilitate cleaning. As the waste



brought from the handcart will be directly transferred to the containers the practice of double handling of the waste is eliminated.

4) Introduction of community bins for the hutments and chawls

Community bins of 80-litre capacity have been introduced in the slum and chawl areas for group of 25 families for the storage of domestic waste. These bins are lifted on day-to-day basis by a specially designed vehicle known as community bin carrier. Chawl and slum dwellers are being encouraged to take advantage of these facilities instead of throwing their waste on the streets.

5) Mobile waste collection system in the congested areas

Waste collection vehicles of one cubic metre capacity are introduced in areas where large size containers

can not be placed. These vehicles are parked at identified sites where sweepers bring their waste in handcarts and transfer it into the mobile vans. The mobile vans have tilting facility for unloading the waste. The mobile vans are emptied mechanically in large size containers at the transfer stations instead of being taken to the landfill sites, thereby making the operation speedy and cost effective.

Financial Arrangements

The Ahmedabad Municipal Corporation was the first in the sub-continent to introduce the closed container system for primary collection and transportation of city garbage. The project took momentum with the financial assistance of Rs. 38 million by the World Bank. Today the Corporation spends about Rs.180 million annually in handling and disposing the city's solid waste.

The financial benefits from the new practices adopted in solid waste management in Ahmedabad have been summarized in Table 5.4.

TABLE 5.4 ADVANTAGES OF MODERNISATION OF LIFTING AND TRANSPORTATION VEHICLES IN AHMEDABAD MUNICIPAL CORPORATION

	Before Modernization	After Modernization
Waste lifted /Shift	7.5 tons	25 to 30 tons
Manpower required	6 labourers, 1 driver	4 labourers, 1 driver
Trips /Shift capacity	3 trips	5 to 6 containers of 5 tons

Source: Ahmedabad Study Report.

The Low User Charges and Tax Rates

The Corporation spends around Rs.180 million on SWM alone. In lieu of this, it charges a conservancy tax of 15% of Annual Ratable Value (ARV). As of this date the total collection accounts to a bare minimum of Rs.27 million to 30 million.

CIVIC AMENITIES AND CULTURAL ASSOCIATION, INDIRA NAGAR, BANGALORE

About 20 to 30 houses are covered under this scheme. Each house has been requested to separate wet and dry wastes. All

houses are doing self composting in the house gardens or any other space available. The dry waste is collected by the corporation sweepers.

RAGPICKERS EDUCATION AND DEVELOPMENT SCHEME (REDS), BANGALORE

It works exactly on the same concept as that of Sadashivnagar Welfare Forum, the only difference being that of the scale, which is 175 houses and 300 kg waste daily as depicted in Table 5.5. The entire activity is funded by Marianist, Society of Mary.



TABLE 5.5 SADASHIVNAGAR WELFARE FORUM AND THE RAGPICKERS EDUCATION AND DEVELOPMENT SCHEME (REDS), BANGALORE

Name of Area	Sadashivnagar Welfare Forum	Ragpickers Education and Development Scheme
HH in area	1000	-
HHs Participating	400	175 and some offices
Waste Collected	Wet Recyclable Segregated by	300 kg/day
Method of Collection	residents	residents
Method of Transportation	door-to-door	door-to-door
Method of Disposal	3 wheel barrows, 1 tricycle	3 tricycles
Land Area for Disposal	dumped in municipal bins	emptied in municipal lorries
Manpower Involved	0.25 acre sanctioned	-
Service Charge	-	6 boys
Payment to Ragpickers	Rs.10/m	Rs. 10/m
Technical Assistance	-	-
Other Help to Workers	Waste wise	-
Grants	Rs.10,000 from Rotary club and Rs.40,000 promised for composting pits	Funded by Marianist (Society of Mary), a religious Christian society

Source: Centre for Environment Education, Bangalore.

For door to door collection of unsegregated waste they follow the same principle. Their other programmes are:

- 1) PEAS: Programme for Environment Education in schools which is designed for motivating the children into concrete action.
- 2) Full cycle Garbage Disposal and Recycling Project, in which two blocks in Koranangala having 500 houses are covered. Two tons of waste is collected here every day.

SADASHIVNAGAR WELFARE FORUM, BANGALORE

This forum began its activities by introducing the rag-pickers scheme for door-to-door collection of waste. This activity is operational in 400 out of the 1000 households in the Sadashivnagar area. The households segregate their waste in buckets and bins and place them outside the house for collection by the ragpickers who deposit the waste in municipal bins.

The organization takes Rs.10 per month as contribution from households. It has received a donation of Rs.10,000 from the Rotary club and Rs.40,000 more have been promised for

composting pits in the future. This information is depicted in Table 5.5.

While introducing the scheme, a systematic and planned approach was developed, and NGOs like waste-wise were asked for help. Presently, the money collected is remitted to bank account under Sadashivnagar Welfare Forum. This account is operated by the Chairman, the Secretary and the Treasurer jointly. The ragpickers involved are verified by the police and are provided with uniforms.

CLEAN BOMBAY FOUNDATION (CBF)

The Clean Bombay Foundation, which was established in 1989 by Mrs. Kunti Oza from Colaba, is a non-profit making organization, committed to the improvement of environment in the city of Bombay. The bad situation due to accumulated garbage in the surrounding areas, prompted Mrs. Oza to create awareness in the MCGB workers as well as the residents. She started working voluntarily towards these goals in her area, at her own expense, and then established the CBF and widened her scope of work. CBF conducts educational awareness programmes in schools, colleges, slums and even for MCGB workers.



The main objectives of CBF are:

- 1) To conduct educational awareness programmes in schools, colleges and even for MCGB workers and slums through workshops, audio visual show, posters, banners, etc;
- 2) To organise the collection of garbage in different areas by maintaining communication and co ordination with the MCGB staff as well as the residents of the area.
- 3) To try to introduce environment friendly disposal techniques.
- 4) To improve the working conditions of the labourers;
- and 5) To beautify the South Bombay area and the Western Express Highway.

The CBF is active in the A and D wards of Greater Bombay which have shown considerable progress in collection of garbage. It has helped the corporation in settling petty technical issues. It is a part of the M.E.I.P. and it has propagated its message through newspapers and talks at various clubs. Twenty Rotary Clubs have joined it in its efforts.

MR. GEORGE BHOPALI

The Operation and Finance

Mr. George Bhopali is a resident of Dadar, Bombay who has ventured into the task of cleaning Juhu beach. He initially started with roping in about 15 hoteliers on the beach front with BMC's approval. These hoteliers sponsored him for cleaning the beach, collecting waste from the hotels and dumping it at

the MCGB's collection points. He had employed 40 people who worked in morning and evening shifts for sweeping the beach and paid them between Rs.1200 to 1800 per month. But after four months the sponsorship was stopped due to which he had to seek BMC's help.

Now there is an agreement between him and the MCGB that he would clean the beach and MCGB in return would give him three hoarding sites, two at Juhu and one at Worli. He nets about Rs.70,000 /month from them which cover his expenses for running the project. The waste collected is about five tons/day.

In addition, Mr.Bhopali has also taken up few slums for clean-up, creating awareness among residents and improving sanitation in that area. The details of his venture are given in Table 5.6.

Problems Faced

He had been promised four lorries by the MCGB for collecting the waste and depositing it at its primary collection point or in the MCGB truck for transportation to the disposal sites. But now he is facing difficulties from BMC staff. They provide him with two lorries only and sometimes not even those, stating that there are no free or spare lorries. In which case he has to manage with a single tractor, which he has arranged himself which is utterly inadequate and expensive for such a huge mass of waste from the beach. He wants some contract to be signed with MCGB which would circumvent this problem.

TABLE 5.6 MR. BHOPALI'S PROJECT AND SAVE PUNE CITIZENS COMMITTEE AT A GLANCE

Name of Area	Mr. George Bhopali, Bombay	Save Pune Citizens Committee, Pune
Area of Operation	Juhu beach	Kanchangalli, Yerandwane
No of HHs	15 hoteliers	70 hhs
Waste Collected	5 TPD	35 to 40 kg /day
	Wet/Mixed	10 to 12 kg /day
	Dry	
Method of Collection	door-to-door in hotels and sweeping on beach	door-to-door by the waste women
Segregation by	-	residents
Method of Transportation	two lorries provided by MCGB	manually in baskets
Manpower Involved	40 people who work for 2 shifts	1 waste picker woman
Service Charge to HHs	-	Rs. 10 /month
Payment to Workers	Rs. 1200 to 1800 / month	Service charge from residents + sale of recyclables.
Grants / Funds	Was sponsored by the hoteliers for first 4 months. Now BMC gives him 3 hoarding sites from which he nets Rs.70,000	-

Source: Bombay study Report.



VASUNDHARA

What started off as an independent efforts by two students, deputed by the Nirmala Niketan College of Social Studies, to survey the damage caused by Bhopal gas tragedy in response to a call by the government has today blossomed into an environment protection cell. It is a city-based institution and concentrates on environmental hazards like pollution afflicting the city. Mr. Elvis Thomas is its director.

The Work Area

Their work encompasses five vital areas :

1) Awareness

To develop awareness round environmental issues through multimedia exhibitions, theoretical inputs, discussions and practical activity among youth groups, communities, Mahila Mandals, B.Ed trainees, teachers and other interested groups.

2) Work in Communities

To assist in building up of action groups for intervention in problem situations and to work in communities affected by environmental problems. Also to work in industries and trade unions in the area of industrial pollution.

3) Documentation

To maintain a good record of concerned periodicals, books, reports, documents, newspaper cuttings and other audio-visual media on environmental issues.

4) Networking

To maintain links with related organizations, groups and individuals for mutual support and joint action.

5) Research

To carry out research work in the field of waste recovery methods and psychological aspects of waste pickers. Vasundhara also works as a resource institution for various other organisations and programmes.

THE CIVIC EXNORA, MADRAS

The Civic Exnora are affiliates of Exnora International which is a non governmental, non-political organization started by a few committed individuals in the year 1989, with the objective of bringing about civic consciousness and environmental awareness among the masses. They are grassroot level organizations which try to bring about cleanliness with the help of community participation.

There are approximately 1500 civic Exnoras functioning in the city of Madras and many more outside Madras including Bangalore, Pune, Vijayawada, etc.

The first experiment of Exnora was at Kamaraj Avenue, Adayar. The Municipal Corporation decided to experiment with hydrocontainers in this area in 1990. This would eliminate the necessity of handling the garbage manually. The Civic Exnora at the street level took over the responsibility of ensuring that the garbage was dumped only in the hydro-containers.

The Civic Exnora took a two-pronged approach. First, it sought the cooperation of the local residents. Whereby they would hand over the garbage directly to a "street beautifier" (a sweeper) who would also sweep the streets. Second, Exnora decided to involve the local rag picker. So that he /she would not look for recyclables in the bin, the garbage would not be strewn by him /her and he /she would not be deprived of his income. The beautifier was provided with a specially designed garbage removal tricycle for which the local residents took a soft loan from a bank. They paid a salary of Rs. 650 every month to the beautifier. The residents of Kamaraj Avenue, contributed a sum of Rs.10 per month towards the salary of the beautifier and repayment of the loan and other incidental expenses.

The experiment saw the birth of the Civic Exnora Movement. After successfully working hand in hand with the Corporation, Exnora International has used this model to promote the idea of community involvement in the collection and transportation of garbage.

SAVE PUNE CITIZENS COMMITTEE

This Committee was started by a group of sensitive residents of a high income group area with about 300 households who always faced problems of choked sewerage system due to litter on street and garbage from overflowing bins finding access to sewers.

The Operation

A scheme of separating the household waste into four baskets was formulated: one for kitchen waste; a second for paper, packaging material, broken glass, wire, rags, plastics of all kinds etc. to be handed over to the *kachrawali* at the doorstep; a third basket for absolute filth like soiled rags, cotton wool, sanitary towels and hair, which could be burnt; and the fourth basket was for the garden waste which was to be separately dumped, next to the bin for cattle and goats to feed from. All households were contacted and urged to adopt this system.

The local sweeper woman has been practically adopted by them and is paid to do house-to-house collection of garbage. They have thus managed to clean their own area without being totally dependent on the municipal vans. Many of them have adopted



vermiculture to take care of their organic waste. Details are given in Table 5.6.

The sweeper woman who is also the ragpicker there, collects the recyclable material, for 15 days on an unoccupied empty plot. She has to guard it constantly, to prevent any theft. After 15 days, she rents a bullock cart, and sells her collection to the co-operative store for recyclable materials.

PRIMARY REMOVAL OF THE SOLID WASTE, RAJKOT

The Operation

The Rajkot Municipal Corporation is responsible for primary solid waste removal in each of the 20 administrative wards in Rajkot. Out of these twenty wards the corporation has contracted out two wards, namely, Ward No.7 and Ward No. 10 for primary solid waste removal.

The wards consist of 330 household units, each with an area of 30,000 sq. ft. The total number of garbage collection centres in these wards are 120.

The sweeper cum waste picker woman's 15 days collection is :		
20 kg	Plastic bags	Rs. 2/Kg
30 Kg	Paper, waste	Rs. 1/kg
25 kg	Notebooks, covers	Rs. 3/kg
20 kg	Tin Sheets	Rs. 4/kg
	buckets	Rs. 10/kg
6 kg	Milk bags	
	• uncleaned	Rs. 5/kg
	• cleaned	Rs. 20/kg
Her earnings are Rs. 515.00 per fortnight approx.		

The Financial Advantage

The viability of contracting out the service to a private entrepreneur can be clearly understood from the assessment of the economic benefits to the corporation. A brief analysis of the same is given in Table 5.7 below:

TABLE 5.7 COMPARATIVE FINANCIAL STATEMENT FOR PRIMARY COLLECTION OF WASTE, RAJKOT (RMC OPERATES 105 SOLID WASTE COLLECTION UNITS OUT OF A TOTAL OF 330 IN RAJKOT)

When Privatized		When not Privatized	
Expenditure & Overheads on these 105 units		Annual	
Unit x Unit Rate / month		Establishment	
105 x 1140 x 120		Expenditure :	
			Rs.16.47 lakh
		1 sanitary inspector	
		1 sanitary subinspector	
		1 naik /peon	
		105 sweepers	
		Annual Cost of	
		Items :	Rs. 0.50 lakh
		* Instruments	
		* materials	
Total	Rs. 14.36 lakh	Total	Rs. 16.97 lakh
		Net Financial Advantage	Rs. 2.61 lakh

Source : Rajkot Study Report.

PRIMARY CLEANING OF HOUSING SOCIETIES, RAJKOT

The Operation

The scheme was introduced in 1978 under which one housing society with 87,750 sq.ft. of open area was given a grant of Rs.500 per month for its internal cleaning. The most important aspect of this scheme is that the whole operation is managed by the society members themselves.

The scheme has gained momentum since 1990, and many housing societies have come up with a request for a grant for the same. Today 14 housing societies and four trusts avail these facilities of grant for internal cleanliness.

Finance

The policy for the approval of the grant for a society under this



scheme is fixed. The rate is fixed on the basis of per sq.ft. of open area. The schedule is as under:

Area (Sq.ft.)	Grant (Rs /month)
10,000 to 20,000	300
25,000 to 30,000	600
more than 30,000	pro rata basis

The viability of grant-in-aid for internal cleanliness of society, by self-management who in turn contracts out the service to the private entrepreneur can be gauged from the assessment of the economic benefits to the corporation. A brief analysis is stated in Table 5.8 as under :

TABLE 5.8 COMPARATIVE FINANCIAL STATEMENT OF SWC IN HOUSING SOCIETIES, RAJKOT.

When Privatized	When not Privatized
For an open area of every 30,000 sq.ft., a grant of Rs. 600 per month is paid by the Municipal Corporation.	For cleaning an open area of every 30,000 sq.ft., Municipal Corporation employs one daily wage sweeper at the cost of Rs. 1100 per month (approx).
Net financial saving of Rs.500 per month for every 30,000 sq.ft. of open area.	

Source : Rajkot Study Report.
* Solid waste collection

PRACTICES / ORGANIZATIONS INVOLVED IN COLLECTION AND NEIGHBOURHOOD DISPOSAL OF WASTE

These are the organizations which work on a scale larger than the ones described earlier as they carry out all aspects of the solid waste as a complete package in the given area. In such cases, there is generally very little involvement of the local body in the total process.

Most of these voluntary organizations (VOs) take the help of ragpickers for collection, transportation and composting or vermicomposting for disposal of solid waste. The ragpickers/workers are taught disposal techniques such as pit composting, vermiculture, etc. Liasoning with municipal corporation is done to get a small piece of land near the locality for waste disposal. Some of them bear their expenses through the sale of recyclable materials and service charges from the households, others get grants /funds from environmental organisations, institutions or government bodies.

CENTRE FOR ENVIRONMENTAL EDUCATION(CEE), BANGALORE

The Centre for Environmental Education (CEE), Bangalore is an organization which concerns itself with each and every aspect of solid waste management. It has done various projects in Bangalore whereby some projects involve mere cleaning of an area and collection of solid waste; some involve total SWM aspects whereas still other projects deal with creating awareness amongst the masses and increasing public participation.

The Objective

The primary aim of CEE is to develop itself into a resource centre, creating educational materials, resource persons and methodologies for spreading environmental awareness.

Garbage disposal has been recognized by them as an issue which calls for immediate attention. The CEE South has made an action plan which is being field tested for its validity at three different places in Bangalore such as Frazer Town, Jayanagar 1-E Block and Rest House Crescent.

A Case Study: The Project Area

Coles Park, a prominent part of Frazer Town in Bangalore city is a well known area of churches and schools. Out of the 180 households residing in this area, only 110 showed willingness to participate in the CEE launched programme.

Mode of Operation

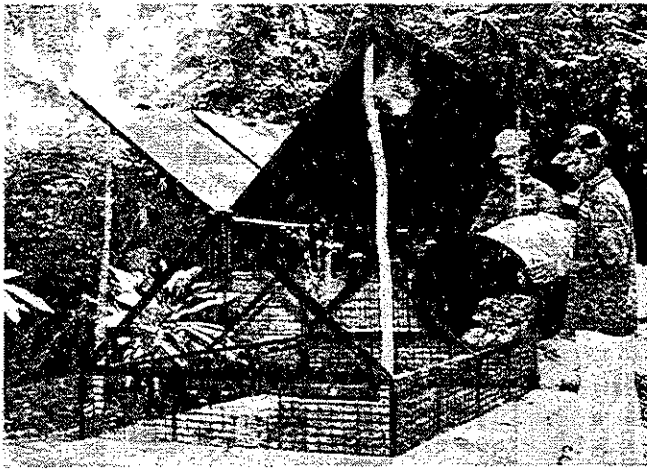
This programme involves door-to-door collection of segregated waste and its disposal at neighbourhood level. This is done by the local boys employed for this purpose. Two tricycles are used for the purpose of collecting all waste and depositing it at the common place where its proper disposal is done. Two plastic bins for the dry waste and a plastic bag for the organic waste is kept on each cycle. In addition, there are buckets, etc. for fetching the waste from the houses.

Disposal

The method adopted for disposal is aerobic composting. The collected organic waste is taken to the composting site where it is further segregated into dry, organic, soiled and toxic wastes. On an average, the wet waste generated per day is 65 to 70 kg while the dry waste is about eight kg. About 2000 sq. ft. of land has been given by the Bangalore Municipal Corporation for composting within Coles Park, where eight pits have been made with a capacity of 500 kgs of wet waste in summer.

These pits are filled upto three-fourths capacity to facilitate turning of material for barbed aerobic composting. Fencing with granite pillars and wire has been provided to prevent vandalism. The heat generated in the pit reaches upto 60\$ C but is brought down to less than 30\$ C by sprinkling water and





Disposal of Organic Waste through Composting in the Neighbourhood, Bangalore

urning regularly every two to five days. The soiled and toxic waste is disposed into municipality bins.

Finance

The dry recycle waste is sold by the ragpickers to the recycling agents. The ragpickers get Rs.100 to Rs.125 by selling the dry waste. Each household contributes Rs.10 /month as service charge.

The salary of the ragpickers is Rs.550 /month which is funded by NORAD (Norwegian Agency for Development Corporation). Funding from outside for such projects and works is essential as the financial gains in terms of service charges are low, only 110 x 10 = Rs.1,100 per month, which barely pays for two workers' salary. Besides the residents are not regular in paying even such small amounts. Hence, all other administrative charges have to come from grants /funds.

Efforts at Public Awareness

Besides managing the solid waste in the given area, CEE makes simultaneous effort at public awareness to increase the efficiency of the programme.

- 1) A motivator goes from door to door stressing the importance of the venture, explaining its system of operation and informing about the end product being rich manure.
- 2) Public meetings are held where experts are invited for talks.
- 3) Cable T.V. is used to reinforce the solid waste message.

- 4) Constant interaction through visits or telephone calls is maintained.
- 5) Media is resorted to in the form of pamphlets, posters, films etc. They are inspired to resort to segregation.

The results are :	Segregation
1 After 1st round of motivation	4.50%
2 After 2nd round of motivation	11.49%
3 After distribution of bins	43.59%

Special Feature

CEE South provides breakfast to the ragpickers and also gloves and gumboots, etc for their safety.

Secondly, ragpickers are made to undergo a literacy programme which specially stresses health and hygiene aspects.

Suchi, Bangalore.

It is an organization performing the activity of collection of household waste from 100 BDA flats out of the total 560 ones. Its operation is based on the methodology exactly similar to the previous one...

Special Feature

An important feature of this organization, is employment of women for the process of collection and transportation. The three women employed, receive Rs.300 /month whereas the households have to pay Rs.5 /month as service charge. These women are domestic servants working in the flats and so are morally more responsible towards the work. The entire process begins at 8 am. and takes three hours every day. The programme has become successful owing to help from the residents.

Waste-wise, Mythri Sarva Sewa Samithi, Bangalore.

This is another organization which has done a lot of work in solid waste. They have started a project called 'Waste-Wise' under which work is done in five different areas for clearing of solid waste. Besides, they also act as resource persons and give technical advice to other organizations venturing into the field.

The areas in which work is being carried out are Jayanagar B.T.M. layout, Jaymahal, Malleswaram and Sadashivnagar. Here too the system is exactly similar to the preceding organization with a little change in scale and persons involved as shown in Table 5.9.



TABLE 5.9 PROJECTS BY MYTHRI SARVA SEWA SAMITHI, BANGALORE

Name of Area		Jayanagar	B.T.M. Layout	Jayamahal	Malleswaram	Sadashivnagar
Waste collected Kg/Day	Wet	150	60	100	100	600
	Recyclable	Segregated and sold by the rag pickers				
Method of Collection		Door to door collection by the waste pickers				
Method of Transportation		Trolleys for local transport		Coordinated by corporation		Trolleys are used
Method of Disposal		Organic waste is composted		Taken away by corporation		Organic waste is composted
Manpower Involved		Each area has 2 collectors and 1 supervisor				4 collectors, 4 organizers
		1 waste-picker organizer, 1 community organizer, 1 composting specialist, 1 project manager				
Service Charge		Rs. 5 to 10 /month from each household				
Grants		They receive Environmental NGO Funds				

Source : Six city based studies.

INDIAN INSTITUTE OF TECHNOLOGY, MADRAS

This Institute has come up with a novel method to dispose the garbage generated by them in an environmentally friendly way. The Indian Institute of Technology (IIT) situated in the heart of the City at Adyar, has 980 apartments, where the staff of the Institute live. There are 14 hostels for the students. Adding to it is the College, library and the administrative office.

A voluntary organization called SWARM (Solid Waste Recycle and Management) is involved in the collection and disposal of garbage generated in this campus on contract basis. Swarm was formed in the year 1993 by a few Professors of IIT. The programme is co-ordinated by Prof. Dr. Durga Prasad Rao. The management of IIT pays SWARM, but it does not interfere with its operating system.

Operation

SWARM has appointed 11 boys to do the conservancy work. They have been provided with six tricycles with two metallic bins. One bin is for dry waste and the other for wet waste.

There are two kinds of bins placed in the Campus. One is the cylindrical metallic bin the other a rectangular bin. Both the bins are mounted on iron legs and are two feet above ground level. The bins are painted in two colours. The blue coloured bins are meant for organic garbage and the green coloured bins for inorganic waste. They are provided with heavy lids attached to the body of the bin to prevent monkeys from ram-paging through the garbage.

The departments have been provided with two gunny bags for depositing wet and dry garbage separately. The canteen has been provided with metallic containers for depositing the garbage.

The boys who are called "SWARM Volunteers" work in two shifts. Collection is done from residential area during the morning shift. Waste from the canteen and hostels are collected during the evening shift. The garbage is segregated at the source.

The garbage that is collected is carried to the ground earmarked for segregation at the western end of the campus. The paper, plastic, glass, metal scraps are separated. Coconut shells are kept in separate bags to be sold as fuel material. The organic waste is vermicomposted.



Separate Bins for Organic and Inorganic Wastes in IIT, Madras



Finance

The volunteers of SWARM are paid Rs.45 per day. Some of them work during the afternoon between 10.00 and 1.00 p.m. They segregate the garbage, help in removing the branches and thorny bushes along the roads. For this they are paid Rs.10/- per hour.

Problems faced by the Organization

- The residents inspite of repeated requests do not segregate their garbage
- Both the wet and dry waste are deposited in the same bin
- Many of the residents feel touchy to touch the dust-bins and leave the garbage outside.

All these examples prove that community participation is the most successful solution to tackle the huge quantities of wastes generated. Secondly, women have a very major role to play in these practices. Managing and segregating the household waste is predominantly a woman's domain in our society. On the other hand, even the ragpickers population mainly consists of women. Thus women have to be made the targets of health education for successful operation of these community-based programmes.

OPERATIONAL AND INSTITUTIONAL FRAMEWORK OF THE 'BEST PRACTICES' IN TRANSPORTATION

Transportation of solid waste is done at two stages. First stage, primary transportation includes transporting the waste to a local temporary storage site, that is, community bins whereas secondary transportation, consists of transporting it from these bins to the final disposal /dumping /landfill sites. The former is done manually with the help of hand carts while the latter is highly mechanised. On the way to disposal sites, the waste is sometimes taken to the transfer station where the waste is transferred to the compactors for speedy and enclosed transportation of larger amount of waste.

Innovations in this operation are mainly initiated by public agencies. The main innovations have been in the design of primary transportation vehicles such as hand carts, tricycles, etc., community bins and transfer stations. In case of secondary transportation, main efforts have been in the hiring of private vehicles on contract basis and also in contracting out garbage lifting of a particular area.

Out of the six cities studied, there are only two examples of private involvement in transportation as detailed below:

AMC'S TRANSPORT MODERNIZATION PROGRAM, AHMEDABAD

As mentioned before, AMC is carrying out modernization of its

solid waste infrastructure with aid from the World Bank. It is in the process of making changes in its equipments and in work methodology. The steps taken are as follows:

1) Changing the design of handcarts

Instead of traditional handcart, a newly designed handcart with six small containers of 40 litre capacity each with three wheels and sealed ball bearings has been introduced. This handcart facilitates direct transfer of waste into the community bins. This way, deposition of waste on the ground causing nuisance and health hazard, is stopped. Such examples of changes in equipment design are found in Madras and Bangalore too, where the handcart has four small bins which can be lifted and emptied into the collection bin easily by one person.

2) Transportation of waste in closed metallic containers

Closed metallic containers are in use for the secondary transportation of waste instead of earlier practice of using open trucks which cause great nuisance. Thus the waste is transported from the city in a hygienic manner. Other additions to the fleet are compactors which carry more waste (7 tons) than the traditional trucks (3 to 5 tons); the front end loaders, and the flat bed trucks with net cloth covering to prevent dropping of garbage.

SECONDARY SOLID WASTE REMOVAL, RAJKOT

THE OPERATION

The salient feature of secondary removal of solid waste is the involvement of private men and machines in this operation in an efficient and effective manner. The Health Department of RMC has deployed its trucks and labourers only in four wards falling in the old city areas. In the remaining sixteen wards, this service has been contracted out to private entrepreneurs. The contractors have to load the waste from the open site / dust-bins into trucks and these are then taken to the dumping site for final disposal. These dumping sites are 4-5 kms. away from the city.

The payments are made on the basis of the auction. The auction amount is for lifting all the waste completely from a particular ward and transporting it to the place of final disposal.

FINANCIAL ADVANTAGE

The advantage of contracting out the service to the private entrepreneur can be clearly understood from the assessment of the economic benefits accrued to the Corporation as a result of introducing this practice. A brief financial analysis of this operation is given in Table 5.10.



TABLE 5.10 SECONDARY REMOVAL OF WASTE, RAJKOT: COMPARATIVE FINANCIAL STATEMENT

Total wards where RMC works	4		
Total wards where privatisation of waste collection has been done	16		
WHEN PRIVATIZED		WHEN NOT PRIVATISED	
Approx Avg. rate/ton = Rs. 50		Daily Establishment Expenditure for 4 tons of waste :	
Max. allowed in a truck = 4 tons			
The cost = 4 x 50		1 driver	Rs. 60
		1 cleaner	Rs. 50
		3 labourers	Rs.150
		Fuel, etc.	Rs. 50
Total Rs. 200 /4 tons of waste		Total	Rs. 260 /4 tonnes of waste
Net Financial Advantage			Rs. 60/4 tons of waste

Of the total 250 tons of waste lifted in the city 200 tons is done by the private sector.

Hence total financial advantage is Rs. 3000 per day on operational cost only. If we add the capital savings on buying of trucks, etc. then the advantage is still more.

Source : Rajkot Study Report.

OPERATIONAL AND INSTITUTIONAL FRAMEWORK OF THE 'BEST PRACTICES' IN DISPOSAL

For years people have been using organic waste from kitchens, gardens and farms for making compost. But it was not always done scientifically. Now, various scientific and result oriented processes have been developed to dispose and recycle the organic waste in a hygienic manner. A few of them are such as can be operated at a very small or household level also. Very recently, the disposal of solid waste has been thought of a profitable venture too by many industries who are coming to the fore with varied processes. Different methods of waste disposal that are being practiced by different industries or organizations are as follows:

1. Mechanical Aerobic Biocomposting
2. Pelletisation
3. Vermiculture and
4. Biogas Production and Power Generation

Some of these ventures are very large with more than 100 TPD input capacity, whereas others are as small as to cover selected housing societies, neighbourhoods, and a campus.

For comparative analysis purpose, the disposal options have been grouped into large scale and small scale as follows:

Large Scale

- 1) Excel Industries India Ltd., Bombay : (aerobic composting)
- 2) DST /CMC, Bombay : (pelletization)
- 3) MCGB /IIT, Bombay : (vermiculture)
- 4) Western Paques India Ltd. Pune : (biogas power generation)

Small Scale

- 5) Green Cross Society, Bombay : (Vermiculture)
- 6) Bhawalkar Earthworm Research Institute (BERI), Pune : (Vermiculture)



- 7) Institute of Natural Organic Agriculture(INORA), Pune : (Vermiculture)

The detailed description of the above along with their processes, manpower and material requirements, the financial arrangements, problems faced and their merits and demerits are given below:

EXCEL INDUSTRIES : MECHANICAL BIOCOMPOSTING

THE BACKGROUND

The project for city solid waste conversion into bio-organic manure /enricher was undertaken by Excel Industries Ltd. Bombay, about six years back. The plant details are as follows:

- 1) Project developers & managers : Excel Industries Ltd.
- 2) Project Capacity : 500 TPD of mixed garbage
- 3) Project Execution Time : 6 to 9 months
- 4) Conversion Rate : 30 to 35% of input in 6 to 8 weeks cycle. The clearance is done 6 to 8 times a year.
- 5) Working Time : 2 Shifts; 20 hrs /day
- 6) Type of garbage preferred : Garden, Fruit, Vegetable Waste
- 7) Ash content in manure: about 6%
- 8) Collection pre-decided with BMC, having predominantly vegetable waste. Points:17 in no.,

Note:

- # The first phase defouling plant is at Chincholi.
- # The second phase bio-conversion and packing plant is at Amboli Hill, Andheri.
- # The Head office is at Jogeshwari.

THE PROCESS

This process is carried out in two phases depicted in Figure 5.1 at two different places as follows :

Phase I : Defouling

The technology is primarily based on application of suitable indigenously selected cultures for speedy fermentation of mixed garbage. The composition of these bio-cultures is done as per the predominance of materials like carbohydrates, lignins, proteins and fatty substances.

Objectives of Defouling :

The main objectives of the defouling phase are :

- 1) To carry out speedy fermentation of waste and thereby remove the foul smell and pathogens, making it safe for handling by conservancy workers and wastepickers and also reducing its bad effects on the neighbouring residential colonies.
- 2) To prevent the nuisance of birds /vultures, etc. which spread disease and also are a menace near aviation routes.

The waste is stocked in long rows or heaps of 500 tons called windrows. The garbage is treated with microbial slurry mixed with herbal concentrate for defouling and accelerated bio-conversion (slurry rate has to be 10 kl/ton). Fermentation being an exothermic reaction, causes the temperature to rise to about 70 degrees centigrade, killing the pathogens and ensuring proper composting.

Required moisture is maintained and aeration is done after about every 15 days (by turning around the garbage). After 45 to 60 days, the full cycle is complete. With the progress of decomposition, the organic biomass changes its colour to dark brown.

Phase - II : Bio-Conversion

At the end of fermentation, it is easier to segregate biodegraded organic portions from plastic, glass, wood, coconut shells, etc. This is done through a series of sieves for the sizes of 1 1/2" and 1/2" separation; including de-stoning operations through cyclone aspirator, etc. The non-organic, non-biodegradable left-over materials are dumped back into the dumpyard. At Amboli, it is further passed through screens of 1/4" (6mm) and 4 mm to get a humus like biomass as end product. It is then packed in 25 kg. packages for export and 50 kg. packages for local use. Oversize residual matter is used for lawns.

Marketing of the product is done at Jogeshwari. Figure 5.1 shows all these stages of the process.



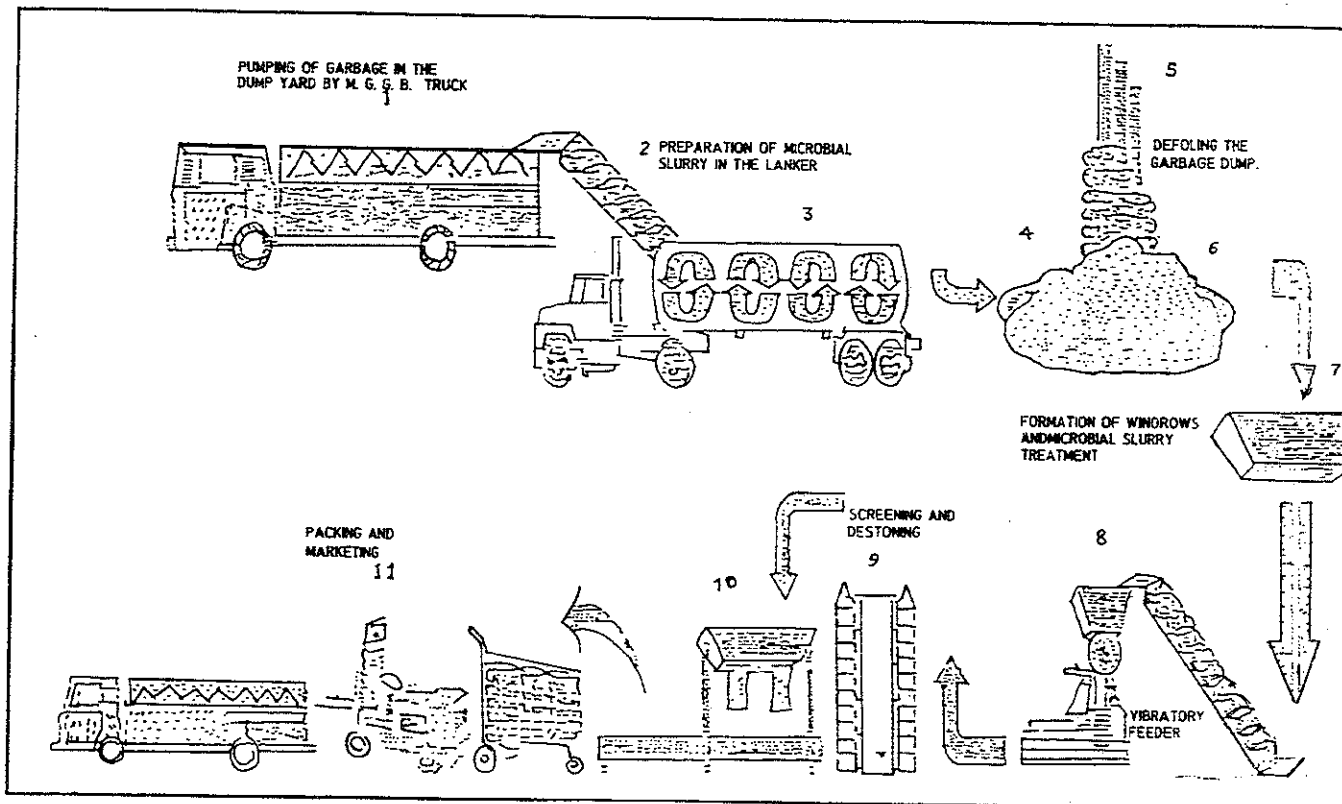


Figure 5.1 : Various Stages of Aerobic Bio-conversion Process as Practised by Excel Industries Ltd.

LABOUR AND VEHICLES REQUIREMENTS

Manpower required : One person /one ton of finished organic manure.

Semi Automatic : 1/2 person /one ton of finished product

For a 500 TPD plant, the company requires one tanker for slurry spraying, two loaders for feeding garbage into the equipment, three JCB's turning and transportation of garbage, and one bull-dozer for making heaps.

The plants work in two shifts, that is, 20 hrs /day

Labour Charges : Rs 40 to 70/day

Land area : 24 acres.

THE ECONOMICS

A 500 tons /day plant is considered to be of ideal capacity. The cost estimates for various plant sizes are given in Table 5.11.

For a 500 TPD Plant, the recovery time for capital investment works out to be three to four years with profit margin being 20 per cent. The capital investment includes transportation costs for up to 100 kms.

TABLE 5.11 : COST ESTIMATES FOR VARIOUS PLANT SIZES OF AN AEROBIC BIOCONVERSION PROJECT

Plant Size	(Rs lakh)		
	500 TPD	300 TPD	100 TPD
(A) Project Feasibility Survey.	20	15	7
(B) Site and Infrastructure Development	120	65	38
(C) Plant Machinery	250	170	90
(D) Electrical O.C.and other operation	40	30	15
GRAND TOTAL	430	280	150

Source: Excel Industries Ltd., Bombay.



THE PRODUCTS

1) Celrich /Organic Manure

The organic manure produced from this process has been given the brand name of CELRICH by Excel Industries Ltd.

This product can be used for special area development projects like saline land improvement, waste land improvement, social rehabilitation projects, afforestation projects, greening of mined areas, etc. The product is priced at Rs.1200-Rs.1600/ton.

2) Celrich substrate DF BC 01

It is used to make slurry for waste treatment. This product is available in powder as well as liquid concentrate form. Celrich substrate DF BC 01 in powder form is available at Rs 30 /kg and in liquid concentrate form at Rs 160 /litre (local taxes extra).

3) Sprayer

Excel Industries markets a sprayer with the solution for inoculation for domestic use also. The sprayer can be used as a deodorant too.

SIMILAR PROJECTS ELSEWHERE AND FUTURE PLANS

The agency has done successful work, especially of inoculation treatment at critical situation in various cities like Bombay and Delhi and Ahmedabad when called upon.

The complete process of bioconversion has already been applied at Deonar and Mulund in Bombay whereas the one in Thane has been sanctioned. According to the company such proposals are also underway in various other cities such as Ahmedabad, Bhopal, Gwalior, Kanpur, Chandigarh, Jaipur, etc.

Thus presently the company is concentrating mainly on the disposal of garbage with future plans in all the major cities of India. At a later date they might diversify into the transportation of solid waste too. This way, they could get selective garbage, as required.

THE MERITS AND PROJECT VIABILITY

- 1) It is a considerably fast process which completes itself within six weeks and also does not require skilled manpower. Its first phase starts showing results within days and the second does so within months.
- 2) It comes as an affordable cost option with the investment recovery period being three to four years.
- 3) Composting acts as a good resource as the organic wastes recovered have a high market potential.

THE DEMERITS

The drawbacks of this process are:

- 1) The organic content of the final product, the manure (Celrich bio enricher) is low i.e. 30 to 40%.
- 2) Ash content in the organic manure is as much as 6% and hence the price obtained for the manure is only about Rs 1600 /ton.
- 3) It requires a good marketing and transportation network for selling the final product which Excel Industries can manage because of their presence in the business for almost half a century.
- 4) During the rainy season the moisture content increases largely resulting in a slowing down of the fermentation process. Therefore, large covered storage space is required for stocking the fermented waste during monsoon time. As this facility is not being provided owing to high cost, there is diminished production during monsoon.
- 5) At distant locations, the cost of production increases, making it a major constraint for the average farmer.
- 6) The product cannot compete with synthetic fertilizers because of the higher maintenance cost.

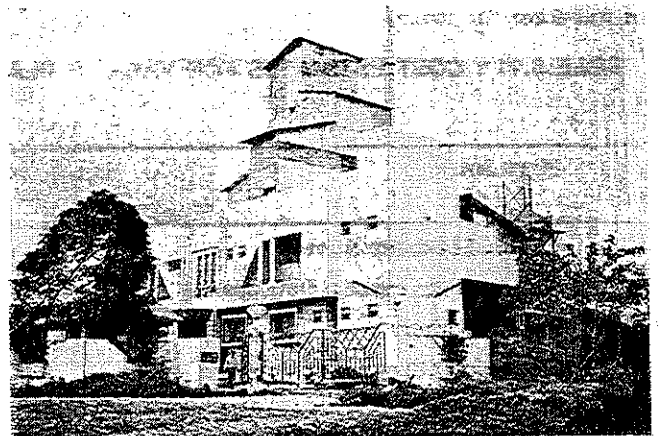
DST/CMC: PELLETISATION PLANT

BACKGROUND

Indepth research was carried out by the Department of Science and Technology (Govt. of India), New Delhi in collaboration with CMC Ltd., in the field of scientific disposal of urban solid waste. Several technological options were scanned, the marketability of various products was assessed and then the technology of pelletization was chosen as a suitable option over other processes like incineration, biogas and compost production for dealing with the issue of garbage disposal in a scientific way.

THE PROJECT

The DST and the CMC have initiated a pilot project on integrated waste management (IWM) in Bombay. This project is not run on a commercial basis yet.



The DST/CMC Plant, Bombay



- 1) The technology developed and funded by : DST
- 2) Established and managed by : CMC
- 3) Project Capacity : 400 - 500 TPD garbage or 100 TPD finished product i.e. fuel pellets.
- 4) Working hours /day : 20 hours
- 5) Working days /year : 250 days
- 6) Conversion Rate : 20 to 25% of input
- 7) Type of Garbage Preferred : coconut shells, textile paper, rags etc.
- 8) Connected Load : 600 HP
- 9) Land Required : 0.8 to 1.6 ha

The product has acceptability in industries. The plant is at Deonar dumping yard.

The above figures are for the plant's full capacity but actually the present plant production is only at the rate of 1.5 TPH working 8 hours, that is, one shift per day in one acre of land. It has to close down for the monsoon.

THE PROCESS

This process is semi-automatic and requires little manual operation. The raw material, that is, the mixed garbage, is obtained free of cost, from BMC. The process of conversion of garbage into fuel pellets involves primarily :

- 1) drying
- 2) separation of incombustibles
- 3) size reduction and
- 4) pelletization.

The plant design has to be tailored in accordance with quality and quantity of garbage from city to city. The BMC trucks unload their city garbage in the Deonar dumping yard. It is taken by the agency in the required quantities as and when needed.

The garbage is spread out in the open for about two days for natural drying and then it is mechanically dried at 400°C. If the moist waste such as vegetables, hospital waste, etc is more in proportion, then extra energy gets wasted in drying. After this, the mass gets reduced by almost 50 percent.

The incombustibles such as sand grit, stones, glass, etc are separated out, through various sieves. The remaining stuff, that is, the combustible material is subjected to size reduction and is powdered. A binding material, which is an agricultural produce is added and pellets are made out of it. These pellets are then matted and they become hard enough to be transported loose and stored like coal.

LABOUR AND VEHICLES REQUIREMENT

A fully automatic plant being an extremely expensive proposition, the plant at Deonar is semi automatic with the manpower requirement being 15 labourers/ shift (8 hrs.)

The present capacity of the plant is 1.5 TPH or 12 TPD, i.e., 1.25 persons per ton of finished product.

For the existing working capacity, they require three vehicles for handling and spreading the garbage. Labourers are paid between Rs. 40 to 70 /day.

THE ECONOMICS

For a capacity of 100 TPD of processed goods (pellets) or 400-500 TPD of mixed garbage input capacity, the capital investment required is Rs 4 crore. The production rate of the project has to be about 4 to 5 TPH, working 20 hrs/day, for it to be profitable and economically viable. Thus the capital cost is very high and its running cost is also high owing to the large amounts of energy required for mechanically drying the garbage. For a 100 TPD project one can get a 5-year tax holiday. Recovery time for capital investment is seven to eight years.

THE PRODUCT: FUEL PELLETS

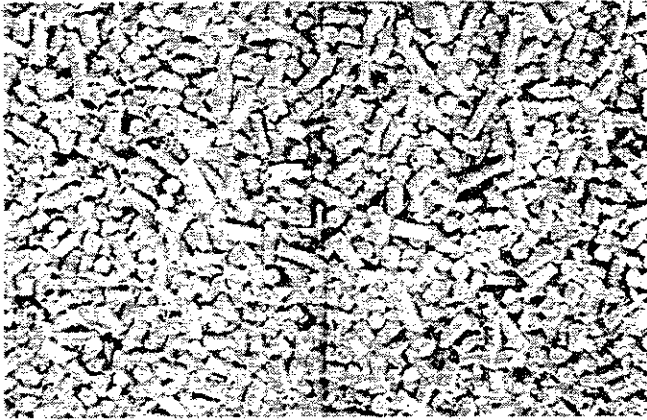
The fuel pellets produced out of the waste combustibles are of cylindrical shape of different diameters upto 30 mm as required by the end users. The pellets are hard enough to be transported loose and stored like coal.

Their calorific value is 4000 k cal/kg as against that of coal being 3500 k cal/kg.

The characteristics of fuel pellets are :

Size	:	dia 8/20/30mm, length 40 mm
Bulk Density	:	0.7 MT /cu m
Density	:	1.3 gms /cc (minimum)
Ash content	:	<15%
Moisture	:	10% (approx)
Product sold at	:	Rs. 1000 /ton





Fuel Pellets

The Market for the Product :

The fuel pellets have market potential in the non-coal producing zones. They can be efficiently used in fixed grate, travelling grate, fluidized bed, and multi-fuel packaged boilers. The advantages that the fuel pellets have over coal are:

- # Clean fuel, free from stones, etc.
- # Lower ash content
- # Uniform size (No size reduction required at the user end)
- # Regular trouble free supply.

VIEWPOINTS OF CONCERNED PERSONS

The Agency

The plant at Bombay is a pilot project producing pellets at 1.5 TPH rate. The agency thinks that when rate of production is increased to four to five or more tons/ hour, this process would be very profitable. It is of the viewpoint that any city's garbage problem cannot be solved by a single process, for example, this process needs only combustible and dry garbage where as composting requires only organic garbage which can be wet garbage. So there should be coordination and understanding between various technology adopters for dealing with the problem of waste management together. Besides, the agency wishes that the civic body would :

- # give them land at a nominal lease
- # deliver the garbage free of cost
- # pay them (the company) the waste conversion charges
- # subsidize electricity
- # give incentives in terms of grant in aids, etc

- # privatise collection and transportation

Also they are of the opinion that private people are already involved in disposal and therefore collection and transportation should also be privatised.

THE MERITS

It is a new and good energy source processed from dry waste and or good option to coal, the natural resource.

It involves less labour at semi-automatic level which saves persons from working in such type of conditions or environment.

THE DEMERITS

- 1) The capital investment required is very high and therefore the recovery period is longer.
- 2) The drying of waste is done mechanically at a very high temperature of 400 degrees centigrade which demands a lot of energy in the form of electricity.
- 3) If the moisture content of waste is more, which generally is the case for Indian garbage, then the energy spent and the cost of production increases tremendously. So, it is suitable for high fuel value garbage only.
- 4) It has to have a good market network and /or be nearer to the industries or the end users to reduce the transportation cost, otherwise the industries always have the other alternative of using coal, open to them.

MCGB/IIT:VERMICULTURE PLANT

BACKGROUND

The project which is being implemented by BMC for part of its solid waste disposal programme at Deonar dumping ground has been developed by Dr. H.S.Shankar who is a professor at I.I.T. Powai. He has studied the ecology of waste environment in depth.

According to Dr. H.S.Shankar, waste has two major components as follows :

1. Cellulose, which is responsible for acidity, and
2. Protein, which is responsible for alkalinity.

Increase in any one of these causes proliferation of pathogens which in turn are responsible for the foul smell. Management of acidity and anaerobicity which are major problems in large



scale organic matter, is the crux of vermiculture technology. This acidity reacts with rock in presence of aerobic bacteria to form soil (one can say that rock arrests acidity).

The vermiculture earthworm, which is a deep burrowing one (*Polyferitima elongata*), plays two main roles in the process as follows:

- 1) The earthworm is at the apex of the soil food chain as shown in Figure 5.2. It is a predator and feeds on selective bacteria giving first preference to the bad and unwanted ones. It regulates the microbial population, keeping it young and productive. These micro organisms produce value added by-products such as antibiotics, vitamins and plant growth hormones, etc, thus enriching the soil. Earthworms are not found in large numbers in good healthy soil.
- 2) On the other hand the earthworm does the weathering of rock due to aberration. The earthworm eats rock and decomposes it, making available more area for reacting with acidity. Besides, it aerates the soil by its burrowing motion.

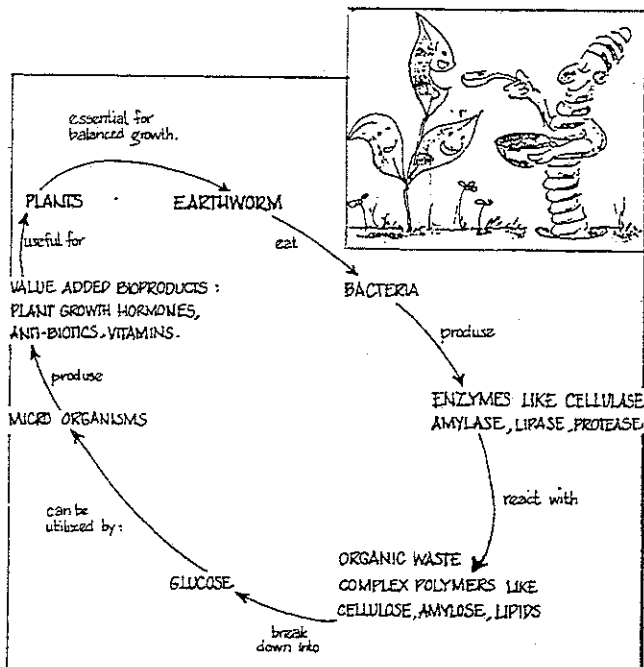


Fig. 5.2 : The Soil Food Chain

The earthworm maintains the soil pH at seven. Decrease in pH value to less than seven represents acidity and one sees the presence of fungi, termites, cockroaches, rats, ants, etc. If the case is vice a versa, it is indicative of alkalinity, which breeds mosquitoes and flies. Either of these extremes are bad for health and hygiene.

The pests and insects mentioned above are the biological indicators and natural alarms for warning us of dangerous unhy-

gienic environment as shown in the Figure 5.3. These indicators inform us of the type of additives required.

One more important role player in this drama is the green plant itself which completes the cycle. Thus the five characters involved are rock, organic matter, earthworm, bacteria and green plant.

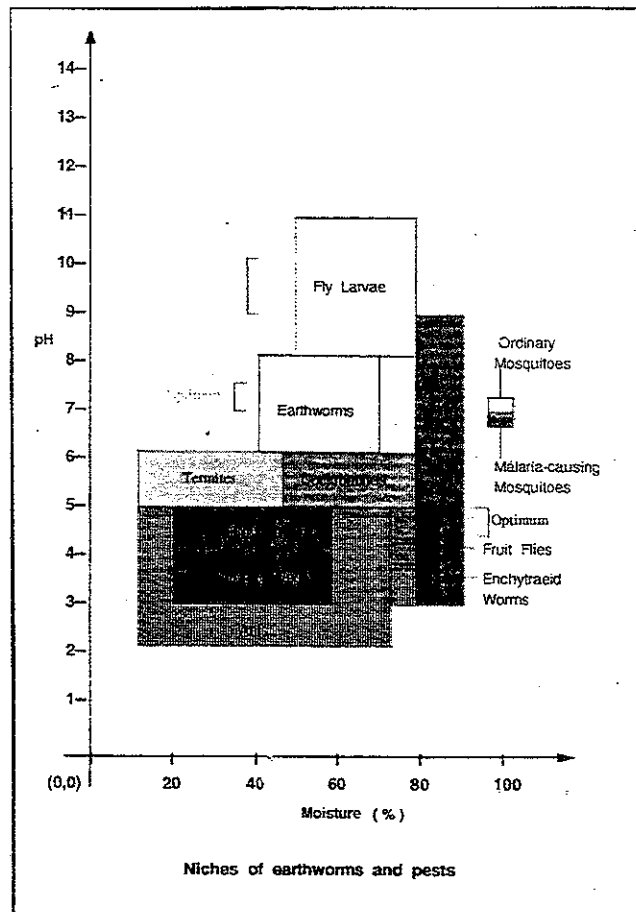


Fig. 5.3 : The Biological Indicators

They together are responsible for enhancing soil nutrient value. This technology can be adopted at the smallest household level and even at the city level.

THE PROJECT

The waste processing project based on vermiculture has been set up by the SWM Department of MCGB at Deonar dumpyard. The details are as follows :

- 1) Project developed by : Prof Dr. H. S. Shankar.
- 2) Project managed by : MCGB.
- 3) Project capacity : 400 TPD (Present project: 100 TPD)



- 4) Soil preparation time for waste loading : 6 months
- 5) Conversion rate : about 30%
- 6) Conversion time : 18 months
- 7) Land occupied : 20 ha. i.e.49.4 acres (Presently utilized:5 ha).
- 8) Clearance/year : twice
- 9) Type of garbage : Any type of organic waste such as that from vegetable market, slaughter houses, hospitals etc. (free from toxic material)
- 10) Process : Fully manual, Large labour requirement
- 11) Vermicomposting beds : 56
- 12) Culture tanks : 7

The project was set up in 1993 on trial basis treating around 35 to 40 TPD. But floods during 1994 monsoon killed the entire earthworm population. Nevertheless design of the unit was changed after that, the capacity hiked and top few inches of soil removed to overcome the flooding problems before restarting the unit.

THE PROCESS

In this process, the major investment goes into making bacterial culture. This culture is made according to the composition of the garbage to be treated. Seven tanks for making the culture have been prepared on site. This culture in turn is used for preparation of the vermicomposting pits. The soil gets acclimatized to receive the waste after 6 to 8 months of application of the culture to it.

The culture is to be applied at the rate of : 15 kg/sq.m.

Rock or murum is added too, at the rate of : 100 gms /1 kg organic matter

56 vermicomposting pits have been prepared to receive the waste.

The waste is loaded at the rate of : 5 kg/sq.m /day

The total land has been scheduled in four parts. Each part is loaded for six months only, in rotation. Its next turn to get

reloaded comes after 18 months. Thus any one area gets cleared after every six months resulting in two clearances per year. Plantation is done in rows in this area and the waste is spread between two rows of plantation. Unwanted materials such as tin, shoes, glass, etc. have to be segregated manually through the ragpickers.

LABOUR, VEHICLES AND MATERIAL REQUIREMENTS

It is a heavily labour intensive process. It is not easy to mechanize, where energy is provided by soil biology. Only harvesting, sieving and bagging are the later peripheral operations which can be mechanized. The various requirements/ton of waste to be treated are as follows:

Labour	: 1 Man day /ton (50 in number at Rs.1000/- per month)
The additive (culture)	: 0.1 to 0.5 ton /ton of garbage
Solids handling machine	: 0.5 machine hours /ton
Potable water	: 1 cu.m/ton (non monsoon)

THE ECONOMICS

For the 400 TPD Vermicomposting plant at Deonar

Estimated project cost	: Rs 51.50 lakh.
Running cost	: Rs 6 lakh/annum
Cost of production	: Rs.800 /ton
Expected price of manure	: Rs.1800 to 3000 /ton
Payback period	: 4 years

The designed capacity is of 20,000 ton of vermicompost per annum at the end of five years.

THE PRODUCT

The bacterial culture required to start the process is very costly at Rs 8,000 to 14,000/ton.

The end product or the manure is called vermicasting or vermicompost. It harbours earthworm cocoons and a wide spectrum of beneficial bacteria. It is a humus-like material of dark brown colour, with very high nutritional value. Due to the nutrient value addition, one kg of organic matter gives 20 kg of nutrients and 10 kg of organic matter fixes one kg of N₂ in soil.

Thus in presence of rock, the magnification of nutrient value takes place by a factor of ten. It is sold at Rs. 20-50 per kg.



The Merits

The advantages and the plus points of vermiculture technology are listed below:

- 1) The value added product has a very high nutrient value and so it fetches better price.
- 2) This process can take care of virtually any type of organic matter and it requires much lesser investment than any other method.
- 3) It utilizes the natural biological energy for bioconversion.
- 4) It is labour intensive and requires unskilled labour.
- 5) It gives excellent results at the decentralized local community, society or household level where the waste gets attended to much more efficiently, reducing the transportation and collection cost. Besides, every household is made responsible for its own garbage.

The Demerits

Some of the problems faced in vermicomposting, especially if not managed properly are as follows :

- 1) There is a possibility of the earthworms migrating during monsoon. Besides, their hibernation period is from November to February when the earthworms remain in cocoon stage.
- 2) In case of high temperature, gas, acid or leachate frequently prevailing in the dumping ground which has been contaminated for years with inorganic wastes; earthworm mortality increases. Besides, several years of burning and dumping have made the area impermeable to water.
- 3) Land and labour requirement is very high.
- 4) Market for the product has to be developed.
- 5) Since garbage segregation is done manually only, some unwanted glass, tin pieces are sometimes left back which show up in the vermicompost.

Vermiculture biotechnology has gained recognition and is in the market for about a decade now, and Mr. Uday Bhavalkar of Pune is one of the persons responsible for the phenomenon. Taking cue from him, various organizations and individuals have made efforts to popularize the technology at the micro level, that is, at household as well as community level, on commercial and voluntary basis.

WESTERN PAQUES (INDIA) LTD. : BIOGAS PRODUCTION AND POWER GENERATION

BACKGROUND

Western Paques India Ltd. is an environmental engineering company which undertakes turnkey contracts in power generation from non-conventional energy sources. The company has also worked in other waste management areas like sewage treatment and recycling of non-biodegradable waste.

They had put up the proposal of setting up a power generation plant in Pune with Pune Municipal Corporation (PMC). In response, PMC asked them to set up a demonstration plant of five TPD upto the methane production stage which was successfully carried out by them (the company). Now they are being asked to demonstrate electricity generation too. The PMC has about four different proposals to choose from, including the one from Western Paques; and it is dragging its feet to make the final decision.

The Company plans to establish a plant of about 400 TPD garbage input capacity at Pune. The details given below are for the pilot plant located at the Paud dumping yard.

- | | | |
|--------------------------------|---|---|
| 1) Project developed & managed | : | Western Paques India Ltd. |
| 2) Pilot plant capacity | : | 5 TPD |
| 3) Proposed capacity | : | 400 TPD |
| 4) Conversion Rate | : | 30 to 35% of the input |
| 5) Conversion Time | : | 18 months |
| 6) Type of garbage preferred | : | Any biodegradable waste |
| 7) Rejects | : | 10 to 15% |
| 8) Output from the : | : | 5 cubic meters of gas
5 TPD plant
1.5 tons of fertilizer
150 cu.m. of effluent
6% wastage |
| 9) Output from a 400 TPD plant | : | 500 cubic meters of methane
3 MW electricity (72000 units)
100 tons of manure
150 cu.m. of effluent. |

THE PROCESS

The process of power generation from city waste can be explained in five major steps.



Manual Segregation

The plant is situated in the dumpyard itself and so garbage can directly be brought into the premise. From this mixed waste all non-biodegradable material such as plastic, glass stones, etc is separated out manually on a platform.

Drum Sieving

The segregated waste is loaded on a conveyer belt and taken to the drum sieve which is a wet sieve. In this drum, the wet waste (water is added) falls and rolls many times and thus disintegrates and reduces in volume.

The Reactor Stage

Next, the disintegrated matter is passed through the floating type reactor where sand and other heavy material separates out. Besides, methenogenic bacterial culture is loaded into the reactor to speed up the decomposition of organic matter anaerobically. The process inside the reactor is much faster compared to natural decomposition. The bacteria acts on organic matter to produce the biogas. The residual mass that accumulates at the bottom of the reactor is used as organic manure and the sludge or liquid waste is disposed off.

Biogas Collection

The biogas which is produced from the reactor is collected into the gas holder for further use. In case of the pilot plant at Pune, it is blown away in a gas flame.

Biogas Power Generation

In the biogas power generation plant, the biogas from the gas holder is used as a fuel for prime mover to produce power. The power produced is pollution free. The process cycle is given in Figure 5.4.

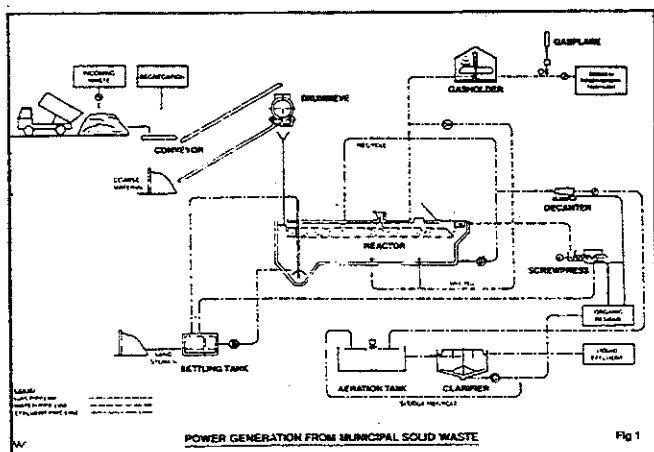


Figure 5.4 : Process cycle for Biogas Power Generation from Municipal Solid Waste

LABOUR REQUIREMENT

For a semi-mechanised fertilizer plant of capacity of 100 TPD, 60 to 70 labourers/day are required for segregating, loading, unloading and bagging, etc. which works out to be 0.6 or 0.7 persons /ton finished product.

THE ECONOMICS

Western Paques not only finances the projects, but also installs, operates and maintains the plant with its own resources. The investment required is Rs 10 to 12 crore /MW as against Rs 3 to 4 crore /MW by conventional sources. For installing a 3MW plant at Pune, investment needed would be over 25 crore. Cost recovery period is 10 to 12 years.

THE PRODUCTS

Organic Fertilizer

The residue of the reactor process is used as the organic manure. Its organic content is 50 percent. It is sold at a price of Rs. 1800 /ton and is used in agriculture and gardening.

Electricity (Power)

The power generation rate for the proposed plant capacity is three MW (72000 units) The cost of power generated is Rs. 2.25 /unit. Almost 10 percent of it goes as input into industries. It is costlier than that produced through conventional energy resources.

SIMILAR PROJECTS ELSEWHERE AND FUTURE PLANS

Presently, the company is involved in the waste processing field only but it plans to expand its horizon into collection and transportation of solid waste in near future. The future plans of the company are as follows:

For Biodegradable Waste

Western Paques have executed projects at Warna, Sangamner, Bazpur, Harihar, Kodinar, Diu, Ahmedabad and Bidar. Latest installations have been done at Calcutta for 1000 TPD and at Madras for 400 TPD.

Many proposals are under considerations for other towns, namely, Bombay, Pune, Delhi and Bangalore, etc. Orders have been received and MOUs have been signed by them with various city corporations such as Calcutta, Madurai, Cochin, Calicut, Belgaum, Vijaywada, Vishakhapatnam, Aurangabad, Kolhapur and Trivandrum.

For Non-biodegradable Waste

The company has also developed technology for recycling of non-biodegradable waste too and is ready to cater to this portion of city waste in future. It is ready to use even debris, sand



and other light aggregate material in building construction works. But city waste pickers and other organisations doing social work opposed this on the ground that it would snatch the means of earning from the ragpickers. It is suggested that they should buy the recyclable waste from the ragpickers at market price.

THE MERITS

- 1) The foremost advantage in this process is that the production or work is not hampered by monsoon. Rather in its first stage of drum sieving, moisture is added to the garbage.
- 2) The whole process is proven in the laboratory and its every stage and components on site are predecided, controlled and monitored. Hence, none of the results are unexpected and the composition of the end product is fully known.
- 3) Being an established company they have a fully developed market network and experienced management.

THE DEMERITS

The drawbacks of the process is as follows:

- 1) The fact remains that it is a very costly proposition even though the company is ready to invest the huge amount required.
- 2) It is an anaerobic process and hence the work site is heavily infested with flies and odour which result in unhygienic and uncomfortable condition for the workers.
- 3) The power generated by the process as its end product is costlier than that produced by conventional methods or that supplied by MSEB which would make it unaffordable.

VERMICULTURE BY BHAVALKAR EARTHWORM RESEARCH INSTITUTE

THE BACKGROUND

This Institute has been established and run by Mr Uday Bhavalkar, a chemical engineer. He is in the field of bio-waste processing through vermiculture for about twenty years. He has made vermiculture his life's profession. At the same time he has strong footing in Pune as well as Bombay.

He has proved that throwing away solid waste is like throwing away a valuable resource which can greatly enrich the environment and soil with the help of vermiculture.

Any organic matter starts decomposing due to the presence of bacteria, fungi, etc. If the composting takes the right course of biological process with the right kind of bacteria, then its product is one which is required for healthy plant growth. On

the other hand, if it is done in an improper manner then toxins are produced which are ecologically harmful. The role of biological indicators has been depicted in Figure 5.3.

THE PROCESS

At Household Level

A family produces 400 to 500 gms of waste per day which is equivalent to 100 gms of dry waste and needs one sq.m. of area for treating it, though Mr. Bhavalkar can do it within 0.1 sq.m. due to his experience and expertise. This process can be done directly below a tree, or in wooden bins of one sq.m. area and 60 cms height, or even in garden pots.

In case of bins :

- # The bottom is lined with 4 to 5 sheets of newspaper.
- # 5 kg of vermicasting is spread over it and covered with 5 kg of cowdung and one kg of oil cake.
- # The next layer is of garden or vegetable waste.
- # Water is sprinkled till it drains out from the bottom.
- # After 15 days the bin is ready for adding fruit and good waste.

In case of pots :

- # 7.5 cms of top soil is removed and 100 gms of vermicastings are added to the soil.
- # It is covered with 100 gms of cowdung.
- # Seven such pots are made, to take care of all household waste. One pot is fed with one day's waste in rotation.



Vermi-composting at Household Level, Pune



Under the trees :

- # The proportions are same as above, only the amount has to be, four to five kg of earthworm culture for trees with girth is of about 30 to 45 cms and about one to two kg for smaller trees like chickoo, guava, etc.

Note: For one kg of organic matter, 100 gms of rock dust is to be added for better results.

THE PROJECTS

Mr. Bhavalkar has managed to reach vermiculture to around 2000 families in Pune within five years. Besides, he also has executed projects at community, industry or company level. The projects which have been installed by him, their capacity and place are listed below:

- 1) Indian Aluminium Company Ltd, Belgaon. Colony garbage and sewage processing. : N.A.
- 2) Canteen Waste Water, Belgaon : N.A.
- 3) Onion Residue, Nashik : 10 tons /day
- 4) Distillery Waste Water, Nashik : 110 tons/day
- 5) Citric Acid, Waste Water, Nashik : 100 tons /day
- 6) Soya Processing Residue, Roha : 3 tons /day
- 7) Soya Processing Project, Devas, MP : 5 tons /day
- 8) Mixed Yard (Garden) Residue, Maryland, USA : 10 tons /day
- 9) House waste, Salisbury Park, Pune : N.A.
- 10) Venkatesharia Hatcheries : N.A.
- 11) Project KISS (Keep It Separate Sir) : separation of garbage technique for public awareness.

All these plants are running successfully and he has proven that any type of waste, ranging from slaughter house waste to sewage to distillery waste can be treated with vermiculture.

LABOUR REQUIREMENT

About five to six labourers are required for handling a ton organic waste at the cost of Rs.300/ton.

One ton of wet mixed garbage is converted to about 200 to 250 kg of vermicastings as end product. Thus the labour required would be 20 to 25 labourers/ton of finished product.

THE ECONOMICS

As per Mr. Bhavalkar, one can recover one's investment within a year. He charges one year's profits or an amount equivalent to the investment as his consultancy fees. A family has to invest Rs. 100/sq ft for its household and garden waste. The family can recover this money within one year by selling the end product, the vermicastings.

The recovery of money from a large vermiculture project is shown in the following chart.

INPUT

For a typical, large project of 300 tons of dry waste/day or 800 tons of mixed waste /day.

OUTPUT

300 TPD of vermicastings X Rs.20,000 /ton selling price.

PROFIT

Recovery of Rs.60 lakh /day X 300 days of the year Rs.18,000 lakh /year.

THE PRODUCT

The bacterial culture made as per the specifications of the waste to start a project costs Rs 8,000 to 14,000/ton.

The end product or the manure is called vermicastings, is sold in the market at Rs.20,000/ton or Rs.20 to 50/kg.

THE MERITS

The advantages of vermiculture technology are discussed below:

- 1) The value added product has a very high nutrient content and it therefore fetches excellent price besides requiring much lesser investment than any other method.
- 2) This process can take care of virtually any type of organic matter utilizing the natural biological energy for bioconversion.
- 3) It gives excellent results at the decentralized local community, society or household level, where the waste gets attended to, much more efficiently, reducing the transportation and collection cost. In addition, every household becomes responsible for its own garbage.



THE DEMERITS

Generally problems are faced in very large scale projects only and especially if they are not managed properly.

- 1) There are chances of the earthworm population migrating during monsoon.
- 2) Their hibernation period is from November to February when earthworms are in cocoon stage.
- 3) Land and labour requirement is very high.
- 4) Overloading creates problems and one has to therefore be very alert for indicators /alarms, besides high temperature, gas, acid or leachet are harmful to the earthworms and so are cats and dogs to the waste.
- 5) Since garbage segregation is done manually sometimes unwanted glass or tin pieces show up in the manure.

THE GREEN CROSS SOCIETY

THE BACKGROUND

The Green Cross Society has been established by Mr. Shantanu Shenoy who incidentally is an electrical engineer. Though the society's self demarcated work area includes Greater Bombay and Thane district, most of its work has been done in Western Bombay only. Mr Shenoy who has made vermiculture his profession started off by spending from his own pocket for the cause. Due to the age old deep set unhealthy attitude of the masses towards garbage, the response to the process was not heartening enough, he feels. It is only recently, after much propaganda through many organizations, that people have started acknowledging and accepting the system. The society has helped construct about 21 vermipits in different parts of Bombay, getting good response and co-operation from the people.

THE METHOD

The vermiculture process can be started off in makeshift wooden bins, or in properly built brick pits in the garden. Bins can be made by using a wooden packing case about one sq.m. in Bins can be made by using area and 60 cms in height. The same method as explained earlier could be applied to this bin as well.

PROGRAMMES

Various activities and programmes of Green Cross Society are as follows:

- 1) Distribution of vermikits consisting of made plants in pots, trays, etc. for house garden alongwith pamphlets
- 2) Talk Shows in schools and colleges

- 3) Seminars in various clubs, etc.
- 4) Coordination with other organizations like YMCA, YWCA, etc.
- 5) Sale of culture
- 6) Biofertiliser Sale
- 7) The Organic Club
- 8) Farming
- 9) Consultancy
- 10) Micro Projects
- 11) Vermi Toilets
- 12) Books
- 13) Vermi tours
- 14) Exports

THE PROJECTS

The Green Cross Society has 21 demonstration projects of various types in various situations.

INSTITUTE OF NATURAL ORGANIC AGRICULTURE (INORA)

THE BACKGROUND

This Institute was established by Mr. M.R.Bhide.

The objective of the institute is development and promotion of organic agriculture using vermiculture as the most environmentally sound way of producing healthy food.



Back to Nature



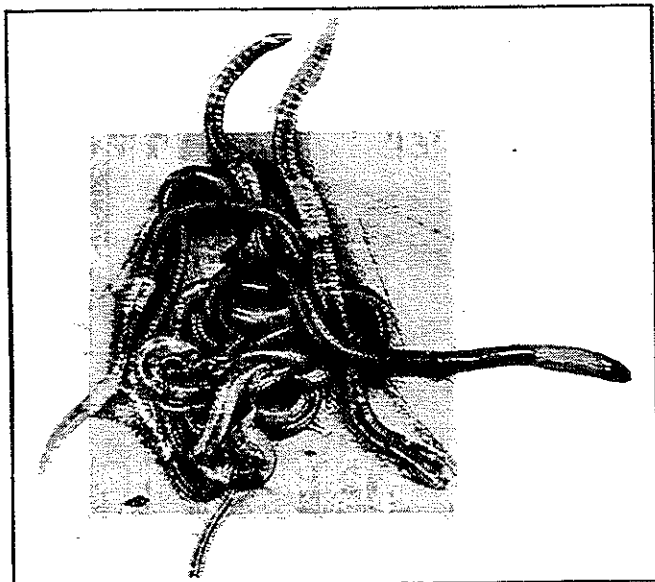
The Activities

It is essentially a voluntary organization which carries out research and development work on organic systems, use of earthworm technology in organic systems and advises individuals and organizations about the potential of earthworm technology in organic farming. For this they have:

- 1) A fully developed organic farm-cum-demonstration land on the Bombay - Pune road, two kms before Kamshet.
- 2) A research programme with a fully equipped research laboratory at Shivapur.
- 3) An advisory and extension service. It has 25 centres throughout India for vermicomposting. They have developed three approaches to research and development work :
 - a) Recycling of organic waste by vermiculture
 - b) Monitoring of the farms after application of vermicompost in the process of conversion
 - c) Conducting farm trials, demonstration and training programmes.

THE PROCESS AND THE PRODUCT

The earthworms used by INORA are surface dwellers, namely, *Eisenia foetida*, *Perionyx excavatus* and *Eudrilus euginae* to convert any organic waste into humus rich fertilizer called vermicompost. The conversion rate is 40 percent of biodegradable segregated garbage. The process of vermiculture and its application is similar to that of Bhavalkar Institute with slight variation.



The Earthworms

THE PROJECT

The organization sells the technology on turnkey basis. It does projects at all scales, for example:

Small Scale: Flats, bungalow : 1/2 kg /day

Medium Scale: Hostels, dormitories factories, etc. 2-3 tons/day

Large Scale: Military dairy farm:11 tons /day

One of the projects executed was Military Dairy farm. The requirement was to treat the cowdung from the military dairy farm. The capacity was 11 tons cowdung/day. The organization operated 11 centres such as Khadki, Pimpri, Deolali, etc. in the southern command for two years. Their responsibility was only till the first harvest of vermicompost.

The institution helps install smaller projects for flats, etc also at the rate of Rs. 200/flat which includes :

- 1) Set-up Visit
- 2) Harvest Visit and
- 3) Follow up visit.

THE ECONOMICS

Being a voluntary organization, it gives services on a non-profit basis.

Vermicompost is sold at Rs 2100 ton.

Vermiculture with adult worms is sold at Rs 1500 / kg.

FUTURE PLANS AND PROPOSALS

They also plan to go into collection field in future. They have submitted a proposal to the PMC for collecting and treating waste in four areas in Pune. They are:

- 1) Gokhalenagar (Patrakarnagar) : 500 kg /day
- 2) Kamala Nehru park : 100 kg /day
- 3) Mitramandal area : 100 kg /day
(to be increased based on availability of land)
- 4) Kalyaninagar : 100 kg /day

THE MERITS

- 1) It can treat any type of organic matter.
- 2) It is completely ecofriendly, it improves soil pH, enhances water drainage and water retention capacity



of soil. The soil productivity improves and agricultural produce obtained is of very high quality.

- 3) It is cost effective.

THE DEMERITS

The demerits of this process are:

- 1) The earthworms can not tolerate excess or very low sun and water.
- 2) The process is labour intensive.
- 3) Great care has to be taken in large-scale projects.

RESOURCE UTILIZATION, RECOVERY AND RECYCLING: ORGANISATIONS AND THEIR PRACTICE

It has already been established that waste is a major resource available in ample quantities, if utilized properly. It requires timely and appropriate treatment for recycling and further use. On the other hand, there is no dearth of human resource too. If these two resources are combined and handled optimally, one can create wealth from them. But the catch word in this type of resource recovery is Segregation, which can only be achieved through public participation.

For any new practice or method of solid waste management to succeed, cooperation and participation from the public is very essential. And it can be acquired only if they are aware of the quantity of garbage produced, the scale of its contribution to deterioration of environment and its hazardous effect on public life. *Segregating the waste and not littering public places is in itself the first major step towards resource recovery.* This way, the recyclable waste is saved by not mixing or soiling it and human resource is optimally utilized by saving time on segregation.

Precisely this kind of work of increasing awareness amongst people and properly channelling resources is being carried out by various voluntary organizations in different cities. They pick up small areas for their operation and then branch out as the idea takes roots. Most of them get funds, grants or occasional help from other environmental organizations.

THE COMMON OBJECTIVES

Most of these organizations which are working in the field of solid waste and environment have more or less common objectives. Only their scale may differ owing to their financial status:

- 1) Some of them stress on helping the poor, destitute and exploited street children, youth, women and

ragpickers; obtaining for them proper footing in the recycling trade.

- 2) A few organizations are working at the city level, organizing the ragpickers of the city and acting as their representatives to set up a dialogue with and ask for help from the authorities and other organizations.
- 3) Few organizations involve themselves in the work of awareness and education of the residents.
- 4) Many of them are presently concentrating fully on ways and means of getting the waste segregated.

Examples of some of these practices are as follows:

SEWA /PRARTHANA CONSTRUCTION PVT. LTD'S 'ZERO GARBAGE ON ROADS' PROJECT, AHMEDABAD.

The New Beginning

In addition to Ahmedabad Municipal Corporation which plays a major role in managing solid waste disposal in the city, there are a few other agencies also which play a small but significant role in this area. They are largely helpful in appropriate utilization of material as well as the human resources and thus also help in resource recovery.

The Ahmedabad civic administration along with the voluntary organizations and NGOs have come up with an innovative concept of 'Zero Garbage On Roads.' The salient features of this programme, the efforts made through it, its success rate and replicability has been discussed as a city-wide best practice in solid waste management in Ahmedabad.

The success of this practice is a result of the efforts of :

1. the women organized and engaged in the job through SEWA or Self Employed Women Association.
2. the chairperson of Prarthana Construction Pvt. Ltd., Mr. Mayur Shah; also the President, Clean Ahmedabad Abhiyan Committee, who through his untiring efforts has floated this new concept with the help of the Dy. Municipal Commissioner (Health) Mr. P. U. Asnani.

To make this experiment a success, various new committees have been set up to monitor the steady progress in this regard.

The Apex Committee

To develop the city of Ahmedabad as a model and to execute and follow up a time-bound programme, an Apex Committee has been formed. The committee is responsible for developing the vision and concept of city cleanliness and disposal of garbage.



The committee is headed by the Deputy Municipal Commissioner of health and also includes representatives from various voluntary organizations of the city.

The main objectives are:

1. Zero garbage on roads.
2. Minimum land fill by recycling most of the waste and minimising the handling and transportation cost of AMC.
3. To bring in economic opportunities for poor and unemployed by encouraging self employment and creating massive awareness amongst the public for participating enthusiastically in civic affairs.

The Ward Committees

This committee consists of persons who are active and leaders in the ward, the health officer in charge in that ward, volunteers from various organizations and representatives from the NGOs.

The tasks before these committees are:

1. To execute and monitor vision programme given by the Apex Committee.
2. To develop new approaches if required for the unique situation of the ward.
3. To coordinate various agencies involved in the management of solid waste in the ward.

The Coordinating Committee

This committee has members from the Apex Committee as well as from the ward committees. This committee is a window for exchange of information between:

1. Apex Committee,
2. Individual Ward Committees and
3. Various Ward Committees.

In Ahmedabad, SEWA operates an excellent system for separation of dry and wet waste. Households are given large HDPE bags to hang outside their gates to be filled with dry recyclable waste. SEWA arranges with local rag-pickers to collect the contents of the bags weekly. The HDPE bags are sponsored by different industries who print their name and logo on the bags. This serves a dual purpose as it gives the corporate sector enormous publicity at negligible cost apart from the environmental benefits.

BANGALORE ONIYAVARA SEVA COOTA (BOSCO)

OBJECTIVES

BOSCO is an organization working with the children on streets of Bangalore. Their solid waste management activity scheme was started in 1992 and aims at motivating the street children to find alternative jobs. It involves collection of waste papers by street children from schools, offices, etc. Three boys collect waste papers from selected schools and private offices on tricycle (shared by 2 boys) and one bicycle. The boys receive a stipend amount of Rs.50 per month funding and an extra amount by selling the recyclable/waste papers. The fund for this scheme is provided by the University for Global Concern, Singapore. The boys are provided with uniforms and identity cards, which give them respectability and save them from residents' suspicion.



Wastepickers engaged in waste collection and street cleaning, Madras

THE CLEAN AND GREEN MADRAS CITY PROJECT

The Municipal Corporation of Madras has started an innovative project called 'The Clean and Green Madras City Project' since 1993, for keeping the city clean by entrusting different areas to different organizations. There are 25 divisions and two zones in the city which are distributed among different organizations. The corporation finances the project, supervises it and also provides any other aid required by the organization.

The work entrusted includes :

- 1) House to house collection of waste
- 2) Sweeping the streets, open public places and cleaning the open gutters.
- 3) Transport the waste to the nearest dumping point allotted by the local body from where the municipal lorries carry it to the dumping ground.



Financial Management

The Corporation of Madras provides the boys boots and gloves and two sets of uniforms. The materials used for cleaning brooms, baskets tricycles are also provided by them. The boys receive a consolidated salary of Rs. 1000 to Rs. 1925 month.

The boys who are employed in this project are given non-formal education. They are given identity cards by the Corporation. They all have individual accounts in the banks and they have to save upto Rs.150/- per month compulsorily. They are allowed to draw festival loans from their account.

PROBLEMS FACED

The project faced many basic problems in its initial phase. But by the efforts of the organisations, the process has become easier and more acceptable. The problem-prone areas are where many shops are located. Packing materials are discarded on the road side at any time of the day. This dirties up the roads after they are cleaned. The Director of AYC says stray cattle are a challenge to the boys.

The Project Officer Mr. Susai Raj of Neesakaram, said that initially they had encountered a lot of problems with the boys. The boys hated working under a particular time frame. Many of them tried to absent themselves from work. But, in the course of time they realized that the job provided them an identity of their own and they got more respect from society. This program has successfully completed its second year.

According to Father David of DBAI, this approach has brought positive results. The residents have now been requested to hand over the garbage directly to the boys. The boys try to remove the recyclables and sell them to itinerant buyers. There is no problem of accumulated garbage in the bins since cleaning is done twice daily. The boys are not paid salary if they are absent on any day. This makes them work everyday and efficiency of work is maintained.

Involvement of various organizations in different areas has brought efficiency and good results. These organizations were already into social work and so had experience in dealing with the public and the poor. They are doing other projects too, along with the corporation's clean and green city project.

NATIONAL SOCIETY FOR CLEAN CITY (NSCC), PUNE

BACKGROUND

This organisation was established by Begam Ali Yawar Jung. It deals with civic issues, has branches in all major cities of India and looking after solid waste is only a part of their overall campaign. The Pune chapter had patrons like Mr. Kirloskar.

They have introduced Mohalla committee system where the region is divided into different zones termed as Mohallas with a committee appointed voluntarily to look after its problems, people's complaints, etc. At the year end, they organize a meeting of all Mohallas from the city and discuss each others work, achievements, setbacks, etc.

ACTIVITIES AND WORKPLACES

- 1) The organization has started a resident's forum. They ask people from various fields such as cantonment board, police, corporation, etc. to address them. They are asked questions by the residents and are made aware of the local problems. Most of these guests have power in their hands to help out the residents in some way or other.
- 2) The NSCC has fully adopted vermiculture and the committee members help people to set up the process. They try to create public awareness for garbage segregation. Ms. Sheila Christian and Ms. Geeta Vir are very strong supporters of this system. They have installed such plants at various places like Boat Club Area, Koregaon Park Area, Maxmuller Bhavan, St. Phelex School, Vimannagar, Sopan Baug, Kondwa, Kalyaninagar and Aundh.
- 3) They have made an association with the ragpickers. A meeting is arranged with them every month and they are asked about their problems, opinions, etc. These ragpickers collect segregated waste from buildings and are paid by the residents on a monthly basis.

PROBLEMS FACED

Inspite of being paid and being lectured every month, the ragpickers do not maintain timings, do not give a substitute if for any reason someone is not able to come some day and so on. Sometimes the ragpickers come and stay at the site along with their families. The committee has to remain alert and prevent any such developments in their area.

Even the residents do not always cooperate always. The committee, therefore, has to strive all the time to keep in touch with them and to make them aware of the advantages.

Two ladies, Ms. Sheila Christian and Ms. Geeta Vir have started 'Greenwich Education Consultants College'.

SNDDT, PUNE

BACKGROUND

In SNDDT Women's University, the department of adult and continuing education, Pune, have involved themselves completely in the welfare of ragpickers. It has organized the



ragpickers of Pune and works for their welfare, education and rights. Ms. Chickermane and Ms. Laxmi Narayan are two very dedicated workers for this cause from the department. They have started an organization called 'Kagad Kanch Patra Kashtakari Panchayat' (KKPKP) whose members are the ragpickers and the cooperative stores which buy the recyclable material from them. They are around 4000 member waste pickers who pay Rs.15 /year towards membership fees. The ragpickers are given photo identity cards, the union cards or the SNTD-GRASP cards as identity cards.

THE EDUCATIONAL AND OTHER DEVELOPMENTAL ACTIVITIES FOR THE RAGPICKERS

1) Garbage Recycling And Segregation Programme (GRASP)

This programme promotes the collection of segregated waste from households and commercial establishments by waste pickers bearing photo identity cards. Presently about 60 waste picker women collect waste from 7000 households in Aundh, Koregaon Park, Boat Club Road, Model Colony and Kothrud. Each woman has a reach of minimum 100 households/day. This doorstep segregated waste collection earns the ragpickers about Rs. 10 /household/month.

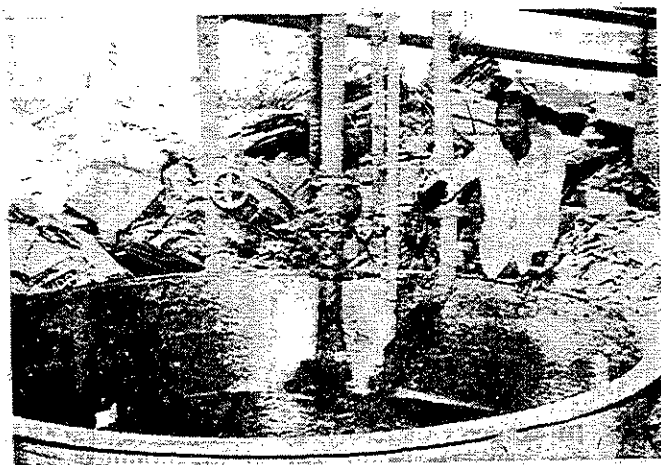
Various other programmes are as follows.

2) Health

Health facilities are provided to 40-50 waste pickers per week through the Spicer College Mobile Clinic.

Over 370 waste pickers from various places were examined and treated in special camps organized by a team of three doctors from Sasoon General Hospital.

3) School Enrolment



Paper Waste Recycling Factory, Bangalore

Waste in Money

If one assumes that a waste picker earns on an average Rs. 30 per day from this business then his earnings per annum are $30 \times 30 \times 12 = \text{Rs. } 10,800$.

There are around 8000 such waste pickers in Pune. So their collective gains are $10,800 \times 8000 = \text{Rs. } 864 \text{ lakh}$.

This large scale money is involved in just the first stage of the primary collection phase.

One can imagine the total turnover brought about by the complete process of waste management.

In 1994-95, 237 child waste pickers attended non-formal education centers conducted by this department. As many as 2000 exercise books provided by 'Inner Wheel Club' were distributed as an educational incentive.

Nearly 630 children of waste pickers were enrolled in school in July 1995 and 82 children gave up waste picking to join school.

4) Domestic Violence

Counselling/arbitration/legal assistance is provided to female waste pickers who are victims of rape and domestic violence. This department is part of Mahila Dakshata Samiti at Pune Municipal Commissionerate.

5) Research

A study titled 'Child Waste Pickers in Pune City : A Situational Analysis' was undertaken by this department in 1994-95. The study was supported by UNICEF.

6) Self Help Groups - Savings

Waste pickers do not have access to lending institutions, consequently they borrow from money lenders and shop keepers at very high rates of interest.

In the savings scheme started, each group of 10-20 women collects savings of Rs 10-20 per week per member. This amount is deposited in a joint account in a Nationalized Bank. After a period of six months, it is used as a revolving loan fund by the group. A circular issued by NABARD directs banks to permit opening of such accounts.

On July 31, 1995, 37 groups of women waste pickers with a membership of 400 were a part of this scheme.

7) Cooperative Stores

They have started cooperative stores with about 200 members where all members (waste pickers) sell the collected waste to the trader. They get higher prices and the profit is shared.



SNDT PROPOSALS

Various proposals put up by SNDT and the KKP KP are as follows:

- 1) They need PMC's authorization letter for the ragpickers and PMC's stamp on their identity cards. PCMC (Pune Chinchwad Municipal Corporation) has already agreed for the proposal and have funded the pamphlets.
- 2) PMC could give licences to the waste pickers for specific areas or the association could be authorized and given licences.
- 3) The ragpicker women could be given vermiculture training and it could be carried out by them (licence holders) at the collection bin itself.
- 4) The waste pickers should be made a part of the solid waste management system. Just like conservancy tax, a separate tax could be levied on the public for the ragpickers operation.
- 5) Space for recyclable material cooperative stores and for the vermipits could be given. Nearly 90 percent of the waste pickers are from backward classes and 90% of those are women. So, help for them is very essential.

WASTE PICKERS

Waste pickers contribute to the solid waste management system by selling sorted waste materials to the buyers and wholesalers and thereby providing raw material for the recycling. And although waste pickers are seen to be self employed producers, in reality, they are part of the whole recycling sector.

ADVANTAGES OF WASTE PICKING

- 1) waste pickers can work every day and have daily though fluctuating earnings
- 2) waste pickers have no formal boss or overseer and do not depend on others for work
- 3) a certain degree of freedom and control over working hours makes it easier to combine this work with household duties including child care
- 4) the amount of work is to a certain extent determined by the individuals themselves
- 5) there is the possibility to combine waste picking with fuel collection
- 6) waste pickers do not have to invest money, they do not have to be trained nor do they have to have contacts to start waste picking

THE DISADVANTAGES OF WASTE PICKING

- 1) the supply of raw materials fluctuates and this fluctuation is uncontrollable. The monsoon rains destroy the waste paper and make it almost impossible to collect paper for several months each year. The monsoon income of a waste picker frequently falls to 25 percent of his/her income during the rest of the year
- 2) the prices paid for materials also fluctuate and thus, regardless of how efficiently waste is collected, they do not have a guaranteed income. Besides, the total number of waste pickers is increasing due to lack of other employment possibilities, this forces the prices downwards
- 3) the activity has many occupational health problems
- 4) picking waste carries no status and waste pickers are looked down upon by others in society. The conditions of this work combined with the victimizing effects of caste belief make a lot of these women/children feel ashamed and have low self-esteem.

ROLES PLAYED BY THE ACTORS INVOLVED IN BEST PRACTICES

Solid waste management is a subject which is a part of day-to-day life of every citizen. And, so, the success of a practice or operation in this field is a function of various actors, their behaviour, attitude and policy. The four major actors who play a lead role in causing the success or failure of any solid waste management project or in improving the solid waste situation in a city are:

- 1) The agency/organisation concerned
- 2) The local body
- 3) The ragpickers/waste workers and
- 4) The residents

Each of these four actors need a genuine and strong support from the other three for smooth functioning of the system and for maximum efficiency coordination is essential. Their role is described below.

THE AGENCY

The word 'Agency' with context to this study implies, the governmental or non- governmental organization or private enterprise which practices an innovative method in solid waste management. All 'best practices' mentioned in this report have been successful in smaller or larger extent and have potential



of being replicated under specific conditions. For the given agency to be successful, the main factors responsible are:

- 1) appropriateness of the technology
- 2) the funds and
- 3) the management

THE TECHNOLOGY

It is extremely important for the technology adopted to be well established and to be applicable to Indian condition in general and site conditions in particular. If this is not the case, output and efficiency reduces. This can be illustrated with the help of following examples:

- 1) *Excel Industries India Ltd.* is a good example of a technology suitable to Indian conditions which can be proved from the number of plants it is helping to establish in different cities and its popularity. Being a big company involved in other areas of biochemical engineering too, it has a widespread market network for its organic manure product. It has also put in remarkable efforts in Research and Development.
- 2) *DST/CMC* on the other hand have a good technology but it is suitable only for a small fraction of Indian garbage, namely, paper, plastic, rags, etc. The process requires dry and combustible material whereas Indian garbage has a high content of wet organic waste, which demands excessive use of energy, rendering the whole process costlier. The *DST/CMC* plant is yet to achieve its installed capacity.
- 3) *Vermiculture* technology is extremely good for small scale projects. Various institutions are experimenting with this, but still, it has not reached the stage where it becomes cost effective at a large city scale. Still more needs to be done in terms of practical application and marketing. The vermiculture plant in Deonar, Bombay is facing various problems due to this.
- 4) *Biogas production and power generation* technology works well as it is an anaerobic process where wet garbage does not hamper production. But solid waste based biogas plants have problems of size reduction, feeding and scum formation which require substantial power input.

THE FUNDS

Adequate funding is important for running the system. This holds good for agencies from all the sectors - Government, municipal, NGO and private. It is always desirable to have a stable financial system which is achieved either by self-sustain-

ing revenue generation or external budgetary support. Solid waste management has been regarded so far as an essential service dependent upon budgetary support. But considering the increased dimension of the services and treatment/disposal facilities required due to rapid urban growth, external budgetary support has become wholly inadequate in a majority of the places. Therefore, every possible attempt should be made to generate revenue from (i) recycling and resource recovery activity and (ii) service charges as the case may be.

Lately, some private enterprises are also trying to make waste management activity paying. However, support in the form of a grant would still be necessary in the pilot demonstration phase of a technology/system/service before it is thoroughly established, especially, if it is being handled by an NGO/CBO.

THE MANAGEMENT

Management plays a vital role in enhancing project efficiency. The concerned agency must have a proper management service backed by rational planning and institutional framework.

It is still more important for small organisations, NGOs and CBOs. They may need manpower training and input of information to a greater extent. Indian experience has shown that many projects had poor output or even failure due to inadequate management support.

THE ROLE

The arrival of all these agencies with best practices in the solid waste management area has made a remarkable difference. There have been innumerable experiments out of which some have been successful. They provide good competition to the local body, and on the other hand also reduce its work load.

As mentioned before, Bombay produces approximately 2742 TPD of refuse and 2260 TPD of debris. Out of this, 500 TPD is taken up by Excel, about 75 to 100 TPD goes into vermiculture plant and about 300 TPD* is expected to be consumed by the *DST/CMC* pelletization plant. Besides there are various other smaller organizations who do not dump their garbage into municipal bins. Thus presently about 900 to 1000 TPD of city garbage is off loaded from the Corporation's shoulders by these agencies in Bombay.

If these agencies take up further load, then the Corporation's responsibilities can be reduced proportionately and it can concentrate on planning, management or other activities.

Whatever is the field of work of all these agencies, it is their moral responsibility to make an effort towards public awareness, which is the basic necessity at the present stage of development. This would directly help the agencies' functioning and increase their efficiency as well as profit.

* The plant capacity of *DST/CMC* is 80 TPD but it needs 4-5 times more garbage.



THE LOCAL BODY

The local body plays the central role in these ventures. According to the BPMC Act, the solid waste is Municipal Corporation's property and so, no private body can do anything with it without their prior official permission.

In many of the best practices discussed in the previous chapters, they have played a very positive role but at the same time the local body has also been found to be inadequate or constrained in many cases.

- 1) One such case is that of Mr. George Bhopali who cleans Juhu beach. In spite of there being an agreement that he would be given four lorries to collect the beach waste many a times these vehicles are not provided.
- 2) The response to Western Paques in Pune by PMC, on the other hand is a case of delay in decision. Even though the pilot plant producing methane gas has been successful, the company has still not been given permission to establish a full scale plant.
- 3) Exactly opposite is the example of the Madras Municipal Corporation. It has started the Madras Clean and Green City Project under which it has allotted different areas to different non-governmental organizations for cleaning. As the Corporation is acting as a funding body and provides an umbrella over the agencies, this project has become a success story.
- 4) Even Ahmedabad Municipal Corporation has taken the reins in its hands and is carrying out solid waste management modernization project with the help of a grant from the World Bank. But the Corporation shows reluctance towards privatization.

A local body, with its infrastructure, experience and its standing in the society can change the solid waste management scene of any city.

THE RAGPICKERS / WASTE WORKERS

The ragpickers form the lowest but one of the most important links in the chain of solid waste management system. Almost all the organizations, especially SNTD Pune and those in Bangalore have made efforts at organizing the ragpickers. But the ragpickers have shown considerable reluctance in some cases.

There have been instances where ragpickers do not come on time, do not turn up without prior intimation and so on and so forth. Through their own sincerity, they can earn respect in the society as well as money. They are the most important link between primary collection and recycling of waste. Their role is being increasingly realised.

THE RESIDENTS

Even though the executing body is some agency or a Corporation, not much can be achieved without the help of the public - the residents, their awareness and participation.

The work done by National Society for clean city in Pune, the Civic Exnoras and other voluntary organizations in Madras has been a success only because of residents' cooperation and participation.

The projects like 'Clean and Green Madras City' faced problems in initial stages as the residents used to throw waste even after the sweepers swept the street and in spite of the provision of dustbins.

Therefore it has been observed that small scale projects have higher success rate due to people's participation as well as cooperation.

INTERPRETATION AND LOOKING AHEAD

Various practices related to collection, transportation, disposal and public awareness have been discussed in the preceding sections. Each of them have made contribution for betterment in their own way, have had an impact on the respective city's scenario and have the possibilities of application at a wider scale. They have their own advantages or disadvantages in different circumstances.

IMPACT OF THESE PRACTICES ON THE SWM SCENARIO

These practices have contributed towards better SWM as a whole through their own areas of operation such as collection, transportation and disposal and wider plans for the future. This point is illustrated with the following cases:

COLLECTION

- 1) Beaches are the most popular tourist spots in all sea-side cities and are thereby places of maximum litter and garbage. Persons such as Mr. George Bhopali carries the responsibility of cleaning the Juhu beach in Bombay and has plans to do so at Marine lines, Gateway of India, Malabar hill, Colaba, Dadar, etc. This would be a major contribution to the city's cleanliness, as well as it would drastically improve the city's image in the public eye. It would thus have a direct impact on people as well as the corporation.
- 2) Contribution of organizations like SPCC, Pune is that they take care of the waste in their own area without relying on municipal lorries. A clean and decent locality is the result. They have spot impact on the city but many such spots can converge into a region.
- 3) Practices by Sadashivnagar Welfare Forum and REDS



in Bangalore have given a professional attitude to the task of collection, a system of working and at the same time, employment to the ragpickers by involving them in the collection exercise. Their impact on residents is that they get good service and clean area and the impact on ragpickers is that they get employment and recognition. The local body is the beneficiary too in terms of reduction of its work.

- 4) Primary removal of solid waste and primary cleaning of housing societies projects in Rajkot has posed an excellent example of positive points of partial privatization by the Municipal Corporation. The RMC has plans to extend it further, the impact is seen in more efficient work in area and increase in people's involvement.
- 5) All the organizations which are doing collection as well as disposal have made two-fold contribution to the SWM. Firstly, the waste gets efficiently collected and secondly, it gets disposed locally within the area, thereby decreasing the amount of waste to be transported to the disposal site and all nuisances attached to it. This holds true for CEE, Mythri Sarva Sewa Samithi and 'Suchi' in Bangalore. The result is, the given area becomes self sufficient in solid waste management.
- 6) The AMC's modernization project has much larger scale effect and impact naturally because of AMC's larger reach, expertise and financial backing. It has made a difference in every aspect of solid waste management in every area of the city.

TRANSPORTATION

Very few private organizations have taken up transportation of solid waste. The Municipal Corporations have complete control on this aspect.

- 1) Under the modernization programme funded by the World Bank, AMC has made changes in the design of its equipments and method of working. This has increased the overall efficiency of the system.
- 2) Contracting out solid waste transportation in Rajkot in 16 wards by RMC has given them financial advantage, improved efficiency and relieved the RMC personnel from related problems to a great extent.

DISPOSAL

Solid waste is an important resource, if treated properly. Till now, only non-organic waste got its due consideration by getting recycled, but organic waste has remained neglected. But the past decade has seen it receive increasing attention with industries like Excel Industries India Ltd (Mechanical bio-composting), DST /CMC (Pelletization), MCGB /IIT

(Vermiculture) and Western Paques India Ltd (Biogas power generation) coming up with different processes to recycle it on a large scale. They have major impact as they take care of large amount of city waste. If the complete disposal of total city waste is given to them, the city Corporation can be free from a major problem.

Other institutions which resort to vermiculture in smaller areas can also become very effective in disposing the waste locally.

RESOURCE UTILISATION, RECOVERY AND RECYCLING

The organizations working for the above purpose have brought about changes at the grassroot level. They have made an impact on the residents who are the generators of waste and the ragpickers who in a way are the foundation of the solid waste management tower and a link between collection and disposal or recycling.

- 1) National Society for clean city, Pune through its mohalla committee has served as a common platform for public bodies, public (users) and ragpickers to interact.
- 2) SNTD, Pune has made drastic impact on the population of ragpickers in Pune. They made possible the historical decision of Pimpri-Chinchwad Municipal Corporation to give municipal identity cards to all ragpickers. Thus a way has been shown to absorb the informal ragpickers into a formal system.
- 3) The Madras Municipal Corporation has shown the way by acting as the coordinator, financer and consultant to various voluntary organizations working in the city. Allotting different areas to different agencies and maintaining the reins in their hand, the MMC has made a city wide impact in a cost-effective manner.

SCOPE OF APPLICATION AT LARGER SCALE

As this whole exercise is to find out best practices and their potential of replication and form national strategies, it now remains to be seen as to which practices could be replicated and at which scale.

COLLECTION

- 1) The system of Mr. George Bhopali can be applied in any coastal city. The only stipulation is, the local body has to provide the vehicles for transportation of waste to dumping place and fund the project. Commercial establishments such as hotels can either wholly or partially sponsor such schemes which will also improve their clientele.
- 2) All other systems of collection described earlier can also be applied if a voluntary organization (NGO/



CBO/Resident societies, etc.) is ready to take up the work.

It can be extended to city scale too. But many such systems of localised collection and disposal have to be established in different areas because a single organization of this nature cannot manage the total city. Besides, it then also loses public faith and participation. In such case there has to be good coordination possibly under the leadership of the local body.

And of course funding has to come from government or trusts or other environmental organizations.

Instead of just collection; if training, land and funds are given to the organizations, they can also do local disposal by composting and vermicomposting. This would automatically relieve the coporation of the burden of transportation.

TRANSPORTATION

Privatization of transportation is one of the good solutions to the problem. Almost all corporations are already hiring private vehicles for the purpose. The basic requirements in the planning of any of these arrangements is a study on how much waste is produced at what point and monitoring of the work. There have to be enough weigh bridges at the dump sites to keep a check on the waste brought in by lorries and trucks. Optimisation of routes and streamlining of the collection system can greatly reduce time and dead mileage.

DISPOSAL

Proper and sanitary disposal of garbage is essential for public health. At the same time, the system has to be technically viable and as economical as possible. The systems of waste recycling and resource recovery are becoming more important in this context.

The treatment/disposal options are related to the nature of the concerned waste. Only a landfill can accept all kinds of waste. Of course precaution has to be taken in the case of toxic/hazardous waste.

Biodegradable organic waste can be treated by any one or more of the following technologies:

- (i) Composting (aerobic, aerobic with defouling, anaerobic, vermicomposting, etc.)
- (ii) Biomethanation (biogas production with heating, power generation facility).

Composting in the urban sector had started in the 30's in our country but only in the 50's composting of nightsoil was practised by some municipalities. In the 70's mechanical composting plants were set up in several towns/cities but the experience was not encouraging due to poor product quality and consequent feeble market response as well as poor O&M. Against

this backdrop, the performance of the aerobic composting with defouling arrangement developed by M/s Excel Industries India Ltd., Bombay brings a ray of hope. So far they have established the technology at a scale of 500 tons of garbage per day. This means, an approximate population of 1.25 million may be covered. For larger population, a suitable number of facilities may be set up in a decentralised manner.

As pointed out already, vermicomposting can play a significant role in a small scale operation and can be replicated in an environment-friendly manner. Anaerobic composting, being a very slow process, is not recommended on a large scale. It can and is, however, used in small private lawns and gardens.

Biomethanation is an established technology but its application to garbage in this country has been limited to laboratory work and a very small number of small demonstration plants. As pointed out already, it has to overcome a number of engineering problems and power input.

Its scale-up and replication, however, is highly desirable in view of our energy shortage. Its success would depend on pricing of the products, that is, biogas, electric power generated, sludge manure, etc.

Combustible dry waste such as paper, plastic, rags, etc. can be subjected to

- (i) direct incineration or
- (ii) pelletisation (refuse derived fuel).

Incineration has a discouraging example at Delhi (Timarpur). But infectious hospital waste, on the other hand, must be incinerated on health grounds. Pelletisation is gradually picking up since one decade but so far there is no plant which is operating regularly at its rated capacity. As pointed earlier, the small fraction of this category of material available in Indian garbage is a big limitation to this technology.

RESOURCE UTILISATION, RECOVERY AND RECYCLING

It is a voluntary activity and cannot be forced on anyone. Though almost all environmental institutions and organizations are making their own contribution, but a city level campaign can be launched only by the local body as no organization will be interested in doing so unless there are some direct gains.

INTEGRATED SWM

The key to the success of any town or city-wide SWM system is overall planning in a meticulous way, taking into account the ground conditions and sufficient future projections. The total system from generation to final disposal has to be intertwined into a meaningful process.

One has also to consider if centralised or decentralised mode has to be adopted. As per the situation obtaining in most of



the Indian urban agglomerates, a judicious mix of both should have the best chances of long term success.

Landfill (sanitary) is still the most used method of garbage disposal. But a judicious combination of appropriate technologies for bio-degradable organic waste, combustible dry waste, etc. may be useful in practice. The 'best practice' studied in this report can thus be utilised meaningfully. For example, a city may have composting/bio-methanation facility, supplemented by pelletisation. There can be a harmonious combination instead of unhealthy competition.

GENDER ASPECTS

The issue of women in solid waste management could be said to be two-fold. Women have an important role in the generation, segregation and primary transportation of the waste. The second is their involvement in waste recycling as waste pickers. In the Indian scenario kitchen is still the domain of women and therefore they can be an asset for better management of waste by practicing the following:

- * reduction in waste generation
- * segregating the waste at source and making productive use of non-organic components
- * appropriately disposing the organic waste through composting/vermiculture
- * inculcating waste management habits in the other members of the family

Waste pickers are mainly from socially backward groups which occupy the weakest economic positions in Indian society. Due to poverty, a large number of women are also forced to work in this sector as an alternate means of living. This sector also attracts women due to their caste position and also because they can only perform unappreciated and badly paid labour. This sector does not attract men due to uncertainty of earning.

WOMEN WASTEPICKERS

A study was carried out in Bangalore on gender aspects of waste picking in 1989-90 and it was found that women far out number men in this profession. A closer look at statistics reveals that of the men, most are boys. Women of all age groups engage on waste picking and no age group is dominant in particular.

These women have a very low level of education or are illiterate. According to the study, before starting waste picking in Bangalore, 64 per cent women had tried other jobs but they switched over to waste picking because of following reasons :

- the work was too heavy (due to health situation or to dependent children) 41%
- to low or no daily wages (the time and mode of payment for work) 25%
- No work available 13%

- husband passed away, left the family or became unemployed 9%
- accident or forced removal 16%
- forced to stay home because of illness 6%

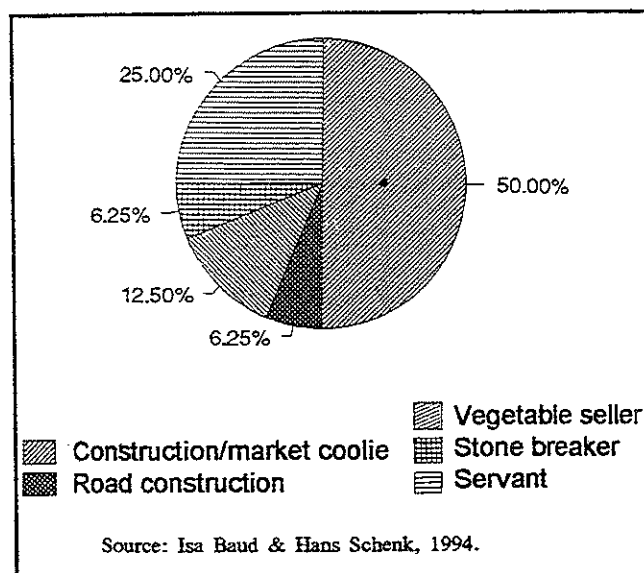


Fig. 5.5 : Jobs before waste picking

GENDER SPECIFIC CASES RELATED TO PRIMARY COLLECTION OF WASTE

EFFORTS IN AHMEDABAD

In Ahmedabad the work of door-to-door collection of waste on a daily basis has been undertaken on an experimental basis. At present nearly 10,000 people of Ambawadi area, a high income group locality of Ahmedabad, are being benefitted under the scheme.

The Practice

Under the present concept of Zero Garbage On Roads, women engaged in the job of waste collection /rappicking are formally grouped together. They are deployed in various colonies and are paid by the beneficiaries on monthly basis. Their job includes the daily collection of household waste from each house and depositing it into the community bins. These bins are subsequently taken to the disposal site by the Corporation employees.

The Advantages of this Practice

The benefit of this practice is that one no longer finds any waste being dumped in the rear lanes or by the sides of the streets. As regards the economic benefits the status of the working women is upheld by a regular income. Moreover from a sociologist view point their social status has improved from



a nomadic waste picker to an organized household worker who collects waste from the houses. She is now a formally employed person as well. Being associated with the elite of the city it can be expected that their perception about living habits and clean environment shall also improve. They can also segregate the reusable/ saleable part of the waste thereby putting some check on wastage of resource.

SEWA and the Paper Pickers of Ahmedabad

The paper/ rag pickers have an important place in the segregation of the reusable matter from the city waste. In this regard SEWA, an NGO in Ahmedabad has contributed in organizing the women engaged in this activity and safeguarding their interests from the clutches of the paper contractors and the middle men. SEWA has plans directed to free them from the dependence on these agents and allow them to take greater control of their work and their lives. A godown of their own has been made from where the collected waste paper is sold to the mills directly. SEWA's efforts have safeguarded them from the drudgery and dangers of work.

The Economic Benefits

In terms of the economic benefits of the system, by eliminating middlemen, the returns have increased tremendously as compared to what they used to get from the contractors or agents of the paper mills.

Social Benefits

From the view of social upliftment their status has improved from a rag /paper picker to an organized worker who collects waste paper /rags and sells it directly to the mills through its own cooperative. Being well organized they can no longer be exploited by the middlemen.

Their contribution is also praiseworthy because they are self employed and most of them are the sole bread earners for their family. Also they segregate the reusable/ saleable part of the waste there by preventing the wastage of resource to a large extent.

Efforts in Pune

The adult education department of SNDT College Pune has put in maximum efforts at upliftment of the waste pickers by starting various schemes for them and by putting up their problems before the local body. Efforts that have been made especially for women waste pickers involve starting a creche for the children of these women so that they can work for the day, free of worry for their children or the hassle of carrying them along. They have also initiated some savings schemes and helped them open accounts in various banks.

CONCLUSIONS AND FORMULATION OF APPROPRIATE STRATEGIES

This study has led to the following conclusions:

- (i) Proper solid waste management practices on a city wide scale is not to be seen anywhere in our country. No local body, whether small or large, has been able to tackle this issue in its entirety.
- (ii) The endeavours studied have the potential of being adopted/adapted as 'best practices' under suitable conditions.
- (iii) They may be integrated into suitable sizes of systems with integrated waste management planning.
- (iv) Long term monitoring and a proper mechanism of feedback would help to generate valuable experience and confidence in these systems.
- (v) Appropriate strategies have to be formulated to obtain optimal results.

APPROPRIATE STRATEGIES

Technology:

- (i) Selection of appropriate technology/combination of suitable technologies is the most important step. It must be viable from the point of view of local conditions, investment capabilities, infrastructure available, etc. Simple rugged technologies have a higher chance of sustainability under developing country conditions.
- (ii) Finance: It is difficult to make solid waste management a revenue earning venture. It is mandatory to protect public health. Therefore, careful planning is necessary to make the most of available finances. Appropriate service charges and taxes may be levied. Lately, some financial institutions, notably HUDCO, have started financing this vital sector. Loans are available on concessional terms for providing an essential support system.
- (iii) Land and other infrastructure: It is imperative that land and other infrastructure be provided at suitable terms for operating solid waste management systems.
- (iv) Institutional and Management Aspects: Proper distribution and delegation of work and responsibilities backed by detailed planning are important for SWM system. Integration of different endeavours would necessitate a coordinator, possibly the local body under whose umbrella different agencies (NGO, CBO, private entrepreneur etc.) may carry out their work. Public participation is crucial for the success of these programmes. As such, public participation should be made an integral part of the institutional mechanism. Efficient management and effective management information services are essential for successful imple-



mentation. Therefore training and HRD components have necessarily to be included.

- (v) Policy and Regulatory Measures: In the absence of a consistent and detailed policy statement/document on solid waste management, decision making becomes difficult and cumbersome and may even lead to inappropriate decisions. This need becomes more accentuated when a number of 'best practices' are considered for application. Their relative merits, scope and benefits of integration must be brought out clearly in a policy document.

Existing regulatory measures, such as the municipal acts are not adequate to handle the complex and constrained present day urban scenario. Suitable amendments and supplements may have to be incorporated in these acts in consonance with the Environment Protection Act, 1986 and considering the obligatory functions of the local bodies as well as the mandatory regulations for the public.

- (vi) All out effort must be made to generate public awareness because this is the best guarantee for the involvement and active participation of the public which is the key to the success of the system.

Under the 'BPMC ACT 1949 Chapter XVIII Sanitary Provisions': Scavenging and Cleansing is an obligatory function for the local body. The Delhi Municipal Corporation Act of 1957 has similar obligatory functions (Chapter XVII). For nearly four decades now, this service is being looked after by the Municipal Corporations. Therefore, only they can play a major rôle in the upliftment of the Solid Waste Management situation in the city, by acting as promoters, coordinators and resource persons. All alterations, amendments or gearing up that need to be done for system betterment, can be categorized under five distinct headings as follows :

- 1) Strengthening the institutional framework
- 2) Develop appropriate technical and managerial guidance material for SWM through research and documentation
- 3) Promote public-private partnership
- 4) Give health education to residents, ragpickers as well as government staff
- 5) Promote community based practices and public participation

(B) Strengthening the institutional framework

- 1) First and foremost, as the BPMC Act states, refuse should not be considered as the sole responsibility

and property of the local body. Those who create the garbage should also be made equally responsible for it and accordingly amendments to the law should be carried out.

- 2) There is no dearth of innovative ideas for any system. New equipments, processes and technologies are constantly being marketed and SWM is no exception. Municipal personnel need training so that they can accept new ideas, can operate new equipments and are kept abreast of latest happenings.
- 3) The local body staff lacks conviction and interest at the lower level. So even if the work is approved by higher authorities, it still does not get done by the next rung of staff. If there is close monitoring, compulsory feedback, incentives or competition, work efficiency would increase.
- 4) The responsibilities should be clearly demarcated without overlapping of work zones or authorities. For instance in most of the SWM departments, the conservancy staff is under dual control of Chief Engineer who provides technical supervision and the Ward Officer who exercises the administrative control, with the ward officer reporting directly to Dy. Municipal Commissioner. This creates administrative problems, delaying decisions including those affecting the outsiders.
- 5) The ragpickers can be given recognition and licences for working in specific areas so that even the residents can identify with them.

DEVELOP APPROPRIATE TECHNICAL AND MANAGERIAL GUIDANCE FOR SWM THROUGH RESEARCH AND DOCUMENTATION

- 1) A detailed survey of the city to find out the type and quantity of garbage produced at different collection points needs to be done. Depending on this, the work norms for the staff, vehicles and private contractors should be rationalized. Strict monitoring of collection time, transportation vehicles and their optimum utilization should be done.
- 2) National, State and Local level information centres should be initiated for reference and coordination.

PROMOTE PUBLIC-PRIVATE PARTNERSHIP

Many new agencies, environmental engineering companies and other private entrepreneurs are coming forward to put up solid waste processing projects or collection and transportation networks in the cities. The Municipal Corporations need to analyse them through experts and then choose the most feasible one. But this decision should not take very long. In



addition, there are some organizations which work for public awareness or in backward areas.

All these agencies require help and cooperation from the local body which could be provided in the following way :

- 1) In order that work on private projects starts on time, quick clearance of papers from the municipality is required.
- 2) In order to prevent encroachment it should be mandatory on the Corporation to produce fencing and boundary for the dumpyard.
- 3) Land for the SWM project plant should be given at minimal rent lease.
- 4) Road to the project site could be made by the local body as it is a very costly proposition for private entrepreneurs.
- 5) Garbage should be given free or at minimal cost by the local body to the private waste processing projects. In some countries, the local body actually pays those private bodies who help process the waste.
- 6) Some grant-in-aid or capital subsidy shall be useful to smaller private entrepreneurs.
- 7) Water and power should be made available. Subsidized electricity could be given.
- 8) Municipal Corporation could pay the conversion charges (because of value addition of the solid waste).
- 9) Incentives from Municipal Corporation are essential.

GIVE HEALTH EDUCATION TO RESIDENTS, RAGPICKERS AS WELL AS GOVERNMENT STAFF

Training of residents and ragpickers in health education can be done by non-governmental organisations with the help of the local body. Government staff can be educated by formal training institutions through workshops and skill upgradation programmes. Other awareness creation activities should be suitably devised through media, door-to-door canvassing, pamphlets, street plays, and so on.

PROMOTE COMMUNITY BASED PRACTICES AND PUBLIC PARTICIPATION

- 1) Any citizen who litters or spits on the streets or any public place should be fined heavily on the spot. But this shall require equally adequate waste collection facility to match the efforts.
- 2) Though house-to-house collection system is not prev-

alent in all cities, the local body should make it compulsory for every household to deposit segregated garbage at the collection points.

- 3) A dustbin place and a composting corner can be made compulsory in the building bye-laws.
- 4) It is every environmental body's moral responsibility to promote and work for public awareness even if their field of work is waste transportation or processing.
- 5) Various bodies are operating towards the same cause or are using similar technologies, but some are working voluntarily while others are working commercially. Hence, there is not much co ordination between them. It is imperative that all these bodies coordinate their activities and keep each other informed about their operations. Only then can very large number of households be reached within shorter time.

CAPACITY BUILDING FOR INSTITUTIONAL STRENGTHENING

It is evident that a variety of institutions are engaged in SWM. What is required is their stock taking and defining a coordinated mechanism for implementation to achieve the desired result. All the actors involved need training and strengthening of the system of solid waste management.

The following points are important for capacity building and institutional strengthening:

- (a) Necessary technical assistance and guidance from central/state Governments;
- (b) political will and commitment;
- (c) city/town level short (say 5 years) and long (say 20 years) term master plans to be developed and implemented;
- (d) for larger towns/cities, separate SWM Department may be established for better coordination of all these "best practices";
- (e) HRD and training - involving the local bodies as well as the other agencies involved; and
- (f) MIS (Management Information System) based on proper database for planning, execution as well as operation and maintenance.

At the outset, it may appear that the multi-agency involvement may lead to confusion and inefficiency. But with proper coordination, it should be possible to consolidate these endeavours.



1) THE AGENCY

All voluntary organisations working at the small local level can be given information and training in various disposal methods which they can utilise and even teach the ragpickers so that programmes can be implemented with maximum reliability of results.

2) THE RAGPICKERS

Ragpickers need to be taught discipline, punctuality and regularity, and have to be given health education and monetary help. In some of the cities, they are a part of some union and these unions can be taken into confidence to reach the ragpickers. They should also be taught the importance of saving, education, health and hygiene.

If these ragpickers are trained in disposal techniques, garbage can be taken care of locally.

3) RESIDENTS

Public in general needs civic discipline and lessons on not to litter the streets and public places and on the importance of segregating their garbage at source.

Segregation at source can increase the disposal or processing efficiency of garbage by almost 20 percent.

4) LOCAL BODY

Many new equipments are bought and latest or new technologies are adopted by the local bodies, but they lie unused as the local body staff does not know how to operate them.

There are always invariably small things that need to be changed, a little change of habits and a little sincerity. However, the small contribution is required from everyone.



HAZARDOUS HOSPITAL WASTE GENERATION IN BOMBAY

HOSPITAL	VOLUME/DAY	INCINERATOR	NO OF BEDS
1) Cama	10 kg	No	400
2) Bhatia	40 kg	No	250
3) Masina	1 ton	No	244
4) Bombay Hospital	1 truck	No	800
5) Wadia	-	No	-
6) J.J.Hospital	40 kg	Yes	1000
7) Breach Candy	10 kg	No	174
8) K.E.M.	1500 Kg	No	1850
9) INHS Ashvini	600 kg	Yes	825
10) Nair Hospital	600 kg	No	1350
11) S.T.Georges	15 kg	No	467
12) Bhabha Hospital	125 kg	No	400
13) Jaslok	25 kg	Yes	-

Source: Bombay Study Report.



DEMOGRAPHIC DATA FOR THE SIX CITIES

Cities	Ahmedabad	Bangalore (incl. BDA area)	Bombay	Madras	Pune	Rajkot
State	Gujarat	Karnataka	Maharashtra	Tamil Nadu	Maharashtra	Gujarat
Estimated Population 1991 (in lakh)	28.77	40.08	99.0	56.8	24.4	6.09
Area Sq.Km.	190.84	151.16	413.3	174	146	69.25
Estimated Slum Population (%)	60%	-	60%	66%	40%	15%
No. of adm/election wards	5 zones	-	23	10 zones	111 election wards	-

Source: Six city-based studies



DETAILS OF SOLID WASTE MANAGEMENT IN SIX CITIES

Description	Ahmedabad	Bangalore	Bombay	Madras	Pune	Rajkot
Total Waste Generated (TPD)	1683	2130	5800	2675	1000	250
Total Waste Collected (TPD)	1500	1800	500	2140	700	220
Total Budgetary Exp. for C ¹ /T ² (in Rs. million)	-	350	1500	400	2.0 (for Disposal)	-
Per ton Exp. for Collection, Transportation	-	Rs.480/ton	Rs.62/ton (for C only)	-	-	-
No. of Workers for Collection i.e n /1000 Population	-	6671 + 1740 hired	22,128	7,500	947	-
No. of Total SWM Staff	-	-	26,239	7,957	-	-
Municipal Vehicles	-	100	161 trips		29 tippers 15 dumpers 5(3T) tippers	-
Contractors Lorries	-	120	389 trips	500 (5T) tippers 100 (3,2,1T) mini lorries 250 (1T) bullock carts	20 road masters	-
Debris Vehicles	-	-	418 trips	-	-	-
Total Lorries/ Trips /Transp. Capacity	-	220	968	(500+100) = 600/850, (8 X 850)	69	-
No. of Dumping sites	6 land fill sites	No official site	4	2	2	-
Total area of dumping sites	-	Done along roads	-	169.9 ha	443 ha	30 ha

¹ Collection² Transportation

Source : The six city based studies.



BIBLIOGRAPHY

1. Bakshi Rajani; "Environment Friendly Earthworm Surfaces", November 27, 1994. The Hindu, Madras.
2. Bhawalkar Uday; "Turning Garbage into Gold: An Introduction to Vermiculture Biotechnology", Bhavalkar Earthworm Research Institute, Pune.
3. Center for Environmental Education, Bangalore, "Monograph on Solid Waste Management", 1994. Manohar Publishers & Distributors, New Delhi.
4. Chakravorty Aruna; "A Squatters Spot in Slum Colony Blooms on Vermiculture", December 9, 1994, Indian Express, Bombay.
5. C.S. Rao "Environmental Pollution Control Engineering", Wiley Eastern Limited, New Delhi.
6. Deshpande P.A.; "Garbage Disposal: Is it Really a Problem?", June 1991, PECR Foundation USW, Pune.
7. Discussion papers of workshop on "Linkages in Urban Solid Waste Management", Karnataka State Council for Science & Technology, 1994, Bangalore.
8. "Educational and Other Developmental Activities for Adult and Child Wastepickers: A Brief Report 1994-95", S.N.D.T. Women's University, Department of Adult and Continuing Education, Pune Subcentre.
9. Express News Service; "Civic Chief Convenes Meet on Garbage Recycling Project", Indian Express.
10. Fernandes Derlene ; "Fields of Dreams", Article on 'Vasundhara', Bombay.
11. Gadkari Shubha; "Pune: Awareness Makes a Difference", The Hindu Survey of Environment, 1995, Madras.
12. George Tchobanoglous, Hilary Theisen & Folf Elisassen; "Solid Waste -Engineering Principles and Management Issues", McGraw-hill Book Company, New York.
13. Government of India, Ministry of Urban Development and United Nations Development Programme (UNDP)/ World Bank Water and Sanitation Programme, "Community Based Solid Waste Management Project Preparation - Panaji Case Study", December 1993, New Delhi.
14. Huysman M, Isa Baud & Hans Schenk; "New Approaches to Urban Solid Waste Management: linkages between formal and informal systems of source separation, collection and recycling in Indian cities", Oct 1994, Research Report, University of Amsterdam, The Netherlands.
15. Huysman M & Isa Baud; "Solid Waste Recovery, Re-use and Recycling: Formal and Informal Aspects of Production and Employment in Indian Cities", Solid Waste Management - Modes, Assessments, Appraisals and Linkages in Bangalore, 1994, New Delhi.
16. Huysman M; "The Position of Waste Pickers in Solid Waste Management in Bangalore", Solid Waste Management - Modes, Assessments, Appraisals and Linkages in Bangalore, 1994, New Delhi.
17. H.V.N. Rao; "Health of the Metropolis - Bangalore", Indian Society of Health Administrators, 1989, Bangalore, a study of management of solid waste in Bangalore city, Bangalore.
18. Indian Express, "Vasundhara's 10 year 'green' mission", December 8, 1994 Bombay (ed).
19. Isa Baud & Hans Schenk; "Solid Waste Management - Modes, Assessments, Appraisals and Linkages in Bangalore", 1994, New Delhi.
20. Joshi Sharmila; "Bombay : The City of Waste" The Hindu Survey of the Environment, 1995, Madras.
21. Maheshwari Shivani; "Little Things That Count", The Forum for Environmental Concerns, plan for recycling paper, Bombay.
22. Narayan Manjula; "Garbage to Gold", Midday, January 25, 1995, Bombay.
23. N Suresh; "Mounting plastic content in solid waste causes concern" April 11, 1994, The Times of India, Bombay (ed).
24. Prabhu Uma; "Citizen's groups wield the broom", November 25, 1994, The Times of India, Bombay.
25. Prasad Ravindranath; "Clearing the Air" February 13-26, 1995, Business India, Bombay.
26. Saraf R.V.; "Biogas Generation from the Hotel Waste", June 1991, PECR Foundation, USW, Bombay.
27. Shiv Kumar and Unnathan Sandeep," Earthworms find new jobs as conservancy workers" Indian Express, Bombay (ed).
28. Shrikhande Snehlara and Bhadkamkar Mangala; "Getting Rid of Hospital Waste", July 11., 1990, Indian Express, Bombay (ed).
29. S. Sham; "Garbage Conversion Project Needed", July 19, 1995, The Times of India, Pune (ed).
30. Staff Reporter; "Dua Assures Incinerators at 2 Hospitals", August 18, Indian Express, Bombay (ed).
31. "Standing Committee's Perversity Deplorable", on Pune Standing committee's decision to shift the Western Paques plant, Pune.



32. Swaminathan S. Ankleswaria Aiyar; "Don't Ruin India's Soil," April 23, 1995, The Sunday Times of India, Bombay (ed).
33. The Hindu Survey of the Environment, 1991, The Hindu Madras.
34. The Hindu Survey of the Environment, 1994, The Hindu Madras.
35. The Hindu Survey of the Environment, 1994, The Hindu, Madras.
36. Timmy Katyal & M. Satake; "Environmental Pollution", Anmol Publications, New Delhi.
37. Tinaikar S.S; "What a Waste" June 15, 1995, Midday.
38. Vallury Santosh; "Bombay's COS", April 2-8, 1995, The Bombay Tribune, Bombay.
39. Warrior Tara; "Once Upon a Garbage Dump", Femina, February 7, 1981, Bombay.





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