IMPROVEMENT OF SOLID WASTE MANAGEMENT UNIT AT PERADENIYA THROUGH PARTICIPATORY APPROACH

BY
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Thesis submitted in partial fulfillment of
the requirement for the degree of
Bachelor of Science

In
Natural Resources

February 2002

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Buttala
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Declaration

The work described in this thesis was carried out by me at the University of Peradeniya, and Faculty of Applied Sciences under the supervision of Dr. B.F.A. Basnayaka and Dr. R. Chandrajith. A report on this has not been submitted to any other university for another degree.

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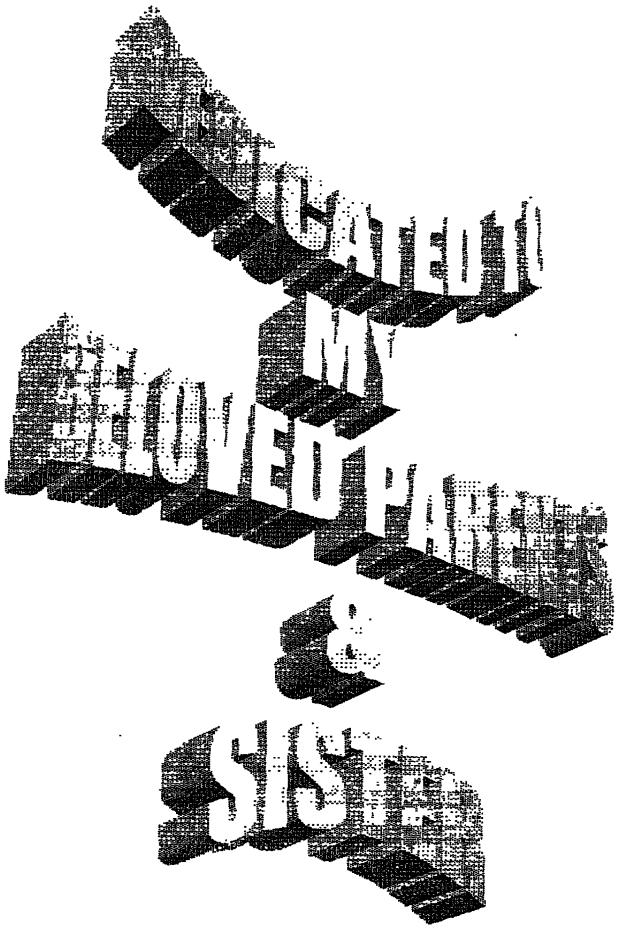
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ACKNOWLEDGEMENT

I owe my deepest gratitude to my external supervisor, Dr. B.F.A Basnayake, Senior Lecturer, Department of Agriculture Engineering, University of Peradeniya, SriLanka, for his excellent guidance, encouragement, advice and supervision throughout my study.

I wish to express my sincere gratitude to Dr. Rohan Chandrajith Lecturer, Department of Natural Resources, Faculty of Applied sciences, Sabaragamuwa University of SriLanka for his supervision and the guidance as the internal supervisor of my study.

I acknowledge with my deepest sense of gratitude to Dr. K.K.D.S Ranaweera, the Dean of the faculty of Applied Sciences, Mr. Jagath Wansapala, course coordinator of Degree programme in Food science and technology, Mr. K.P.L Nishantha, course coordinator of Degree programme in Natural Resources, Miss. Enoka Kudawidanage, Lecturer, Department of Natural Resources, Sabaragamuwa University of SriLanka for all the arrangements made through out my study period.

I wish to express my sincere gratitude to Dr. Jayatissa Head of the Department of the Agriculture engineering, University of Peradeniya for giving permission to use the facilities in the Department of the Agriculture engineering.

Further, my sincere appreciation is extended to Ms. Nilanthi Bandara, senior Lecture, University of SriJayawardanapura, and Professor R.O. Thatil, Professor of crop science, University of Peradeniya for the encouragement given to carry out this project as external resource personals.

Also I express my gratitude to the members of the Hantana conservation,the members of the solid waste Management Research Unit at Peradeniya, Miss Senani Perera, senior student, Faculty of Applied sciences and Ms. Gunawardana, Retired English teacher for giving me numerous help to make this study a success.

I am grateful to secretaries, chairmen and environmental officers of the Pradeshiya sabahs (Udunuwera, Yatinuwera, Gangawata) for me secondary datas and suggestion all the minor staff members of Department of Agricultural Engineering, University of Peradeniya, SriLanka, for giving me numerous help to make this study a success.

Finally my heartfelt thanks are extended to all my colleagues for arranging a good working environment to conduct this study.

ABSTRACT

Urban waste is a rapidly arising problem in many countries including Sri Lanka. It has become a critical environmental concern particularly in the more urbanized areas. With growing quantities of waste materials, caused by changing consumption patterns, the volume of the solid waste has exceeded the present capacity for adequate and effective waste management. The Inclined, Step Grate (ISG) composting unit developed by the Department of Agricultural Engineering, University of Peradeniya, is specially designed to treat urban waste and produce compost for the agricultural sector of the country. The plant is designed to operate under minimum pre-sorting. Therefore the produced compost is contaminated with various kinds of materials found in urban waste, and the effectiveness of compost making process is reduced by 25%. Appropriate sorting procedure will create ideal condition for composting process in the developed units. Therefore the aim of the study was to develop suitable methodologies for participatory approach in source separation of urban waste leading to improved quality compost.

This study was carried out within three Pradeshiya Sabahs (Udunuwera, Yatinuwera, Gangawata Koralaya). Secondary data such as disposal practices of local authorities, availability of resources, number of locations, disposal practices of generators, systems of collection of the existing system were gathered within the study area. Waste composition identification was done and awareness programme was launched. A questionnaire was prepared for conducting a survey. The system of management and commitments of the local authorities were collected to develop a suitable methodology for participatory approach and to motivate and create enthusiasm.

According to the public views, local authorities are not doing their duty as expected. There is no regular supervision of the waste collecting system. Local authorities have limited resources to conduct the programme well. Main problem for this unsatisfactory system is due to the poor linkage between public and local authorities. Public always expect financial incentives, consider source separation a burden, and think that the local authorities should clean up the waste that they generate. Without getting rid of the ideas, providing financial incentives and regular supervision of local authorities, participatory approach will not help in the source separation programme, since the statistical analysis of the questionnaire did not show a significant difference between before and after introducing the programme. As a suitable method for reducing solid waste, composting can be done without any contamination problem by introducing source separation through participatory approach.

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CHAPTER I

INTRODUCTION

Most Asian countries are faced with rapid urbanization and urban population growth. These reasons have caused an increase in the amount of solid waste generation. Sometime ago the country had been identified to be a basically non-spoilt (i.e. not polluted) island paradise. Such statements are no longer valid today with gross environmental abuse to be witnessed in many instances. Today, Sri Lanka is experiencing the problems due mainly to mounting "solid waste" and mismanagement. This situation had been brought about by

1. Better and improving standards of living.
2. Growth of consumerism (throw away habitats)
3. Population growth
4. Increasing presence of substances in the municipal waste stream, which are difficult to degrade/ break down.
5. Increasing industrial activities.
6. People's poor participation in funding solution.

The current population in Sri Lanka is close to 20 million of which 72 percent is rural. Rural areas of the country produce little amount of waste and it mainly consists of bio- degradable. By contrast the urban areas are densely populated and generate larger quantities of waste, which contains a higher quantity of non- biodegradable components. Growing solid waste problem impose pressure on individual local authorities who are responsible for the management of waste.

Table 1: Solid Waste Quantities of Local Authorities

Local Authority	Number	Per capita waste generation per day (kg/day)
Municipal council	12	0.65-0.85
Urban council	37	0.45-0.65
Pradeshiya sabah	255	0.20-0.45

Sources: (a) MOFE (1999) and (b) adapted from ERM (1997)

Due to waste accumulation, Degradation of the quality of water, Land, Biodiversity and Public health occur. There are many options available for the management of solid waste such as direct dumping on approved sites, sanitary land filling, dumping in sea, incineration and direct or indirect recycling. As an agricultural based country Sri Lanka can use direct or indirect recycling methods, specially making compost.

Waste from residential and commercial sources is mainly organic in nature. A municipal solid waste characterization survey, conducted in 1993 by the secretariat for Infrastructure Development and Investment, projections for waste collection amounts have been carried out for the year 2001 to 2010. The projections are based on current waste collection rates and growth rate of 1.2 percent.

Table 2: Projections for Quantity Of Waste Collected In Sri Lanka

Year	*Projected quantity of waste collected (Tonnes per day)*
2000	2560
2005	2720
2010	2885

Like in other countries, Sri Lanka also faces immense problems in managing urban solid wastes. Landfill and incineration have until now been the most widely used means of solid waste disposal methods, but in recent years interest has grown in disposal methods which take recycling into consideration. One of the most successful systems used in many countries is the

transformation of biodegradable organic material from various sources into humic substances known as compost.

Composting of wastes at household level has been piloted in many local authorities by the introduction of composting barrels/ bins either by the Local Authority or NGO's. Centralized composting projects have been initiated in a few local authorities.

There are many opportunities in resources recovery. The organic fraction of our waste is about 70-80% and this can be exploited profitably. There should be a strong communication program. It is quite important to increase awareness among the general public, as they are at present more or less unaware of the issues and options available. It is necessary to carry out awareness programs in order to minimize waste generation at source.

According to the Forestry and Environmental ministry 1170 Tonnes of waste collected from Colombo and it contains 50 Tonnes of plastics (Central Environmental Authority, 2000) . Value of these plastics is nearly five hundred thousand rupees. According to the environment and technical engineer of SWAC institution, there is necessity to remove the waste after sorting it into various components.

By considering the above factors mainly time duration and the need for continuous operations, a new compost making system was developed at the Department of Agriculture Engineering, University of Peradeniya. This system can produce sanitized decomposed product, which is used as a soil conditioner with certain fertilizer properties.

1.1. OBJECTIVES

The specific objectives of this project are:

1. Identifying the waste composition within three Pradeshiya Sabahs (Udunuwera, Yatinuwera, Gangawata Koralaya)
2. Development of methodologies for participatory approach in point source separation of urban solid waste.
3. Identification, Quantification and extend to which the developed methodologies are applicable.

CHAPTER II

LITERATURE REVIEW

2.0 Literature Review

2.1 Resources Recovery From Solid Waste

Resources recovery is essentially a two-phase process: the extraction phase and the utilization phase. In the initial phase, separation of that portion of the waste stream can be re-used or recycled through material and energy conversion is accomplishes. The second phase is the actual phase in which utilization of waste is obtained, depending upon the re-use or recycling options. (U.S. EPA, 1973)

Abert et al. (1974) divided potential materials into two groups (a) mechanical recovery and (b) conversion recovery materials. The first group refers to those materials, which may be re-used as relatively pure raw materials. The second group consists of the materials, which can be recovered only through some conversion process.

2.1.1 Initial Recovery

Initial recovery of materials may be obtained either through source separation or through mixed waste processing for material and energy recovery. This broad definition is presented conceptually in Fig. 1.

2.2 Source Separation

Source separation may be defined as the setting aside of recyclable waste materials at there point of generation for segregated collection and transport to the secondary materials dealer, or to specialized waste processing sites for recycling or final manufacturing markets (U.S. EPA, 1973). Transportation can be provided either by the waste generator, by city collection vehicles, by private haulers and scrap dealers, or by voluntary recycling or service organizations. In general, for developing countries, transport provided by city collection vehicles seems to be the most efficient option.

The primary aim of source separation is to segregate valuable items from the valueless fraction before they become part of the mixed waste stream. This obviates the need for extensive manual or mechanical separation and decontamination processes. Source separation is a complementary and vital step to facilitate the use of subsequent conversion process requiring advanced technology.

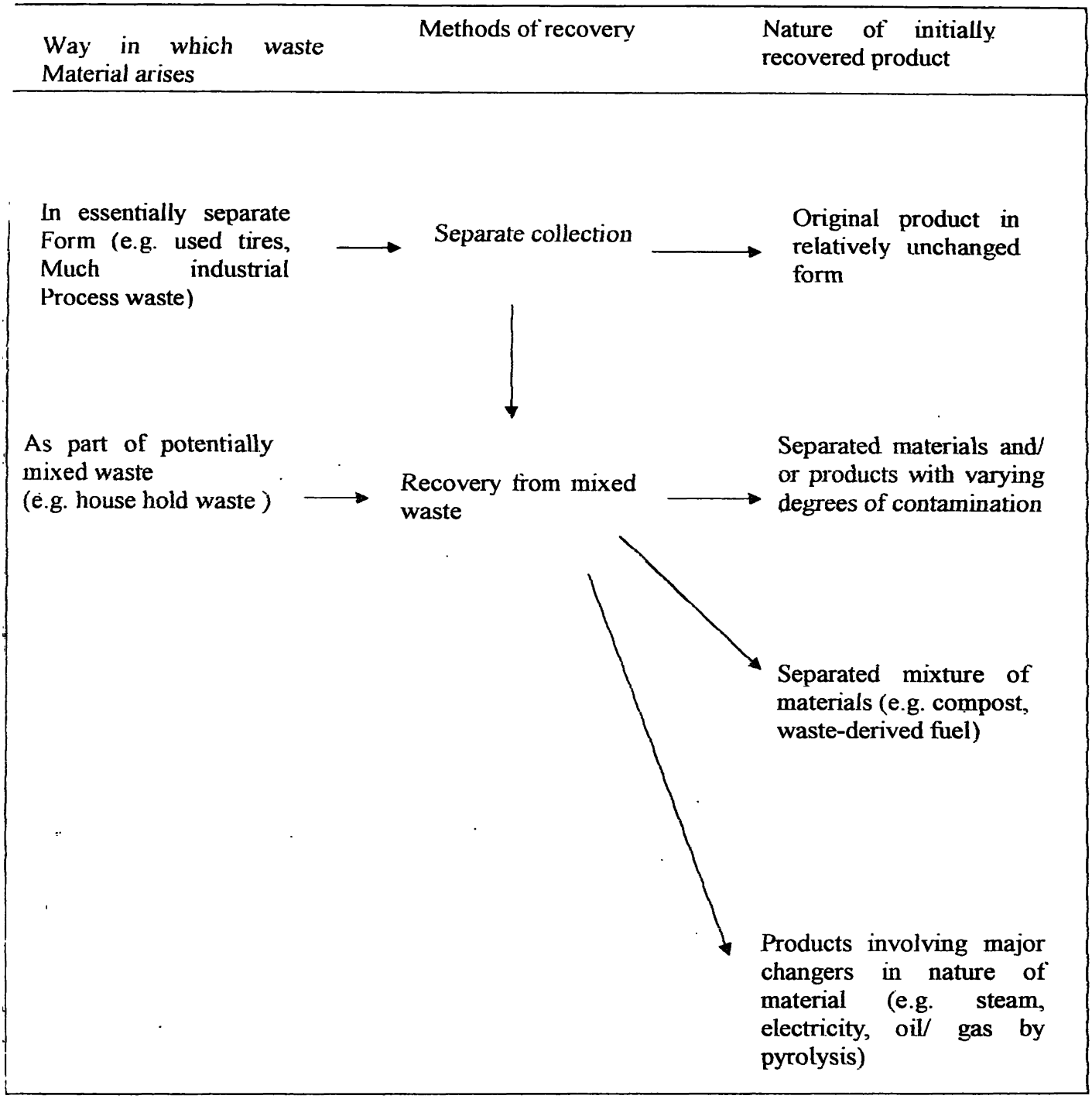


Fig. 1: Initial Recovery Methods and Nature of Initially Recovery Methods and Nature of Initially Recovered Product (Betts, 1978, Environmental Sanitation Reviews)

Source separation can be quickly put into effect and requires a relatively small capital expenditure. However, the success of this scheme depends on two critical factors (Betts, 1978; Willing, 1979, Environmental Sanitation Reviews):

a) The sustained cooperation of householders and
b) The existence of local markets for the reclaimed materials

With few exceptions, this practice does not occur, especially in urban areas, and strong incentives (moral, financial or legislative) would have to be applied to obtained sufficient sorting of a significant proportion of the waste (Baumool, 1977, Environmental Sanitation Reviews)

2.2.1. Source Separation Related Practices Of Other Countries

Gotoh I (1979) described the waste separation practice in Japan. In Numuzu, as well as in many cities in Japan, waste is broadly separated on cite into three kinds: combustibles, landfillables and recyclable. In this method, known as 'group recycling', a group of people representing a civic group or the like cooperate in separating and sorting materials at points of collection previously designated by the city authority. City collection crew then picks up the materials and the waste at the stations.

A more systematic system that was first introduced in Japan in 1969 is the 'Toshima method' (Sugito, 1982, Environmental Sanitation Reviews). First, civic groups consult with secondary materials dealers and plan a source separation program and announce it to the municipality. According to the program, the 'left over' waste is picked up by collection trucks for landfilling. At present, more than 204 municipalities in Japan practice some form of materials recovery from the collected waste stream. Table 3 indicates the amount of glass and metals actually recycled and the revenues accruable to the civic groups and gained by the city treasurer (Gotoh et al., 1979). The effect of recycling on the amount of waste to be land filled led to a reduction by 22%.

In the United states, a wide variety of waste products from households and commercial establishments are presently recycled, including glass and metal containers, automobile tires, large household appliances, etc. (U.S. EPA, 1973).

In Cairo, Egypt, the household waste collection and sorting for recovery of saleable components of the waste is entirely in private hands. This is administered by two hereditary occupational groups known as the Wahis, and Zarrabs (Kodis: et al, 1982)

In Istanbul, Turkey, the 'source separation' is practiced in the following ways (Curi & Kocasoy, 1982):

-Collectors specialized in the trade of one type of material do the sorting at the refuse respectacles. It is possible to see one person collecting papers, another plastics, another glass, etc.

-A considerable amount of solid wastes from commercial or residential areas is sorted at source and is sold to small merchants who operate sorting deports, or to street collectors. Paper, glass (bottles, etc) and metals (tin cans) are recovered in this way.

Composting source separated organic began in earnest in Maine back in the 1980s has been accelerating ever since. But while interest in recycling organic rapidly increased, three had been several public agencies dealing with composting information at different levels. (Richard K. Verville, 1994); To coordinate the various agencies, the University of Maine Cooperative Extension brought them together as a compost team in 1990 to do a demonstration project with the cities of Waterville and Winslow. The success of that program, where 2000 cubic yards of yard trimmings and leaves were composted on a local farm, brought many additional requests for assistance.

Over the past four years, the team's existence has allowed a step-by-step approach to problem solving. Negotiations also occur as meetings proceed, and duplicated efforts by agencies are avoided. For a demonstration project, various tasks can be assigned, a calendar of events developed and a coordinated approach to public relations made, benefiting every one involved. All this leads to a strengthened educational project demonstration.

Members of the Maine compost team vary with each demonstration project. There are five governmental agencies involved. The University of Maine Cooperative Extension is the team organizer and project coordinator, and is also charged with developing the educational aspect of and public relations for projects.

Table 3: Amount of Recycled Materials and Revenues in Namazy City, Japan

Month	Bottles , Glass cullet	Tin,Cans, other metals	Total amounts recycled (tons)	Part of revenues[1] returned to civic groups		Part of revenues[2] gained by the city treasurer	
				(Yens)	(US$)	(Yens)	(US$)
April, 1975	107	15.42	122.42	428500	1428	117160	390
May	115	20.62	135.62	469983	1567	184340	614
June	137	22.60	159.60	547252	1824	165640	552
July	130	22.22	152.22	561705	1872	112560	375
August	180	30.23	210.23	729375	2431	188070	627
September	150	27.96	177.96	625361	2085	157560	525
October	140	28.61	168.61	546543	1822	165280	551
November	135	29.5	164.50	509842	1699	118000	393
Total	1094	197.10	1291.16	4418561	14729	1208610	4027

2.2.2 Source Separation Related Practices in Sri Lanka

There are two approaches to solid waste management in Maharagama.The waste is either collected from the streets and dumped at Mirihana or it becomes part of the Pradeshiya Sabah integrated SWM projects which incorporates composting and recycling. It is estimated that 73 tones of waste are produce every day in Maharagama are about 43 tones of which is collected by the Pradeshiya Sabha.

The project started in 1998 and at present involves approximately 1600 households. Households are given four-coloured bag to separate their waste. The waste types separated are plastic and polythen, paper and cardboard, metal and coconut husk and glass. The bags are given to the households free of charge and generally people have been very willing to separate. The bags are collected twice a month and taken to store building to be further store. Some form

[1] This part of revenues corresponds to the sales of bottles and glass cullts.

[2] This part of revenues corresponds to the sales of all metal scraps including tin cans.

N: B Currency exchange rate of 1 US$ = 100 yens is assumed.

of waste cannot be recycled and so this is taken to the dump. The remainder is sold to private organizations. The paper is sold to the National Paper Corporation, the glass to the Ceylon Glass Company, the coconut husk and the plastic is stored until a suitable organization is able to recycle it. The money made from these sales is used to fund the coloured bags. The remaining waste is kitchen waste, which is ideal for composting. Some households bury this remainder but the PS also provides composting bins at a reduce rate of Rs. 525 to non-rate payers. At present about 700 bins have been distributed. At the initial stages of this project target groups were educated and leaflets distributed in order to arise awareness.

Ceylon Glass Company (CGS) prices for glass are Rs.3.50 per Kg for flint and Rs.3.00 per- Kg Amber glass. CGC used from 35% to 45% recycled glass production and could increase this to 60% if they were able to improve the collection system.

Some other local authorities through the intervention of NGOs have established collection points where residents are requested to bring recyclable materials for purchase at these centers. However, this method has not proved to be very effective. Low income groups extend their cooperation to these activities more readily than high income groups (Ministry of Forestry & Environment State of the Environment Sri Lanka pp. 48)

There are number of NGOs which attribute effectively to minimize solid waste in Sri Lanka today. Arthacharya foundation is one of them. Initially in Galle Arthacharya built up a partnership between stakeholders (private industries, Municipal council, World Bank, Arthacharya and Community base organization). The waste was separated by the household and composted by them. It has been very successful. The separated waste (not organic) is collected from each house then sorted until private sector companies collect it.

EMACE organization has launched a project to provide credit facilities to waste collectors who collect mainly paper, bottles, poly bags and empty containers to sell to middle level collectors. They provide small and medium polythene recycling plants, which can recycle 3-5 tons monthly. EMACE promotes household level composting barrels.

'Sevanatha" started by experimenting with the idea of composting barrels. Their pilot project was in Dabara Mawatha low-income settlement in Narahenpita. The barrels were given to 10 families. A project officer visited them everyday for two weeks and then every week for two

months. There has been a lot of demand for the barrels and extensive positive media coverage initiated by Sevanatha and also from out side parties. The families were encouraged to dispose of the remaining non-organic waste at the council collection points.

2.2.3. Mixed Waste Recovery System

Resource recovery from mixed municipal refuse involves the centralized processing of collected raw waste to separate out recyclable materials and to convert the remaining mixed fractions into useful materials or energy forms. Because of the heterogeneous nature of mixed refuse and the economics of recovery, virtually all such systems are designed as multiple product operations (American Public Works Association, 1966)

2.2.4. Waste Separation

Resource recovery and recycling of solid wastes is the broad subject under review in this process to be developed. Most economically recoverable materials such as metal, paper and glass are to be separated from waste. Depending on the place where separation takes place. There are two categories.

1. Separation at source
2. Centralized separation

The separation of solid waste components including waste paper, cardboard, aluminium cans, glass and plastic containers at the source of generation is one of the most positive and effective ways to achieve the recovery and reuse of the material. Once the waste component is separated, the question facing the homeowner is what to do with the wastes until they are collected or taken to a local buy back or recycling center. Some house owners store the separated components with in the home, periodically transferring the accumulated wastes to large containers used for the storage of these materials between collections. Other homeowners prefer to take separated waste components and place them directly in the containers used for the storage of these materials.

2.3. Utilization of Waste

There may be several options for waste utilization. Depending on the character and quantity of the waste, and on economic considerations and the technology available, any of the following options may be chosen:

-Re-use of useable items in household wastes and similar solid wastes, e.g. glass bottles, metal containers, etc.
-Direct application of the refuse on land.
-Recycling through materials recovery process
-Energy recoveries through thermal combustion refuse derived fuels, biogas, incineration, pyrolysis, etc
-Other chemical and biological processes

2.3.1. Direct Application of Refuse

Food waste contained in municipal refuse may be considered as a source for producing animal foods. In the areas of India and other developing countries, the feeding of cats, dogs and other animals on left over food is common.

It is worthwhile noting that in Italy, substantial amount of dried garbage derived animal feed are regularly marketed. In Norway, it has been recognized that the great amount of food in domestic waste represents a nutritional resource. Feeding experiments indicate the 2.5-3.0Kg of fresh food waste is equivalent to 1 fodder unit which correspondent to 1Kg of barley of good quality (Minsaas& Heie, 1980)(adapted by the thesis of Fernando, Dehiwattage Sandun Fernando)

To utilize the great potential of domestic waste as animal food, it is necessary to segregate it, collect it and process it. The segregation can be done in two ways, viz. At source in the household before it is mixed with the rest of the refuse, or in a central plant from mixed refuse. Direct feeding of food waste to pigs would be the simplest possible way of converting waste to feed. However, food waste for animals has to be examined carefully in the context of health problems due to the pathogen content in the waste. Processed and sterilized food waste may be used for feeding in liquid or dried form.

2.4. Waste is a Problem

Solid waste has become a growing problem in Sri Lanka. In the past, the focus was mostly on finding lands for the dumping of waste. With population increase and changes of life styles and composition patterns over the last few decades, both the quantum of waste and the proportion of non-biodegradable have escalated, making current disposal practices more problematic. These problems are extending gradually from the urban to rural areas as well. Storage, transport, treatment and final disposal facilities are grossly inadequate throughout the country.

According to the data collected in 1998 by the Ministry of Forestry and Environment, total waste collection by local authorities daily is about 2700 tones of which 54% is from the Western province, 44% from the Colombo district and 25% from the city of Colombo. In Kandy the generation of about 80 tones of domestic solid waste (DSW) per day and requiring a substantial expenditure to dispose has become a problem within Kandy municipal area. (Fernando et al Tropical Agriculture Research Vol.7, 1995).

2.4.1. The Definitions of Pollution and Wastes

Pollution can be define as follows:

Changes in quality of water, food, land and air, which affect the human health, comfort, aesthetic senses, efficiency, and capability of people to attain satisfactory social adjustments (Hanlett, 1979) (adapted by Basnayaka, B.F.A, 2000)

The term wastes refers to the materials, which are discarded by community activities to the environment, and includes solid, liquids and gasses (Barton, 1979) (adapted by Basnayaka, B.F.A. 2000). The definition of 'solid waste' encompasses all of those wastes, which are neither wastewater discharges nor atmospheric emissions. A so-called solid waste may therefore be a semi-solid, solid or even a liquid.

2.4.2. Reduce, Reuse, Recycle

Waste disposal sites are necessary if society is to function smoothly. However, no one wants to live near a waste disposal sites. The rise in public consciousness surrounding environmental problems and solutions associated with waste disposal has resulted in the development of new waste management strategies. The concept emerging today is known as integrated waste

management (IWM), which is best defined as a set of management alternatives including reuse, source reduction, recycling, composting, landfill and incineration.
The three Rs of IWM are reduce, reuse and recycle. The ultimate objective of the three Rs is to reduce the amount of urban and other waste that must be disposed of in landfills, incinerators or other waste management facilities.

Study of the waste stream is areas that utilize IWM technology suggests that by the year 2000 the weight of urban refuse disposed of in landfills or incinerated could be reduced by at least 50% and perhaps as much as 70%. A 50% reduction by weight of urban waste could be facilitated by:

- Better design of packaging to reduce waste, as element of source reduction (10% reduction)
- Establishment of recycling program (30% reduction) and
- Large scale composting programs (10% reduction)

Recycling is a major player in the reduction of the urban waste stream. The overall objective was to reduce the amount of waste requiring landfill by 60% by the year 1998.

In Berkeley, California, has set its recycling goal at 50%. Other large cities, including New York and Los Angelese, have initiated recycling programs and states such as New Jercy, Rhode Island and California have set recycling goals. Recycling is defined as the process for reusing materials, either direct or indirect manner or for energy (Flintof and Thomas, 1974). To recycle waste should be separated into homogeneous groups like metal, paper and glass. Therefore selective removal separation is essential when waste to be in recycled.

In practical terms the new paradigm promotes the 4R strategy of reduce, reuse, recover and recycle wastes to conserve resource and reduce the pollution by emulating, adopting and maximizing beneficial process of an ecosystem.

2.4.3. Impacts of Waste

- Impacts on land,

(+) Reduction in flood retention area due to a majority of the disposal sites being located in low-lying areas such as marshy lands and abandoned paddy lands.

(+) Reduction and pollution of wet land habitats.

(+) Aesthetic impairment.

- Impacts on water resources

(+) Pollution of ground water and surface water.

- Impacts on biodiversity

(+) Changes in ecological balance

- Impacts on air quality
- Impacts on health

(+) Insects/ mosquito breeding

(+) Health hazardous to workers and neighboring residents

(+) Nuisance caused to the neighborhood residents due to odor; flies and constant movement of refuse transporting vehicles delivering water to the site.

(Adapted by Basnayaka, B.F.A. 2000)

2.4.4. Sources of Solid Waste

Sources of solid waste in a community are, in general, related to land use and zoning. Although any number of source classifications can be developed, the following categories are useful:

1. Residential
2. Commercial
3. Institutional
4. Construction and demolition
5. Municipal services
6. Treatment plant sites
7. Industrial and
8. Agricultural

(Adapted by Basnayaka, B.F.A. 2000)

Table 4: Sources of Solid Waste Within a Community

Source	Typical facilities, activities, or locations where wastes are generated	Types of solid waste
Residential	Single family and multifamily detached dwellings, low-medium, and high-rise apartments, etc	Food waste, paper, cardboard, plastics, textiles, leather, yard waste, wood, glass, tin cans, aluminum, other metals, ashes, street leaves, special waste (including bulky items, consumer electronics, white goods, yard wastes collected separately, batteries, oil, and tires), household hazardous wastes
Commercial	Stores, restaurants, markets, office buildings, hotels, motels, print shops, service stations, auto repair shops, etc.	Paper, cardboard, plastics, wood, food waste, glass, metals, special waste, hazardous waste, etc.
Institutional	Schools, hospitals, prisons, governmental centers	As above in commercial
Construction and demolition	New construction sites, road repair/ renovation sites, razing of buildings, broken pavements	Wood, steel, concrete, dirt, etc.
Municipal services (excluding treatment facilities)	Street cleaning, landscaping, catch basin cleaning, parks and beaches, other recreational areas	Special wastes, rubbish, street sweepings, landscape and tree trimmings, catch basin debris, general waste from parks, beaches, and recreational areas
Treatment plant sites: municipal incinerators	Water, waste water, and industrial treatment processes, etc.	Treatment plant wastes, principally composed of residual sludge
Municipal solid waste	All of the above	All of the above
Industrial	Construction, fabrication, light and heavy manufacturing, refineries, chemical plants, power plants, demolitions, etc.	Industrial process waste, scrap materials, etc. Non industrial waste including food waste, rubbish, ashes, demolitions and construction wastes, special waste, hazardous wastes
Agricultural	Field and row crops, orchard, vineyards, dairies, feedlots, farms, etc.	Spoiled food waste, agricultural waste, rubbish, hazardous wastes

Sources: H.L.S. Tandon,Recycling of crop, animal, human and industrial wastes in Agriculture

2.4.5. Waste Composition

Waste composition is affected by many factors of which a population's standard of living and culture play main roles. Low-income countries have a high percentage of organic matter in their waste stream as opposed to high-income countries. The World Bank (1999) study quoted earlier has reported that the biodegradable matter in low-income countries ranges from 40 to 80%, where as in high-income countries ranges from 26 to 33%.

The % of paper and plastics in the waste streams of low-income countries is rather small compared to high-income countries. In low-income countries, the % of paper ranges from 4 to 11 and the percentage of plastics ranges from 2 to 8. On the other hand for high-income countries, the % of paper ranges from 9 to 16 (World Bank, 1999)

Hence, in literature it has been shown that not just living standards but the culture or lifestyles also play a role in the composition of municipal solid waste characteristics. The living standards of the individuals, the source of energy, social and religious habits and the extent of resource recovery operation practiced in a community are some factors found to affect waste composition. Understanding these issues is crucial to the development of an appropriate waste disposal plan for a community.

2.5. Solid Waste

There are two types of solid waste, namely:

1. Bio-degradable solid waste
2. Non-biodegradable solid waste

Basic physical and chemical processes can be applied to treat waste for either reuse or disposal purposes, but biological treatment such as compost making can only be applied to the biodegradable waste.

Physical treatments are the best methods because they require less time, low cost and can be easily conducted giving value added products. Liquid effluent and solid waste pollutants cause pollution of water bodies such as canals, lakes, rivers, estuaries and seas.

Second type of solid waste cannot be degraded by microorganisms. The wastes, which are considered not hazardous, are usually dumped on approved sites.

2.5.1. Available Techniques of managing Urban Solid Waste

- Direct dumping on approved sites, Non-hazardous material could be dumped on sites and later rehabilitated.
- Sanitary landfills: These require well design sites with minimum pollution of ground water with leachate treatment, flares or fuelling prime movers of electrical generators.
- Dumping in deep sea/ land reclamation from sea, which is now not advisable.
- Elimination by incineration: Particularly useful for eliminating hazardous wastes like hospital waste.
- Direct and indirect recycling

a. Physical methods of separation and recovery
1. Salvaging by mechanical means or
2. Selective removal by people

b. Chemical separation and conversion processes.
1. Chemical treatment to produce primary products
2. Formation of secondary products (solid)
3. Thermal conversion
    1. Incineration
    2. Pyrolysis
    3. Gasification
    4. Power generation

c. Microbial
    1. Composting
    2. Anaerobic digestion

d. Other uses
    1. animal feed
    2. road surfacing
    3. Roofing felt
    4. fertilizer

2.5.2. Cost Effectiveness of Various Techniques

Managing solid waste is one of the major problems in urban cities in developing countries. Solid waste can be disposed of with or without separating into wet and dry components. When it is disposed of without separation, direct dumping, sanitary land filling, or incineration can be carried out. When it is separated, dry component can be disposed of by direct dumping, incineration or by recycling and the wet component can be utilized to produce compost or biogas and fertilizer. Cost effective analysis was conducted within Kandy area to evaluate the cost of different methods as suggested above using secondary data. Findings reveal that the least cost methods are to produce compost from the wet part and to recycle the dry part. (S. Liyanage and J. Weerahewa, University of Peradeniya, 2001)

2.5.3. Importance of Recycling Waste

It is generally observed that the generation of waste increases two or three fold in urban areas parallel to their population growth. This becomes a difficult problem where there is a more rapid urban population growth as seen today. It is very significant that 09 out of the 15 cities with the largest populations (million cities) in the world are in Asia. (Jayasingha L.H., Director, CEA, 1997)

Everyone appreciates the beauty of the environment. But what is seen in the city environment today is a very sad spectacle. Heaps of discarded waste could be seen on the high ways, by ways, pavements and in every other place where there are people.

Mass media highlighted indiscriminate disposal of waste as one of the main reasons for the dengue epidemic last year. The increase in incidence of malaria, dengue and filariasis is a strong indicator of the degradation of the urban environmental situation. There were 300-500 million cases of malaria with two million deaths world wide in 1993. Similarly there were 23,000 deaths from dengue.

Urban waste is really a resource consisting of a number of raw materials. More common among these are paper, plastics, shopping bags and decaying organic and inorganic matter. The major part of these could be used as raw material for industrial processes.

43% of the paper produce in Germany is recycled paper. 40% of the waste in Hong Kong is used for the production fuel. The daily out put of waste in the city of Colombo is about 800 tones

(CEA, 1997). It is a very large reserve of raw material. The separation of various raw materials in the waste has to be done by us. For this purpose industrialists, consumers, planners and media should be given awareness.

2.6. Refuse Composting

Refuse composting as a method of disposal, with the added benefit of resources recovery, may surely be considered of great interest to many developing countries (Weber, 1982). This has been suggested the studies of various international organizations such as the World Bank, UNIDO and WHO. According to Ambrose (1982), the answer to recycling in developing countries could be the installation of composting plants. He even considers that composting has the greatest potential for recycling refuse in developing countries.

2.6.1. History of Refuse Composting

Refuse composting was practiced in ancient times in China and India, although on a small scale and without any technical aids. Over the last few decades, more sophistication has been installed in major plants for the recycling of refuse in towns and cities (Ambrose, 1982). Four major compost plants were installed in Bangkok in the early 1960's(economic viability questioned), a compost plant in Cairo was built in 1974, and in Rabat, Morocco, One plant was commissioned in 1961. Numerous plants have been installed in the Arab states; three major plants have been just completed in Libya. The World Bank/ U.S. EPA studies show that ' forced-aeration composting' (BARC method) is an attractive composting process which is appropriate for use in developing countries (as well as industrialized countries) which will achieve disinfections of pathogens as well as being affordable (Ludwig, 1984).

Regarding the refuse composting in Europe and America, Tarjan (1978) gave some statistics as follows: about 22% of the solid waste in Leningrad (Russia) is being converted to compost; the Swiss and Dutch are composting 15% of their refuse; Czechoslovakia, England and Germany compost 2 to 5% of their city waste.

2.6.2 Definition of Composting

This natural process gets accelerated if piling of organic material takes place. Gathering the material into heaps and promoting 'composting' which may be define as the decomposition of heterogeneous organic matter by a mixed microbial population in a moist, warm, aerobic environment (Gray and Biddlestone, 1974).

Many other definitions of composting can be found in the literature, varying in their focus, priorities and specificities. Two of them are given below,

a) Composting is the biological conversion of wastes materials, under controlled conditions, into hygienic, humus rich relatively; bios table product, which conditions soils and nourishes plants.

b) Composting is a controlled bio-oxidative process that involves a heterogeneous organic bios rate in the solid waste, evolves by passing through thermophilic phase and temporary release of phytotoxin and leads to production of carbon dioxide, water and stabilized organic matter.

2.6.3. Process of Composting

Composting is a traditionally- establish process of degradation or reduction of organic matter into a sanitary, nuisance free, humus like material, which can be used in several ways, e.g. as a soil conditioner, fertilizer, bulking agents for land reclamation cover material for landfills, etc. (NEB, 1982).

-the extraction of constituents of the waste, which could be undesirable in the compost. Some of these extracted constituents may be saleable.
-the use of methods and equipment, which facilitate decomposition of the organic content under, controlled conditions, so as to avoid risks to health or the environment.

2.6.4. Suitability of Refuse for Composting

Before considering a composting project it is necessary to carry out a physical analysis of the waste to judge their suitability for the process. According to the Weber (1982), all types of refuse having a composition similar to those given in Table 4* are readily compostable.

The dominant refuse components suitable for composting are organic kitchen wastes, organic garden wastes (except wood), paper and cardboard. Composting doesn't appear to be a viable option if these fractions add up to less than 30% of the waste mixture to be treated. (Goosmann 1979)

Table 4 *: Analysis of refuse from various countries

Areas investigated	Aver. Values var. cities in Iraq	Alg eria	Hong Kong	Abu Dha bi	Accr a	Taipei 1976	Cairo 1981	Suburb Sap Paulo Brazil
Constit.	Wt.%	Wt %	Wt%	Wt%	Wt%	Wt%	Wt%	Wt%
Veget.	68.6	72.0	46.2	22.5	87.1	39.7	43.8	46.9
Textiles	3.8	2.6	9.0	0.3	1.2	12.8	3.0	3.4
Paper/ carton	10.2	16.0	25.7	42.4	5.7	20.6	9.2	25.9
Straw	1.0	0.10		0.4		3.1	7.7	
Timber	1.1	1.0	2.5	2.9		1.0	2.5	1.9
Leather/rubbe r	1.8	1.2	0.3			1.0	0.9	1.5
Horns/bones	1.2	0.2	0.3	2.9			1.3	0.1
Plastics	2.1	2.5	8.1	6.3	1.3	4.0	2.0	4.3
Metals	2.3	2.5	1.9	14.1	2.6	2.5	3.0	4.2
Crockery	5.5	0.7	0.4	3.8	1.4	7.7	24.7	9.7
Glass	1.2	1.2	5.6	4.4	0.7	7.6	1.9	2.1
Total	100%	100 %	100%	100 %	100 %	100%	100%	100%
Moist. Cont. of crude refuse	58.5	60	44.7	30	50	60.7	30-40	62
Compostable portion	87.7	90.0	77.9	73.5	94.9	78.7	87.3	84.6

.2.6.5 Composting Principles and Methods

Principles and fundamentals of composting have been described and explained in a detailed and elaborate manner by a number of researchers,

e.g. Flint off (1976), Golueke (1972,1977, 1980), Gotaas (1956), Gray et al (1973), Haug (1980), Satriama (1974), Skitt (1977)(Environmental Sanitation Reviews)

Three bases of classification in composting are:
The degree of aeration, temperature and technology. The resulting classes are

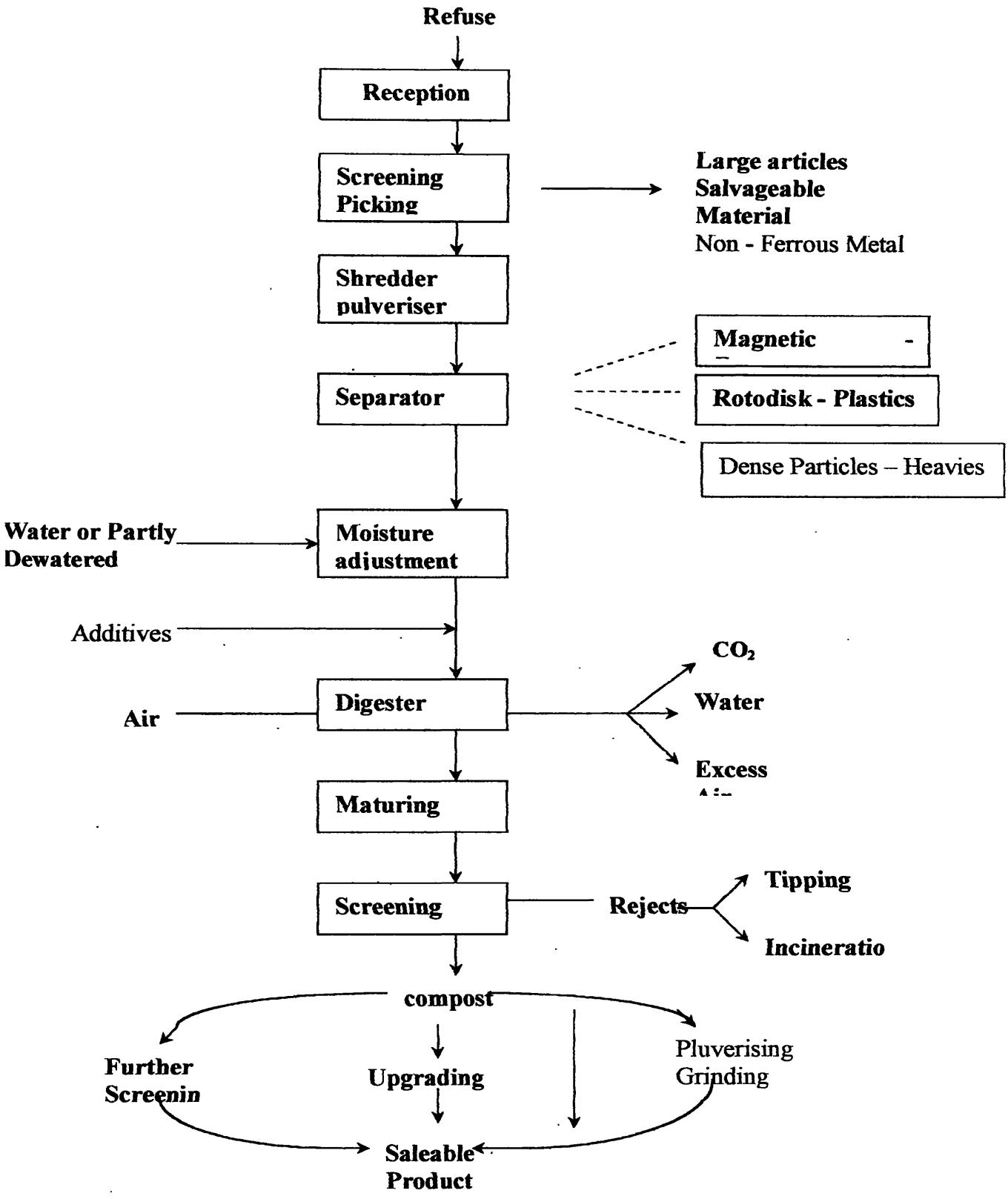
- Aerobic vs. anaerobic
- Mesophilic vs. thermophilic
- Mechanized vs. non mechanized systems (or closed vs. open, or mechanical vs. windrow system)

Composting is a biological process involving a number of organisms, mainly bacteria, fungi and actinomycetes. Two main groups of organisms, which decompose organic matter, are

- Anaerobic bacteria which perform their work in the absences of oxygen and
- Aerobic bacteria which require oxygen

In a practical sense, modern composting systems are a combination of the aerobic and anaerobic phases of the process. Even though the aim is to attain aerobic conditions in the inner portion of waste. Aerobic composting is much more rapid than anaerobic composting, due to high temperature, also it is safe for public health and crops due to pathogen destruction at high temperatures, foul odors are absent.

Fig. 2. : Typical Process Flow Diagram- composting Plant



2.6.6. Process Control

For controlled composting operations the parameters which need to be monitored are as C: N ratio, the moisture content, the bulking agent, the temperature, the particle size, the aeration, and the mixing and turning pattern of the process. For a reasonably accurate process design of composting plants, the values of the important parameters are summarized in Table 5 (Gray et al.)

Table5: Optimum Values of Major Composting Parameters

Parameter	Value
C/N ratio of feed	30-35:1
C/P ratio of feed	75-150:1
Particle size	0.5-1.5 in for agitated plants and forced aeration
Moisture content	50-60%
Air flow	10-30 ft^3 air/ day/lb volatile solids during thermophilic stage, being progressively decreased during cooling down and maturing
Maximum temperature	55c
Agitation	Shorts periods of vigorous agitation, alternating with vary in length from minutes in the thermophilic stage to hours during maturing
pH control	Normally none desirable

2.6.7. Compost Application and Results

Compost is brown, peaty material the main constituent of which is humus. It is added to soil, it aids in (Ambrose, 1982)

-the lightening of heavy soil

-improvement of the texture of light sandy soil

-increased water retention

-enlarging root systems of plants and

-making available additional plant nutrients

Refuse compost can be utilized for all sorts of crops in developing countries. Some countries practice compost applications as below (Weber, 1982):

-Northern Africa: fruits, vegetables, and parks
-Arabian Gulf: maize, vegetables
-Mexico: cereals, vegetables, parks, afforestation projects
-Brazil: coffee, vegetables

2.6.8. **Planning Considerations**

In planning a composting system and operation there are several factors, which must be taken into consideration. Flintoff (1976) stated five pre conditions for successful composting:

-Suitability of the wastes
-a market for the product;
-support from the government authorities
-a price for the product, which is acceptable to most farmers,
-a net disposal cost (plant costs minus income from scales), which can be sustained by the local authority

Weber (1982) postulated some boundary conditions to be fulfilled for the success of a composting project, these are

- An organized refuse collection system to ensure a regular delivery of materials,
- Training of plan t staff by experts, with particular emphasis on management, mechanical and electrical maintenance, process supervision and control and compost marketing
- Maintaining an adequate stocks of spare parts
- An adequate yearly operating budget, to be fixed and secured well in advance.
- A land fill for screening rejects to be located in the vicinity
- Considerations of the social aspects, the labour market, working conditions, etc.

According to Weber, the degree of fulfillment of these boundary conditions decides whether a composting project will be a success or a failure.

2.6.9. Economics of Composting

Weber (1982) stated that the essential cost items of a composting plant, such as processing, civil works, equipment, transportation etc, differ from project to project and location to location. Thus, the capital costs are not readily comparable. He further said that the civil works – 60%account for 40 of the total cost of the plant. According to him, the total cost for plants of 80t/ 8h to 400t/ 8h sizes should lie between US 4 35,000 and US $ 65,000 per tones capacity.

Goosman (1978) considered the cost of composting a rather complex subject. As a basis for rough estimation, he presented an example based on German conditions and reflecting recent cost levels. Investment and personnel costs for composting plants estimated in Germany are shown in Table 6 and 7. The lowest cost is for simple windrow systems.

Table 6: Investment Costs for Composting Plants in Germany (Goosmann, 1978, Environmental Sanitation Reviews)

Annual throughput (Tonnes)	Investment cost	
	DM per tonne per day	Million DM
15,000-20.000	250-330	3.8-6.6
35,000-40,000	200-290	7.0-11.6
75,000-80,000	170-255	12.7-20.4
>150,000	150-230	22.5-34.5

Table 7: Total Cost for composting and Manning Requirement in Germany (Gooosmann, 1978)

Annual throughput	Total cost DM per tonne of waste	Personnel required
15,000-20,000	55-85	6-9
35,000-40,000	45-70	9-13
75,000-80,000	35-60	13-19
>150,000	30-50	17-25

2.6.10. Prospects for the Future

Refuse composting is looked upon by many (NEB, 1982) an insufficient methods of recovering certain of the valuable materials contained in refuse, because refuse fractions with the highest material and/ or energy value (wood and hardboard, rubber and plastics, textiles and materials) are constituents which are either impossible or very difficult to compost. There fore these must be separated out otherwise they will detract from the quality of compost product.

Porteus (1977) pointed out the factors, which mitigate against the sale of compost as:
High C/N ratio, i.e. low fertilizer value, glass, metal or plastics present in refuse and so in the compost product, causing hazards to live stocks while grazing, and traces of heavy metal present in all compost products from domestic refuse (e.g. lead, zinc, cadmium) which have harmful effects on crops and cattle. List of hazardous waste given below.

Table8: Products and Potentially Hazardous Waste They Generate

Product We Use	Potentially Hazardous Waste
Leather	Heavy metals, organic solvents
Medicines	Organic solvents and residues, heavy metals (e.g. mercury& zinc)
Metals	Heavy metals, fluorides, cyanides, acid &alkaline cleaners, solvents, pigments, abrasives, plating salts, oils, phenols
Oil, gasoline and other petroleum products	Oil, phenols and other organic compounds, heavy metals, ammonia salts and acid
Paints	Heavy metals, pigments, solvents, organic residues
Pesticides	Organic chlorine compounds, organic phosphate compounds
Plastics	Organic chlorine compounds
Textiles	Heavy metals, dyes, organic chlorine compounds, solvents

Source: U.S Environmental Protection Agency, SW-826, 1980

2.6.11. Sources of Contamination of Compost

Batteries, consumer electronics, ceramics, light bulbs, house dust and paint chips lead foils such as wine bottle closures, used motor oils, plastics and some glass and inks can all introduce metal contaminants into the solid waste stream.

Batteries are a particularly significant source of metal contaminants. Even after 80% of lead-acid automobile batteries are recovered for recycling, the remaining 20% are estimated to contribute 66% of the lead in MSW in the U.S. house hold batteries account for approximately 90% of the mercury, though that level is projected to decline greatly as manufactures remove mercury from alkaline batteries. Nickel- Cadmium batteries may be responsible for up to 52% of the cadmium. Plastics are estimated to contribute approximately 305 of the cadmium as well as significant amount of nickel and lead. Metals in plastics and some other fractions of the MSW stream can be difficult to recover because they are as so widely dispersed.

2.6.12. Options for Reducing Contaminant Levels

While there are a wide Varity of possible approaches to reducing contaminant levels in MSW compost, most can be placed in one of five categories. This list can be viewed as a kind of hierarchy, with options at the top of the list having great potential to minimize contaminants than those lower down. All options except for the first can be implemented at the local level.

- Reduce or eliminate contaminant levels in products to become municipal solid waste (MSW).
- Separate clean organic materials at the source for separate collection and composting.
- Separate contaminants at the source for separate collection and proper disposal or processing.
- Separate contaminants from MSW at a centralized facility prior to composting.
- Separate contaminants from MSW compost at a centralized facility after composting.

2.7. Public Participation

Recent legislation and policy statements have often emphasized the need for greater community participation and dialogue between different stakeholders in order to reduce environmental conflicts. Achieving this objective however requires major shifts in attitude. Government agencies must be more flexible, accommodative and willing to work with local communities, to ensure true public participation. The local communities and community

organizations, on their part must become more motivated, better organized and more self-reliant. Truly meaningful public participation will take place only when the multiple stakeholders are involved in the planning, implementing, monitoring and evaluation of a development activity with full transparency and accountability on the part of all parties.

Encourage community participation in control of industrial pollution. Local communities can make a significant contribution towards control of industrial pollution. Community group can play and important role in conducting public awareness and education programs, carrying out surveys and research also assisting in the enforcement of environmental lows and regulations.

2.7.1. Creation of Public Awareness

The next major factor in public participation in environmental protection is the creation of general awareness of natural processes and their interrelatedness and of the consequences of human activity and development on the environment. In recent years the formal system of education has attempted to bring the massage across from the earliest stage of the school system. This approach has worked well in developed countries where civic awareness regarding the environment has now reached high levels; local authorities as well as government agencies don't carry out actions without the approval of the communities and groups concerned. In our country environmental awareness is still in its infancy. Yet, it needs to be realized that children and young people of today are going to be the policy makers and environmental managers of tomorrow. The problems that the next generation will have to face are enormous. Their solutions will require informed action and participation by all citizens.

The importance of the general understanding of environmental concerns is important if ordinary people are to play an effective role in environmental protection and sustainable development.

2.7.1.1. Public as Environmental Watch Dogs

The general public has to become the watchdog for the environment. This is so in developed countries at present. It has to become so in our countries as well. In EIA process, there is a section for public debates. The public opinion debate would be meaningless in the absence of public opinion that is well informed and balanced, that is able to make appropriate value judgments.

2.7.2. Participatory Approach for Improving Utilization of Resources

Resource—→ reused, recovered and recycled improved systems of management for mutual benefit.

Household economically viable cells of habitats and institutions group cells to form zones and lastly in contributing to provincial or local systems of management.

Can do one or several waste management systems' supplying containers, bioreactors, and collection direct or indirect methods of transportation to disposal sites or processing plants.

Quantity and generation rates depend on the levels of participation and income level of generators.

2.8. Responsibility of Local Authorities

Local authorities (Mc/Uc/Ps) are the first line of defense and the most effective point for action. Their plans should be properly drawn up and targets established. Proper zoning plans for all authorities are important in implementation.

The role of public authorities

- ☞ Setting up objectives related to environmental protection
- ☞ Establish and set in place a proper framework to facilitate the achievement of the objectives
- ☞ Monitoring the effectiveness and compliance

Local authorities are responsible for the collection and disposal of solid waste arising from the following sources

- Residential and commercial (including market waste)
- Hospital waste (clinical and non clinical)
- Industrial Waste
- Slaughter house waste and
- Drain clearings and street sweepings

(CEA, 2000)

Composting of waste at household level has been piloted in many local authorities by the introduction of composting barrels/ bins either by the LA or NGOs. Centralized composting

projects have been initiated in a few local authorities. The method widely used is windrow composting. Other methods such as vessel composting too are being tested on a pilot scale.

Table 9: Compost projects based on the Use of Municipal Solid Waste

Current	Local authority	Feed stock
150 compost bins	Colombo Mc	Kitchen/garden waste
150 compost bins	Dehiwala- Mt Lavinia Mc	Kitchen/garden waste
1500 barrels	Moratuwa Mc	Kitchen/garden waste
20 barrels	Kolonnawa Uc	Kitchen/garden waste
18 barrels	Jaela Uc	Kitchen/garden waste
30 barrels	Wattala Uc	Kitchen/garden waste
200 barrels	Maharagama Ps	Kitchen/garden waste
Centralized plant by a NGO	Kesbewa Ps	Market waste, animal gung and coir fiber
15 barrels	Mahara Ps	Kitchen/green waste
Centralized plants	Matale Mc	Market waste
	Ratnapura Mc	Market waste
	Balangoda Uc	Market waste

Source: Strategic overview of potential solution to the crisis of disposal of MSW in the Local authorities of the GCA, Western province Sri Lanka-1999

2.9. National Program for Solid Waste Management

There are no national programs for SWM at present. The reason primarily had been that, the national planner has not identified this issue of national significance. (Dr. Ajith P. de Alwis, 1998). The situation however, still need not be looked upon as a national issue as solid waste related environmental problems primarily results as result of urbanization, industrial growth with resultant population clusters with increasing population densities. Thus broadly the issue has been discussed primarily related to cities and semi-urban town centers and industries.

Where the industry sector is concerned a policy statement that was published recently is the National Industrial Pollution Management Policy statement- 1996 (Dr. Ajith P. De Alwis). This statement envisions an integrated approach to industrial pollution management embracing a number of alternative opportunities. The policy statement advocate the following principles,

Pollution prevention at source

Polluter payer principles

Incentives and enforcement

Community, private sector and government interaction

Waste disposal regulations under the public health act;

- Wastes must be placed in designated location.
- Municipalities have duty to ensure collection of waste

1. Fines for violators
2. Can set standards for emissions
3. Offence to pollute
4. EIA report format is prescribed

There is 'no policy' on solid waste management in Sri Lanka. There is certainly no implementation. Law to protect the environment is not implemented.

2.10. General Description about Meewathura Composting unit

Urban local authorities in Sri Lanka face immense problems in attempting to manage urban solid waste. Therefore it is high time that the national policy is formulated for upgrading and maintaining deteriorated cropping land by making use of compost produced from bio degradable urban solid wastes. An innovative cost effective composting technique has been developed and now it requires commercialization. It was decided to design and develop and engineering model specifically to determine some of the crucial parameters for the purpose of designing a commercial prototype.

The engineering model, which is situated at Meewathura, Peradeniya treats waste from small towns of Gelioya and Peradeniya. It is built to demonstrate the usefulness and efficiency of making compost since higher forms of organisms can be cultured inside the unit. The types of organisms as well as the rate of decomposition have been monitored. It has been found that the wastes are well stabilized and can be matured in less than four weeks after the initial treatment

inside the unit. One of the major advantages of this system is that the non- biodegradable wastes can be separated after the initial phase of composting. Weather conditions interrupted the regular operational system and it led to anaerobic conditions and leachate formation.

2.10.1. Specific Objectives of the pilot Project

- To demonstrate the usefulness and efficiency of a full scale inclined compost vessel (with chimneys)
- To assess improve and standardize the quality of compost by introducing and maintaining effective and useful organisms.
- To establish demonstration plots using the made compost from urban waste.
- To undertake market potential studies on the demand for compost and compost making equipment (with additional technologies for full scale compost making plants, including a feasibility study for a specific town)

2.10.2. Experimental Site

The windrow composting plant was constructed in University firm, Meewathura, Peradeniya. The average rainfall during the period was 252.2 mm/month. The daily mean temperature was 25.4c. The plant construction was commenced on 30th March 1997 and the completion was on 30th April 1998. Total expenditure was Rs. 3,016,562.52. The capacity of the vessel is 4 tonnes per day and nearly 1tonne of compost can be extracted as output. Biological studies revealed the absence of pathogenic bacteria due to optimum (high) temperature inside the vessel. It is joint project with the assistance of the Metropolitan Environmental Improvement Program (MEIP), urban development Authority (UDA) and private sector Company.

The waste undergoes biodegradation inside a bio- reactor (vessel) and rapidly become stabilized within 21 to 30 days. The retention time 30 days was chosen to optimize the process condition required for almost all the waste.

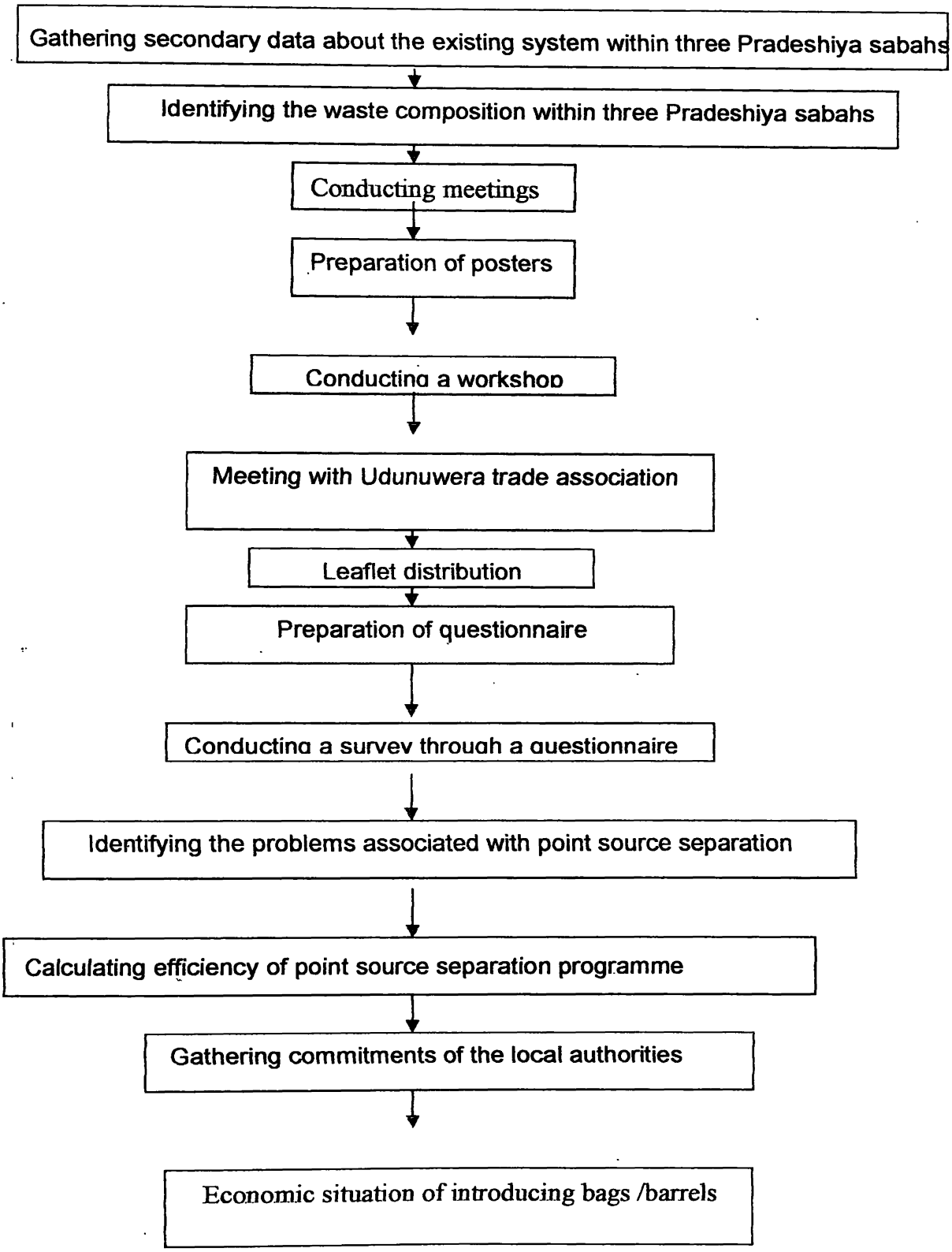
2.10.3. Market for Made Compost

It is apparent that there is a very high demand for compost in the plantation sector, particularly in tea. For the plant making compost also have a great demand in the private sector. According to the analysis of the compost by them, they have revealed that the compost is in good quality and free from contaminants. Pre sorting is good within the plant. Ten have been allotted to do it and 20 tones of compost have been made so far.

CHAPTER III

MATERIALS AND METHODS

Figure3: Flow diagram for the methodology of the study



Above flow diagram shows the materials and methods, which used for the study. All the steps were done within the given period at Peradeniya using available resources.

3.1.1 Gathering secondary data about the existing system within three Pradeshiya Sabahs

Secondary data were gathered by interviewing the environmental officers of the three Pradeshiya sabahs (Udunuwera, Yatinuwera, Gangawatta Koralaya). According to the project proposal following data were expected to collect

- Number of locations
- Specific quantities from different locations
- Types of storage and classification
- Disposal practices of generators
- System of collection and efficiency
- Disposal practices of local authorities
- Availability of resources

But some data could not be gathered due to lack of proper database in the Pradeshiya sabahs. Therefore data from other government agencies were collected. Locations which they collected waste, quantities of waste, availability of resources, disposal systems of waste, number of labourers and their salaries were collected. Maps of three Pradeshiya sabahs are attached in the Appendix 1.

3.1.2. Identifying the waste composition within three Pradeshiya sabahs

Each waste loads from each of the three Pradeshiya Sabhas were determined. The statistical technique of stratified sampling was employed for each selected load. The load was divided into three equal parts and each part was again sub- divided randomly into three. Then took one bucket from each of the three parts separately and separated the various waste components as possible like biodegradable (food waste), cardboard, polythene, papers, other waste materials like used king coconut shells, hard waste, hair, glass, plastic, tin, clay, porcelain, clothes, coconut shells and metal. Using a balance each component was weighed. Moisture content of waste also was analysed. Except for Udunuwera PS, the entire composition of a load was

analyzed for its composition. Proximate analysis for the combustible component of municipal solid waste includes the following test.

- Known sample of waste is heated to 105° C until it reaches a constant weight.

$$M (\%) = (W-d)/W \times 100$$

Where, M = moisture content %
W = initial weight of sample
d = weight of sample after drying at 105°C

3.1.3. Conducting meetings

Three meetings were held at the Department of Agricultural Engineering, University of Peradeniya. Local Authorities were made aware of the point source separation programme and discussions were held to obtain their ideas and suggestions. Several suggestions were put forwarded by them and discussions were centered on what kind of information that should be included in the leaflets.

3.1.4. Preparation of Posters

The Hantana Conservation Society prepared posters illustrating clearly the message. For each Prädeshiya Sabha 10 posters were drawn and 3 posters were in Tamil language. These posters were prepared to display in public places to inform about the proposed programme.

3.1.5. Conducting a workshop

A workshop was held on 11-10-01. The Chairman of Udunuwera Pradeshiya Sabah, tractor drivers and waste collectors of the three Pradeshiya Sabhas, public health inspectors, environmental officers and medical officers of health were invited. The members of the solid waste management research unit described the programme and documented the problems, suggestions, and other commitments to continue the programme smoothly. Posters were displayed for them to make their comments and handed over these to the local authorities.

3.1.6. Meeting with Udunuwera trade association

Another meeting was held on 15-10-01 at Udunuwera Pradeshiya Sabah. The aim of this meeting was to make the traders aware of the proposed programme and acquire their assistances for making a successful programme. Various kinds of problems were forwarded by them.

3.1.7. Leaflet distribution

Leaflet distribution commenced on 23-10-01 in Udunuwera, 24-10-01 in Gangawata Koralaya, 25-10-01 in Yatinuwera Pradeshiya Sabah. Three colored leaflets were printed, distributed among the public in order to make them aware. Gelioya town, Waligalla, Kosshinna, Watadeniya, Buwalikada were the areas covered from the Udunuwera Pradeshiya Sabah, Peradeniya, Panideniya, Iriyagama, Hantana were the areas covered from Gangawata Pradeshiya Sabah and Peradenya, Illukwatta, Pilimathalawa, Kadugannawa and Kiribathkubura were also the areas covered from Yatinuwera Pradeshiya Sabha.

1500 leaflets for Udunuwera, 500 leaflets for Gangawata and 1000 leaflets for Yatinuwera were distributed. Public health Inspectors of the area, environmental officers assisted in this activity. The samples of distributed leaflets are in appendix 2.

3.1.8. Preparation of questionnaire

A questionnaire was prepared to identify the effectiveness of the introduced programme and identify the ground truth of the waste problem. Name of the Pradeshiya Sabha, commercial information such as address, sex, age, education level, occupation, income, methods how they dispose their waste, difficulties they face in waste disposal practices, whether they separate their waste or not, the difficulties faced in source separation, their willingness to use bags or buckets, suggestions to improve the present waste collection were included in it. 115 questionnaires were prepared, see appendix 3.

3.1.9. Conducting a survey through a questionnaire

For conducting the survey, areas were randomly selected according to the availability of resources. Peradeniya and Gelioya towns were selected. The questioning was undertaken in 36 locations in Yatinuwera Pradeshiya Sabah, 34 in Udunuwera Pradeshiya Sabha and 45 in Gangawatta Pradeshiya Sabha questioned. Questionnaire was a face-to-face interview.

3.1.10.Identifying the problems associated with point source separation

Through the questionnaire survey, identified the problems with point source separation and recorded them.

3.1.11. Calculating efficiency of point source separation

Results of the questionnaire was analysed using Minitab statistical analysis programme.

3.1.12. Gathering commitments of the local authorities

Each of the Pradeshiya Sabha Secretaries was made aware regarding the results of the questionnaire. Then discussed with them whether there was a possibility in distributing bags or buckets. Their suggestions also gathered. Commissioner of Local government of Central Province was invited to discuss about the problems, which arise during the leaflet distribution and questionnaire. She promised to invite the three Pradeshiya Sabha and CEA members. Then the meeting was conducted to discuss the problems.

3.1.13. Economic situation of introducing bags/ barrels

Feasibility of distributing the bags was studied. For this, various private organizations were contacted to obtain quotations.

3.2. Materials of the study

Parameter monitoring	*Instruments/ Materials used*
1. Waste composition	Bucket, cardboard, box, balance
2. Moisture content of the waste	Petry dishes, oven, electric balance

CHAPTER IV

RESULTS AND DISCUSSION

4.1. The status of the existing system within three Pradeshiya Sabha

These secondary data were gathered by interviewing the environmental officers of the three Pradeshiya Sabha. The data gathered may not be accurate but has been recorded for analysis of the existing system.

4.1.1. Yatinuwera Pradeshiya Sabha

4.1.1.1. Waste collecting locations

- Pilimathalawa
- Peradeniya
- Illukwatta

} Use tractor

- Muruthalawa
- Danthure

} Use handcart

4.1.1.2. Quantity of waste

One load was collected daily, except on market days where 2-3 loads are collected (Saturdays and Wednesdays)

4.1.1.3. Waste collection time

It was reported that the waste collection takes place between 6-7a.m.

4.1.1.4. Numbers of labourers

Seven permanent labourers and three extra labourers are working.

4.1.1.5. Number of labourers working in various towns

- Peradeniya- 1
- Pilimathalawa- 3
- Illukwatta- 1
- Muuthalawa- 1
- Danthure- 1
- Assigned tractor driver and helper.

The total number engaged in collecting and handling is nine

4.1.1.6. Locations used for disposing of wastes

- Muruthalawa- Malgammana road
- Danthure- Udewela road
- Peradeniya University
- Siyabalagoda
- Premises of the Pradeshiya Sabha

It is important to note that there is no fixed system of collecting the wastes

4.1.2. Gangawatta Koralalaya Pradeshiya Sabah

4.1.2.1. Waste collecting areas

- Ampitiya
- Thannekubura
- Peradeniya
- Hantana

4.1.2.2. Quantity of waste

- Ampitiya- hand cart 1
- Thannekubura- hand cart 2
- Peradeniya – one and a half tractor loads
- Hantana- one tractor load

4.1.2.3. Locations used for disposing waste

- Ampitiya-close to forest area
- Thannekubura- close to forest area
- Peradeniya- Peradeniya University
- Hantana- Peradeniya University

It is important to note that there is no fixed system of collecting the wastes

4.1.2.4. Number of labourers

There are nine permanent labourers.

4.1.2.5. Monthly waste handling costs (Rs)

a. Wages for one tractor driver = 6069.77

b. Wages for one waste collector = 5704.77

For twelve waste collectors, two drivers and environmental officer. = 87,640.00

Extra waste collector (per day) = 235.77

4.1.3. Udunuwera Pradeshiya Sabha

4.1.3.1. Waste collecting places

Mondays- Waligalla, Gelioya, Koshinna, Aganawera, Meewathura, Peradeniya,Eludoda

Tuesdays- Gelioya,Murugahawela, Daskara, Buwalikada, Dawulagala, Lankathilaka, Ambakke, Arawwala

Wednesdays- Gelioya, Welambada, Watadeniya, paranapattiya, Ambagaasthanna, Galawuva

Thursday- Waligalla, Gelioya, Koshinna, Angunawewela, Meewatura, Panideniya, Elugoda, Mapitiya, Naranwela

Fridays- Gelioya, Muruthagahawela, Daskara, Buwelikada, Hapugahayatathanna, Dawulagala, Lankathilaka, pamunuwa, Elamaldeniya

Saturday- Gelioya, Ambacka, Arawwala, velambada, paranapattiya

4.1.3.2. Quantity of waste

Generally about 6 metric tones per day are collected. The generation in the towns is approximately 2 metric tons.

4.1.3.3. Locations used for disposing of wastes

- Government lands
- Peradeniya University

4.1.3.4. Number of labourers

There are six permanent labourers and one extra labourer.

4.1.3.5. Number of vehicles

One tractor and five handcarts are used for collection and transportation.

4.1.4.Other secondary data collected from other sources

Apart from the above information, Forestry and Environmental Ministry (1999) has published information and data on waste management, generation and composition in the Kandy district, see Table 10. Table 11 contains the composition of the waste in Kandy district. The Solid Waste Management Research Unit at Meewathura is recording the quantity of waste brought to the site so far. Quantity of waste, which has been generated from March to June, within three Pradeshiya Sabhas, which is given in Table 12.

Unfortunately, non-of the Local Authorities maintains databases on waste management. Therefore, the expected information could not be obtained, since these Local Authorities are unable to provide services to the entire extent under their jurisdiction.

Table 12: Handling the waste at the solid waste processing plant

Month	Number of Dates			Waste quantities of each month (tons/month)		
	U	Y	G	U	Y	G
March	16	16	16	23	27.3	29.4
April	21	25	18	24	35.1	37.8
May	13	20	16	18	29.9	29.4
June	17	23	12	28	27.3	21.0

U- Udunuwera Y- Yatinuwera G- Gangawata Koralaya

Table 10: Waste Management Practices in Kandy District

	Name of the local authority	Population	Have any disposal practice/ successfulness (%)		Frequency of collecting waste	Have any land for disposing waste	Number of labourers	Availability of resources					Use the waste for any other activity	Waste collection per day(Kg)
			Yes/ No	(%)				T4	T2	C	W	O		
1	Mahanuwera MC	145000	Yes	50-75	Daily	Yes	411	11		65		1	Yes	102000
2	Kadugannawa UC	2200	Yes	25-50	Daily	Yes	15	1	1	2			No	4000
3	Watthegama UC	12500	Yes	>75	Daily	Yes	11	1		1			No	1500
4	Gampola UC	31750	Yes	50-75	Daily	Yes	60	2		13	2		No	8000
5	Akurana PS	58166	Yes	50-75	Daily	Yes	7	2	2	2			No	3800
6	Harispattuwa PS	76824	Yes	50-75	Daily	No	5		1	3			No	20000
7	Pujapitiya PS	58966	Yes	50-75	Daily	No	5	2		6			No	1500
8	Gangawatta PS	225000	Yes	50-75	Daily	Private	6	1	1	2			No	800
9	Thumpane PS	68000	No		Daily	Temporary	5	1		3			No	870
10	Pathadumbara PS	74823	Yes	25-50	Daily	No	7	1	2				No	865
11	Ududumbera PS	25787	Yes	25-50	Daily	No	4			2			No	1100
12	Pahathahewahata PS	85407	Yes	25-50	Daily	No	16			5			No	1300
13	Minipe PS	60000	Yes	50-75	Daily	Yes	3			3	1		No	200
14	Udunuwera PS	92677	Yes	50-75	Daily	No	3	1					No	6500
15	Panwela PS	22770	Yes	<25	Daily	No	5			2			No	1300
16	Udapalatha PS	160500	Yes	25-50	Daily	Yes	19			5	3		No	2000
17	Kundasale PS	101000	No		Daily	No	7	1		3			No	3000
18	Gangaihala PS	56000	No		Daily	Yes	6			3	2		No	300
19	Pasbage PS	67620	No		Daily	No	2			1			No	50
20	Yatinuwera PS	92338	Yes	25-50	Daily	No	8	1		6			No	500
21	Madadumbars PS	62380	No		Daily	No	10	1		2			No	2500

T4--four wheel tractor T2- two wheel tractor C-carts W-wheel barrow O-other
MC-municipal council UC- urban council PS- Pradeshiya Sabah

Source: Forestry and Environmental Ministry 1999

Table 11: Composition of the Waste in Kandy

Name of the local authority	Waste composition and percentages						
	Polythene and Plastic	Short term biodegradable waste	Long term biodegradable waste	Metals	Wood	Glass	Paper
Mahanuwera MC	5.90	63.29	12.19	3.69	3.10	0.53	11.30
Kadugannawa UC	1.00	90.00	5.00	1.00			3.00
Wattegama UC	2.00	70.00	5.00	3.00	2.00	2.00	16.00
Gampola UC	0.83	60.42	29.16	2.08	0.43	0.83	6.24
Akurana PS	0.44	89.49	4.21	0.26	2.58	0.68	2.3
Harispattuwa PS	10.00	2.00	20.00	3.00	10.00	5.00	50.00
Pogapitiya PS	1.64	71.70	16.40	0.65	6.50	0.97	1.30
Ganwata Korale PS	1.56	62.50	6.25	9.37	14.06		6.25
Tumpane PS	1.72	60.33	28.73	1.14	1.14	1.14	5.94
Patadumbara PS	0.57	1.14	11.43	22.80	34.20	5.70	22.80
Ududumbara PS	0.15	90.90	4.50				4.05
Pahathahewahata PS	1.15	54.80	14.60			27.30	
Menipe PS	10.00	15.00	50.00	1.00	1.00	0.50	22.50
Udunuwara PS	1.54	10.0	46.15	15.40		23.07	3.85
Panvila PS	15.35	38.50	38.50				7.65
Udapalatha PS	10.00	50.00	20.00	2.50		2.50	15.00
Kundasale PS	10.00	65.00	5.00	5.00	5.00	5.00	5.00
Gangaehala PS	3.00	40.00	20.00	6.00	6.00	1.00	24.00
Pasbage PS	0.50	94.40	3.00	0.10	1.00		1.00
Yainuwara PS	6.00	50.00	24.00	2.00	8.00	8.00	2.00
Madadumbara PS	0.84	72.00	12.80	1.20	0.36	1.42	11.36

4.2 Analysis of Waste composition within three Pradeshiya Sabhas

The waste composition study was limited to few days prior to source separation program. The number of samples that was used for determining the composition and the analysis may not be so accurate to predict the waste composition for the entire local authorities. However, table 13 shows the variations between the three local authorities.

Table 13: Waste Composition within three Pradeshiya Sabhas

Waste components	Weight of various waste components (Kg)			Density of each component (Kg/m$^{3)}$			Weight percentages of various waste components (%)		
	U	Y	G	U	Y	G	U	Y	G
Food waste	884	85.17	74.15	413.66	220.59	192.04	72.64	61.8	60.88
Cardboard	64	5.5	8.02	29.94	14.24	20.78	5.25	3.99	6.59
Polythene	114	7.45	7.12	53.34	19.30	18.45	9.37	5.4	5.85
Paper	72	12.45	13.55	33.69	32.24	35.09	5.92	9.03	11.12
Used coconut	30	10.95	2.65	14.04	28.36	6.86	2.47	7.94	2.18
Hard waste	30	3.95	4.35	14.04	10.23	11.266	2.47	2.86	3.57
Hair	7		0.005	3.28		0.388	0.0057		0.04
Glass	4	0.005	0.775	1.87	0.129	2.007	0.0033	0.036	0.64
Plastic	1	0.35	0.375	0.47	0.906	0.971	0.0008	0.253	0.31
Tin	3	0.25	1.05	1.40	0.647	2.719	0.0025	0.18	0.86
Clay			0.325			0.842			0.27
Porcelain			0.550			1.424			0.45
Cloths	8	1.8	2.675	3.74	4.661	6.928	0.0066	1.3	2.20
Coconut shell		1.475	0.150		3.820	0.830		1.07	0.12
Metal		0.15	0.005		0.388	0.129		0.10	0.04
Weight of the waste sample (Kg)	1217	137.8	121.8						
Moisture (%)	55.95	54.85	50.2						

U-Udunuwera Y- Yatinuwera G-Gangawata Koralaya

All the three Pradeshiya sabhas have high percentage of biodegradable (food waste) and moisture content is in between 50% - 60% Therefore the three Pradeshiya Sabhas supply suitable waste loads for making compost.

When comparing the above analysis with the CEA data, in Gangawatta Korale has a significant difference in polythene, metal, wood and paper. Polythene and Paper contents are higher in the analysis than reported by CEA; Metal and Wood percentages are lower. Paper content is high due to proximity to the University. Wood content is lower; since it may be that these items are not brought to the unit. Metal content is lower due to less number of industries in and around the Meewathura plant and perhaps sold as scrap, not reaching the processing plant.

Udunuwera Pradeshiya Sabha has a significant difference in polythene, biodegradable, glass and paper percentages. Biodegradable, polythene and paper percentages are higher than the CEA analysis. The polythene and paper percentages are high because the waste collecting area is highly urbanized.

Yatinuwara Pradeshiya Sabha has a significant variation in biodegradable, wood, glass and paper percentages compared with the CEA report. Findings of this study on the polyethylene percentage of the Yatinuwara area seem to be a match. Difference in the biodegradable fraction between these two studies may be due to seasonal effects. The lower percentages of wood and glass found in this study are mainly due to the selective collection of waste that is brought to the unit.

There seems to be an ambiguity of the results reported by CEA. Per capita waste collection rates between the local authorities differ vastly and when compared with the wastes recorded at the Meewathura Plant, see table 11, the CEA data cannot be relied upon. It is interesting to note that the number of collection workers and the tonnage recorded also differ between the three local authorities. Some of the other aspects such as frequency of collection as indicated in table 10.is not correct. The tonnage should be higher since the wastes have already deteriorated before reaching the processing plant. The new sensors conducted in 2001 see table 14 show that there is a mark difference in population in the Gangawatta PS.

4.3 Conducting meetings

The meetings have been documented and they are in Appendix 4as minutes. Such meetings helped in getting the assistance and contribution from the members of the

3.04: தொடர்ச்சி.
3.04: Contd.

ප්‍රා.ලේ. කොට්ඨාශය සහ අංශය பிரதேச செயலாளர் பிரிவும் நகர/ கிராம/ பெருந்தோட்டப் பிரிவும் D.S. Division and Sector	මුළු පුද්ගලයින් සංඛ්‍යාව மொத்த எண்ணிக்கை Total no. of persons	ස්ත්‍රී පුරුෂ භාවය ஆண், பெண் பிரிவு Sex		වයස வயது Age		ආගම சமயம் Religion						ජන විචිත්‍රය இனம் Ethnicity							
		පුරුෂ ஆண் Male	ස්ත්‍රී பெண் Female	අවුරුදු 18 ට අඩු 18 வயதுக்குக் குறைந்தோர் Under 18 years	අවුරුදු 18 හා ඊට වැඩි 18 வயதுடையோரும் அதற்கு மேற்பட்டோரும் 18 years and over	බෞද්ධ பௌத்தம் Buddhist	හින්දු இந்து Hindu	ඉස්ලාම් இஸ்லாம் Islam	රෝමානු කතෝලික ரோமன் கத்தோலிக்கம் Roman Catholic	වෙනත් ක්‍රිස්තියානි ஏனைய கிறிஸ்தவம் Other Christian	වෙනත් ஏனையவை Other	සිංහල சிங்களவர் Sinhalese	ශ්‍රී ලංකා දෙමළ இலங்கைத் தமிழர் Sri Lanka Tamil	ඉන්දියානු දෙමළ இந்தியத் தமிழர் Indian Tamil	ශ්‍රී ලංකා මූරිස් இலங்கைச் சோனகர் Sri Lanka Moor	බර්ගර් பறங்கியர் Burgher	මැලේ மலாயர் Malay	ශ්‍රී ලංකා චෙට්ටි இலங்கைச் செட்டி Sri Lanka Chetty	භරත பரதர் Bharatha
පාතදුම්බර පාත්තුම්පරෙ Pathadumbara	80,224	38,295	41,929	27,063	53,161	59,948	2,083	17,048	922	216	7	60,517	2,105	661	16,733	88	80	0	0
නාගරික නගරය Urban	11,344	5,440	5,904	3,542	7,802	8,468	934	1,544	317	81	0	8,648	979	364	1,305	21	24	0	0
ග්‍රාමීය ගිරාමම් Rural	68,795	32,819	35,976	23,488	45,307	51,477	1,076	15,495	605	135	7	51,866	1,048	297	15,424	67	56	0	0
වතු පෙරුන්තෝට්ටම් Estate	85	36	49	33	52	3	73	9	0	0	0	3	78	0	4	0	0	0	0
පාතහේවාහැට්ට Pathahewaheta	53,107	25,674	27,433	18,045	35,062	47,286	3,572	1,394	448	396	11	47,532	2,132	2,124	1,262	24	7	0	0
ග්‍රාමීය ගිරාමම් Rural	50,965	24,613	26,352	17,217	33,748	46,763	2,246	1,360	236	349	11	47,001	1,613	1,068	1,229	21	7	0	0
වතු පෙරුන්තෝට්ටම් Estate	2,142	1,061	1,081	828	1,314	523	1,326	34	212	47	0	531	519	1,056	33	3	0	0	0
පූජාපිටිය Poojapitiya	53,644	26,004	27,640	18,882	34,762	43,781	1,152	8,387	112	200	12	43,900	423	1,026	8,259	11	9	5	0
ග්‍රාමීය ගිරාමම් Rural	52,720	25,527	27,193	18,537	34,183	43,731	1,331	8,360	110	186	2	43,852	302	298	8,236	11	9	5	0
වතු පෙරුන්තෝට්ටම් Estate	924	477	447	345	579	50	821	27	2	14	10	48	121	728	23	0	0	0	0
තුම්පනේ Thumpane	35,306	16,712	18,594	11,024	24,282	32,457	173	2,490	81	103	2	32,515	236	90	2,429	8	21	0	1
ග්‍රාමීය ගිරාමම් Rural	35,306	16,712	18,594	11,024	24,282	32,457	173	2,490	81	103	2	32,515	236	90	2,429	8	21	0	1
උඩදුම්බර උදුම්පරෙ Udadumbara	22,651	11,279	11,372	8,049	14,602	20,525	1,832	229	45	15	5	20,480	896	987	281	6	1	0	0
ග්‍රාමීය ගිරාමම් Rural	20,804	10,339	10,465	7,333	13,471	20,153	414	211	18	8	0	20,096	349	138	214	6	1	0	0
වතු පෙරුන්තෝට්ටම් Estate	1,847	940	907	716	1,131	372	1,418	18	27	7	5	384	547	849	67	0	0	0	0
උඩපලාත Udapalatha	86,136	41,572	44,564	30,464	55,672	47,640	18,131	17,896	1,690	769	10	48,401	6,415	13,523	17,359	87	297	6	0
නාගරික නගරම් Urban	24,283	11,667	12,616	8,420	15,863	10,081	2,801	10,654	552	194	1	10,359	1,962	1,268	10,441	53	177	6	0
ග්‍රාමීය ගිරාමම් Rural	48,087	23,217	24,870	16,745	31,342	35,800	4,045	7,189	613	433	7	36,219	2,394	2,408	6,885	32	118	0	0
වතු පෙරුන්තෝට්ටම් Estate	13,766	6,688	7,078	5,299	8,467	1,759	11,285	53	525	142	2	1,823	2,059	9,847	33	2	2	0	0
උඩුනුවර Udunuwara	98,879	47,946	50,933	33,614	65,265	71,736	2,373	23,630	713	402	25	72,297	1,382	1,737	23,093	134	42	12	0
ග්‍රාමීය ගිරාමම් Rural	97,858	47,423	50,435	33,211	64,647	71,467	1,670	23,625	701	370	25	72,040	1,357	1,003	23,088	134	42	12	0
වතු පෙරුන්තෝට්ටම් Estate	1,021	523	498	403	618	269	703	5	12	32	0	257	25	734	5	0	0	0	0
යටිනුවර යට්ටිනුවර Yatinuwara	96,946	46,568	50,378	30,907	66,039	85,269	2,523	7,309	1,146	689	10	86,289	1,201	2,084	7,222	70	52	6	1
නාගරික නගරම් Urban	1,215	640	575	364	851	872	46	251	43	3	0	916	40	2	251	4	0	2	0
ග්‍රාමීය ගිරාමම් Rural	93,848	45,016	48,832	29,887	63,961	83,581	1,572	7,016	1,004	665	10	84,566	1,161	1,048	6,933	66	48	4	1
වතු පෙරුන්තෝට්ටම් Estate	1,883	912	971	656	1,227	816	905	42	99	21	0	807	0	1,034	38	0	4	0	0
දිස්ත්‍රික්ක සඳහා එකතුව மாவட்டத்திற்கான மொத்தம் District Total	1,272,463	616,630	655,833	429,672	842,791	930,644	135,708	173,837	22,345	9,336	593	940,963	50,405	106,259	168,960	2,080	2,210	84	17
නාගරික නගරම් Urban	156,923	77,432	79,491	48,997	107,926	95,288	18,719	33,008	7,212	2,402	294	99,806	14,118	9,050	30,876	988	1,250	21	12
ග්‍රාමීය ගිරාමම් Rural	1,023,092	493,865	529,227	345,429	677,663	823,377	43,310	139,693	10,933	5,524	255	828,926	26,604	27,813	137,040	1,047	926	63	5
වතු පෙරුන්තෝට්ටම් Estate	92,448	45,333	47,115	35,246	57,202	11,979	73,679	1,136	4,200	1,410	44	12,231	9,683	69,396	1,044	45	34	0	0

Table 14: Population analysis of 2001

Pradeshiya Sabha. Such activities have developed a good relationship between the SWMRU and Pradeshiya Sabah Members.

4.4 Conducting a workshop

In this workshop one of the PHI suggested to keep separate, rather nice looking bins in town areas for bio degradable and non-degradable. Other than that waste collectors and tractor drivers said that resources as well as labourers are lacking and assured to help as much as possible for the programme. They added that they also could make the public aware and it will be a benefit. This kind of workshops does cause strong linkages between the SWMRU and the members who are involved in the management of solid waste in the area.

4.5 Meeting with Udunuwera trade association

Members of the trade association agreed to assist in the point source separation programme. However, they accused the Pradeshiya Sabha for the poor waste management services. They said that the collection is not regular and they are not equipped with essential tools and equipment for collecting and for final disposal of the collected waste. The members further added that, sometimes they do not even return the waste bins and baskets and also demanding money to remove the waste.

4.6. Conducting survey through a Questionnaire

Out of the 115 samples, there are only 13 commercial places that separate their waste. Others continue to do the usual activity as before. Seventy persons expressed their willingness to get bags to separate their waste. Most of the commercial places did not have even a dustbin for themselves. Appendix 5 gives detailed description on the questionnaire.

4.7. Identifying the problems associated with point source separation

a) Irregular collection by tractor and wastes ending up in drains and rivers.
b) Labourers do not have essential equipment to cleanup the waste.
c) No one to supervise the waste management practices.
d) Waste collection only from the first half of the road.
e) Lack of waste collection labourers.
f) Demanding remuneration to remove the waste.
g) Even if the waste is separated, all the separated items are again mixed in the tractor or cart.
h) Lack of awareness of the people about waste accumulation.
i) There are people bringing wastes in vehicles and just throw their waste into waste collection common dustbins or on to either side of roads.

4.8. Calculating efficiency of point source separation programme

Questionnaire was statistically analyzed using chi-square method. Source separation practice did not depend on age or education levels. Between Pradeshiya Sabhas also show no significant differences. Statistical results are given in appendix 6.

4.9. Gathering commitments of the local authority

The view of the Local Authorities is that enforcement of point source separation on the public is difficult due to political reasons and interference. But they assured to look upon it when they issue trade licenses, because in the local authority policy, every trader should have a proper dustbin to dispose their waste. Due to lack of funds, the Secretaries of the three Pradeshiya Sabah are reluctant to introduce the practice of distributing bags among the public. The public is not adequately taxed or there is no separate charge for handling the wastes, so there is no income but expenditure for the LA's. The allocation of funds for waste management is low and legal action or change in the legal status is difficult under the present circumstances.

Further they added that they should know the economic feasibility of distributing bags and possibility of operating a landfill site. They also proposed that further awareness programmes should be conducted to change the attitude of he public and initially to undertake this activity within a small selected area.

4.10 Management of PS

The quality of incoming wastes to the processing plant is poor, since the frequency of collection is low while trying to serve most parts of the large extent of PS. The actual delivery time to the processing plant and as reported by PS differs and it is likely that the real situation of the management practices is not frequently monitored. The wastes are already contaminated with flies and causes odor problems, particularly so when late delivery takes place. The dumping of wastes in authorized and unauthorized locations is now becoming a serious health hazard.

In order to get a better understanding of the existing systems in the each of the PS, it is useful to re-tabulate the Tables 10 and 11 with additional information such as collection workers per PS, see Table 15.

Table 15: Efficiency of Collection

Description	Udunuwara	Yatinuwara	Ganagawata Korale	Report
Laborers	3 6+1	8 7+3	6 9+3	CEA Meewathura
Waste (Kg/day)	6500 Kg	500 Kg	800 Kg	CEA analysis
Waste (Kg/day)	1377 Kg	1442 Kg	1877 Kg	Meewathura
no. of Kg handled by a person/day	229 Kg	206 Kg	208 Kg	

The reordered data at Meewathura shows that the average waste quantity that is brought by each local authority is as follows:

Gangawata -1877 kg/day
Udunuwara-1377 kg/day
Yatinuwara-1442 kg/day

The CEA reported that the waste generation is 800 Kg/day in Gangawata, 6500Kg/day in Udunuwara, 500Kg/day in Yatinuwara. The results show that the amount of waste generated in Yatunuwara and Gangawata PS is much less than the real amount of waste that is generated from the PS and delivered to Meewathura. These two PS bring waste from selective locations to Meewathura. Therefore the actual amount of waste generation in these PS must be higher than the amount brought to Meewathura. The records obtained from the Unit were recorded on a daily basis therefore the reliability of those recorded data are of greater reliability. The differences in the values of the waste generation rates given by the CEA may be due to the lack of a proper database in those authorities. If the waste collection system is viewed the per capita collection of the waste is around 215 kg according to the data collected in this study. Since the number of the working hours per day is 8, a person can handle only 28 kg per hour. But when the average capacity of a person is considered this value seems to be very low, therefore the working efficiency of the laborers has to be improved in the collecting system.

Considering the lack of resources, local authorities are unable to do their duty in proper manner. Labour availability is low. It is hard to find people who will work as waste collectors for the poor wages offered (Rs 130 per day) and so the staff is unreliable. They are also ashamed to use brooms, bins etc in the heart of the town. There is a lack of co-ordination among the Pradeshiya Sabha members and lack coherence in their date bases, especially waste collection practices. Public health Inspectors do not supervise the waste management practices, when they issue the trade licenses they neglect about such things. Even though some officers would like to do something, they were prevented from political interference. Not only that, there are laws prohibiting dumping but they are not implemented. It's the council's responsibility but it has been reported that within the council, the notion of responsibility is unclear. Drains and sewers are blocked by waste such as plastic and polythene. This causes flooding and the costs the government to clear it. This occurs due to lack of proper waste collecting system.

4.11: Management of Meewathura Plant

The quality of wastes arriving at the processing plant is much more than the design capacity of the composting unit. The entire wastes from surrounding locations of the University should be handled at Meewathura. Unfortunately, the demarcated boundaries are such that one side of the road is handled by one authority, whereas the other side by another. This situation is not ideal in view of costs, management of resources, time management and enforcing of management systems.

The compost making is only one aspect of waste management and improvements should be made to introduce 3 R systems for managing non-biodegradable and long lasting biodegradable. The economic benefits of source separation would depend on reduction of labour requirement for composting operation and increase in labour for managing 3 R systems.

CHAPTER V

CONCLUSION, RECOMMENDATIONS AND SUGGESTIONS

5.1 Conclusion and Recommendations

There is a high percentage of biodegradable waste for composting MSW from the three local authorities. The reported data by CEA differ from the waste composition study that was undertaken at the Meewathura Processing Plant. Some of the wastes are not brought to the site since it would be a problem for the SWMRU to handle. However, the information given by the CEA may not be accurate if population densities are compared between the local authorities.

Capacity mobilization studies indicate that there is great potential in developing a rapport between the three Urban Local Authorities being served by the SWMRU. The ULAs gave a positive indication that they would support the point source separation program at the meetings and at the workshop, which were held at the University.

This study reveals that there are grave problems encountered both by the community at large and the three local authorities. It has been pointed out that these local authorities are inefficient and they lack resources and equipment and machinery to maintain the urban centers clean. Irregular collection of wastes seems to be the major problem most commercial establishments and residents complained when questioned of the services. Also they mentioned that the waste collectors are corrupt. Such corruption could be attributed to very low wages given to collectors, including the tractor operators. There are at least nine to ten distinguished problems identified in point source separation.

Interestingly only 11.3 % were separating wastes at the time of concluding the results of the questionnaire. However, 70% are willing to separate the wastes if bags are provided, since some of the commercial establishments do not even have their own dustbins. Unfortunately, the LA's do not have adequate funds for waste management and distribution of bags would depend on willingness to pay for the services. The statistical analysis indicates that there are no significant relationships between age, education or between locations. Local authorities are skeptical in enforcing legislation on point source separation due to many reasons.

Since collection is irregular, the quality of waste arriving at the processing plant is low with already degraded and contaminated wastes, particularly with flies. Odor nuisance is one of

the major problems. Although the analysis of collection efficiency based on the data at the processing plant indicate that it is much below expectation, it has been transpired that part of the collections are dumped, since the capacity of the processing plant is insufficient to serve all three local authorities.

Dignity of labour is one of the aspects the country as a whole should address. The workers are reluctant to perform their duties in public, particularly so of the stigma attached to the type of work done. The officers concerned are very indifferent and avoid their duties. There is lack of coordination between Public Health Inspectors and the Local Authority Officers, leading to conflict of interest as well as negligence. They are not concerned of their responsibility and sometimes ignorant about it.

The status of the Meewathura Plant should be improved to process or dispose wastes that cannot be composted. An integrated management approach is needed and the higher authorities are presently examining the possibility of developing a landfill and increase the capacity to handle all the wastes generated in the three local authorities.

People are willing to accept solid waste disposing as also their responsibility. However, they are unaware of the negative impacts of waste accumulations. The attitude of the people should change through awareness. Awareness must be created through social mobilization. This must include all income groups, as the rich are also very irresponsible and programs should be conducted regionally and nationally. It is also vital that the Pradeshiya sabahs should be aware of the issues so that they are able to tackle the problems rationally. There must be general environmental education that could be conducted by distributing leaflets written in all three languages. Awareness programme should be conducted for schools, business and urban employees. Information sharing workshops, the state media, electronic media and schools could be used as means to educate people. Also people should be encouraged to process their waste at home.

Waste is a business. The authorities must be made aware of this. In Malaysia, Indonesia and Thailand waste provides a substantial part of their income.

There should be a coordinated governmental approach. It may be necessary to increase tax or establish a charging system in order to manage the waste more efficiently. The involvement of the private sector should increase the efficiency of the project.
It is difficult to carry out such advance programs with the kind of problems encountered in Sri Lanka. If these obstacles could be tackled, point source separation can be done successfully

through participatory approach and be in a position to produce more non-contaminated compost from using urban solid waste, while reducing solid waste accumulation in urban centers.

5.2 SUGGESTIONS

Following suggestions can be made to improve the "point source separation through participatory approach" concept in the three-Pradeshiya Sabha areas,

- Programs should be conducted to raise the awareness of 'point source separation' practices among the public and officers of the local authorities.

- In parallel to the awareness program bags or buckets distribution should be implemented within a selected area and should supervise regularly to check the public do the activity or not.

- Source separation program needs more commitment form all the parties of the area. This is not an individual work. Team work towards the "point source separation' can gain lots of benefits to the plant as well as the environment.

- Should keep relationship between SWMRU and the local authorities through meetings and commitments. Their assistances are very useful for the success of he source separation program.

- Incentives should be put forward not only to the public, but also for the tractor drivers and waste collectors. Because they're the persons who can encourage the public and enforce on them.

- Time to time questionnaire surveys should be done to identify the problems, which are associated with the source separation programme. This may help to overcome the difficulties, which cause to discourage the programme.

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APPENDIX 1

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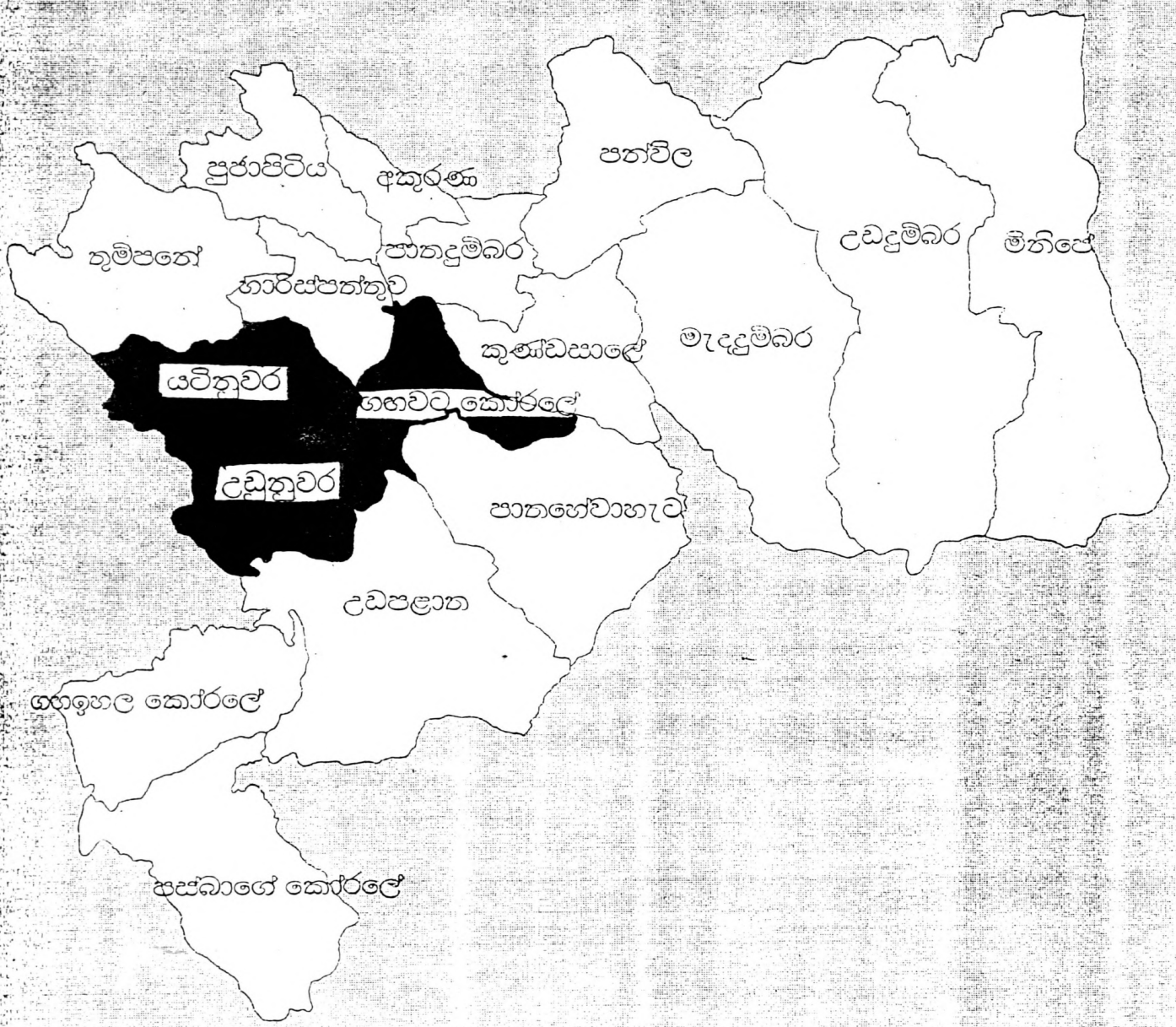

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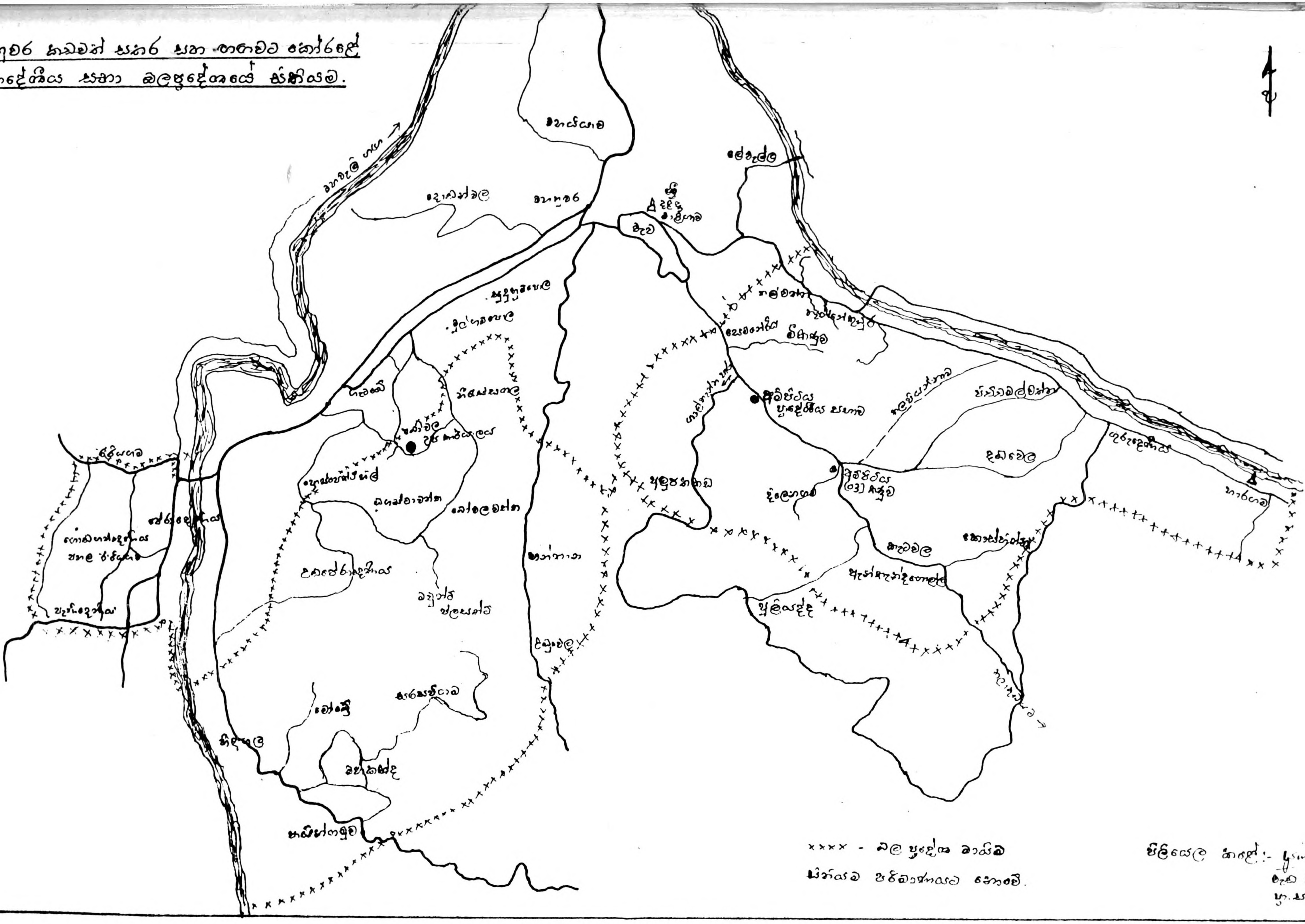

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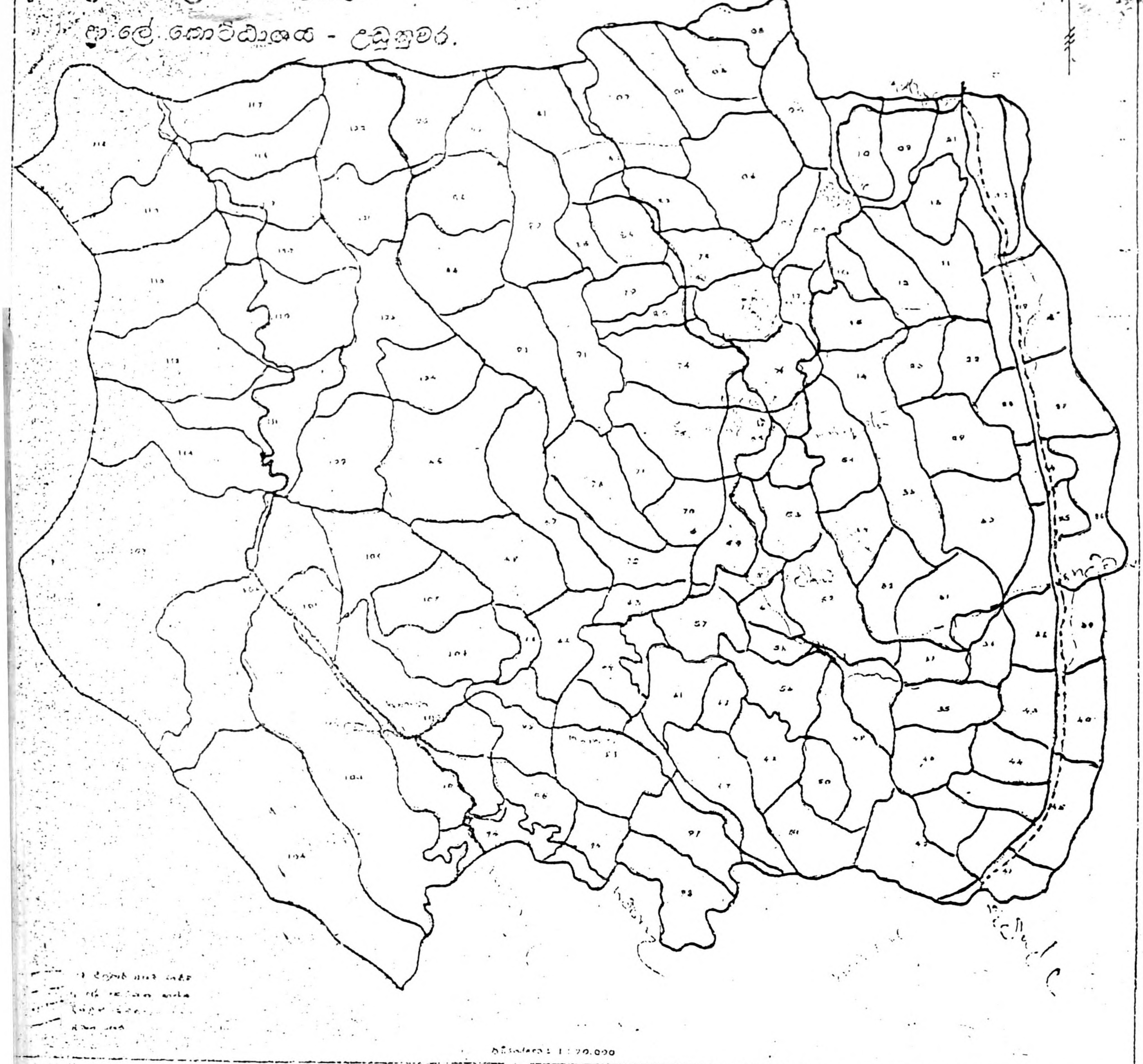

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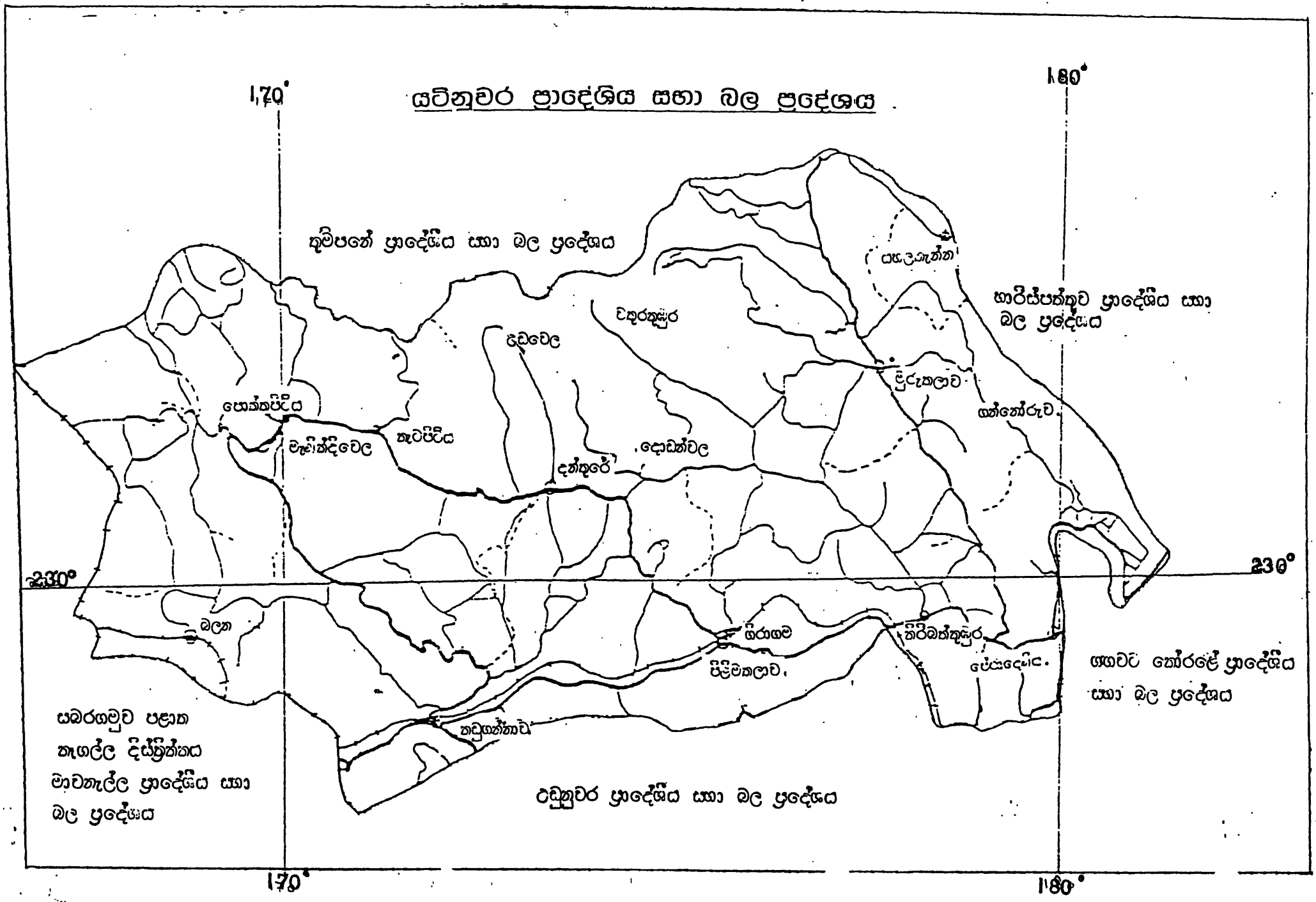
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පේයාදෙණිය
තඩුගන්නාව

APPENDIX 2

නිවේදන අංක 01

පළමු පියවර

මහත්මයාණෙනි/ මහත්මියණී

නිවසේ / ආයතනයේ කැළිකසළ තෝරා බෑහැර කිරීම

පේරාදෙණිය විශ්ව විද්‍යාලයේ ඝන අපද්‍රව්‍ය කලමනාකරණ පර්යේෂණ ඒකකය ප්‍රාදේශීය සභා හා එක්ව ප්‍රථම වතාවට කැළිකසල පරිසර හිතකාමී ලෙස බැහැර කිරීමේ ව්‍යාපෘතියක් ආරම්භ කර ඇත. එහි පළමු පියවර ලෙස ඔබ නිවසේ/ආයතනයේ................

1. ඉවතලන වීදුරු භාණ්ඩ - බෝතල් / බල්බ්ස් හා වීදුරු කැබලි ආදිය එක් ඇසුරුමකටද

2 ටින් හා බැටරි තවත් ඇසුරුමකටද අසුරා

වීදුරු බහාලූ ඇසුරුම හා ටින් හා බැටරි ඇසුරුම අනෙක් කැළිකසළ සමග වෙත වෙතම ප්‍රාදේශීය සභා කරත්තයට භාරදෙන්න.

නිවසේ/ ආයතනයේ කැළි කසළ ක්‍රමානුකූලව බැහැර කිරීමෙන් නගරය අලංකාරව හා පිරිසිදුව තබා ගැනීමට ඔබගේ දායකත්වය නොකඩවා ලබාදෙන්න

අපද්‍රව්‍ය කළමනාකරණය නිවසින් / ආයතනයෙන් අරඹමු

ගගවට කෝරළය ප්‍රාදේශීය සභාව සහ
පේරාදෙණිය විශ්ව විද්‍යාලයීය ඝන අපද්‍රව්‍ය කළමනාකරණ පර්යේෂණ ඒකකය

APPENDIX 3

QUESTIONNARE

1. Pradeshiya Sabah area that you belong?
   ඔබ අයත් ප්‍රාදේශීය සභාව?

2. House hold/ Commercial information
   නිවැසියන්ගේ/වෙළඳසැලේ තොරතුරු

Address ලිපිනය	Age වයස	Sex ස්ත්‍රී/පුරුෂ බව	Education level අධ්‍යාපන මට්ටම	Occupation Primary Subsidiary රැකියාව	Income ආදායම

3. How do you dispose your waste?
   ඔබ කැළිකසල බැහැර කරන්නේ කෙසේද?

   Home garden
   ගෙවත්තට

   P.S. Tractor
   ප්‍රාදේශීය සභා ට්‍රැක්ටරයට/ කරත්තයට

4. From your point of view what are the major difficulties you face in waste disposal ?
   අපද්‍රව්‍ය බැහැර කිරීම සම්බන්ධයෙන් ඔබට ඇති ගැටළු

5. Do you separate your waste now?
   ඔබ දැනට කසළ වෙන්ව බැහැර කරනවාද?

6. What are the major difficulties you face in source separation?
   කසළ වෙන්ව බැහැර කිරීම සම්බන්ධයෙන් ඔබට ඇති ගැටළු මොනවාද?

APPENDIX 4

Minutes of the First Technical Committee of the Solid Waste Management Research Unit

Date: 17th September, 2001 - 10.00a.m.
Venue: Dept. of Agriculture Engineering, Faculty of Agriculture, University of Peradeniya

Members present

Mrs. U.W.I.P. Wijesundara
Mrs. N.S. Sahabdeen
Mrs. W.M.S. Weerkoon
Mr. S.J.M. Dayananda
Dr. B.F.A.Basnayake
Ms. G.S.D.Perera
Ms. Kumudu Nirosha Priyangani

Matters discussed as per the Agenda

01.01.01. Introduction to the participatory approach
An introduction was made by Dr. B.F.A. Basnayake regarding the overall objectives of the Unit and highlighted the importance of participatory approach in source separation to improve the efficiency and quality of compost at the Meewathura processing plant.

01.01.02. Data on existing waste collection
All the data on the specific areas, waste collection method, transport, no. of workers, no. of households, maps of the area etc. are required form each Pradeshiya Sabha. It was agreed that they could provide the same.

01.01.03. Difficulties in the existing system
The representatives of three Pradeshiya Sabhas explained the difficulties and the limitations of the existing waste collection system.

01.01.04. Constraints for the total source separation
Representatives of the Pradeshiya Sabhas explained that the attitudes of public towards source separation is poor. Well organized public awareness programme should be launched before launching the source separation programme.

01.01.05. Difficulties without a source separation
Dr. B.F.A. Basnayake pointed out that the quality of the compost is poor since there is no source separation of waste. 25% of effectiveness is reduced at the Meewathura composte unit due to glass, polythene etc. in waste.

01.01.06 Climatic conditions/ Moisture content
It was discussed that the quality of waste will be affected by climatic conditions. Moisture content of waste is very high in rainy seasons. It was agreed to examine the possibility of making dry storage (bins to be dried) conditions before waste collection.

01.01.07 Separation of specific items.

Since all the items cannot be separated at the same time, all participants agreed to separate some specific items at different levels.

- House hold
  Glass/ house hold hazardous waste /batteries/polythene

- Markets
  Vegetables etc.

- Industrial sector
  Textile, ceramic

First, it was suggested to start the source separation programme from the household level. Public will be made aware to separate polythene, glass and batteries from the waste at the first phase.

01.01.08 Achieving the targets

It was suggested that the organizational structure should include three phases.

- Commercial sector
- Community leaders ----------→ SWMRU technical committee
- Local Government Authorities

Representatives of all three level should participate at the SWMRU Technical committee meetings.

01.01.09 Future working arrangement

It was agreed that all Pradeshiya Sabha members should meet once a week to discuss matters regarding the source separation programme and the date and time should be fixed as at 2.00p.m. on every Tuesday.

Date for next meeting

It was decided to hold the next meeting on Tuesday 25th September, 2001 at 2.00 p.m.

Secretary/ Technical Committee meeting Date:

Minutes of the Second Technical Committee of the SWMRU

Date: 25th September, 2001 - 2.00p.m.
Venue: Dept. of Agriculture Engineering, Faculty of Agriculture, University of Peradeniya

Members present

Mrs. N.S. Sahabdeen	Mrs. W.M.S. Weerkoon
Mr. S.J.M. Dayananda	Dr. B.F.A.Basnayake
Mr.A.W. Wanigarathne	Mr.A.S.H. Chandrasena
Ms. G.S.D.Perera	Ms. Kumudu Nirosha Priyangani
Ms. Nayana Madhugeethika	

Matters discussed as per the Agenda

01.02.01 Confirmation of the minutes

The minutes of the first committee meeting were confirmed subject to the correction in 01.01.07 should be read as "glass and batteries from the waste in the first phase:

01.02.02 Awareness to the public regarding the source separation program

All members of the meeting agreed that a prior awareness should be given to the public before the source separation program commences. It was agreed to notify in both languages to all waste generators the manner in which they can contribute to this program.

01.02.03 Content of the notice

Dr.Basnayake suggested that it should be mentioned that this program is launched by the SWMRU of the University of Peradeniya with the Collaboration of Pradeshiya Sabhas and perhaps the Hantana Conservation Society. The date and time of collection, types of waste, which has to be separated, should be mentioned in the notice. It was decided to inform the generators to store the wastes in any type of bag or container.

The notice should be forwarded to the Chairman of each Pradeshiya Sabha for approval.

01.02.04 Distribution of notices

The programme to distribute notices is scheduled for 09th, 10th, 11th and 12th of October, 2001. The students under the supervision of environmental officers of each Pradeshiya Sabhas will carry out the programme.

01.02.05 Collecting the separated Waste by PS

It was decided to collect the separated waste in wooden boxes for glass. The Wooden box will be fabricated by each Pradeshiya Sabha. If the date of collection would fall on a holiday, the following day will be the collection date. If there is a problem of collection for one of the Pradeshiya Sabhas, another Pradeshiya Sabha should help in transporting the wastes.

01.02.06 Disposal of Clinical Waste

Dr.B.F.A.Basnayake explained the problems regarding the disposal of clinical waste. Clinical waste should be separated at the source itself in order to avoid those problems. It was suggested that a letter should be sent to the Director-Ministry of

Health-Central Province through the Commissioner of Local Government - Central Province.

01.02.07 Future plans

All members agreed that source separation programme should include several phases in which more of the wastes are separated and methodologies developed to introduce the management system to the public. As the first stage, only glass and other hazardous wastes to be separated.

01.02.08 Landfilling *the rest of* Waste

The representative of the Udunuwara Pradeshiya Sabha informed that the Chairman will provide an extent of land to construct a landfill for the non biodegradable and un-recyclable waste. It was suggested that if non-biodegradable waste is separated at the source, it could be directly sold or landfilled.

Mrs. N.S.Sahabdeen, the representative of the Udunuwara Pradeshiya Sabha added that a place would be provided at Gelioya town for the storage of polythene, glasses etc.

01.02.09 Recycling of separated Waste

The possibilities of reusing/recycling of separated waste were discussed at the meeting. The representative of Udunuwara Pradeshiya Sabha pointed out that the Udaya Industries would buy the waste glass. It was agreed to inquire and get more information from them.

01.02.10 Disposal tax

It was suggested that if the public does not do the separation systematically, the local authorities should impose penalties or fines on waste disposal, introducing a command and control system.

01.02.11 Appointment of new members to the Technical Committee.

The Head of the Unit informed that the University wastes should also be processed at the Plant. However, another source separation program is needed for the hazardous wastes generated. It was suggested to get the assistance of the University PHI and the President or his nominee of the Hantana Conservation Society for all the activities.

Date of the next meeting

It was decided to hold the next meeting on Thursday 04th October, 2001 at 2.00 p.m.

Secretary/ Technical Committee meeting Date:

Minutes of the Third Technical Committee of the SWMRU

Date: October 04, 2001 - 2.00p.m.
Venue: Dept. of Agricultural Engineering, Faculty of Agriculture, University of Peradeniya

Members present

Mrs. N.S. Sahabdeen
Mr. S.J.M. Dayananda
Mr.C.D. Hettiarachchi
Ms. S.Gunathilake
Mr.A.S.H. Chandrasena
Ms. Nayana Madhugeethika
Ms. Kumudu Nirosha Priyangani
Mrs. W.M.S. Weerkoon
Dr. B.F.A.Basnayake
D.J.S.S.Jayalath
Mr.A.W. Wanigarathne
Ms. G.S.D.Perera

Matters discussed as per the Agenda

01:03:01 Confirmation of the minutes

The minutes of the second committee meeting were confirmed.

01:03:02 Approval on the notice for the Source separation programme

The notice has been approved by the Chairman of Three Pradeshiya Sabhas. The Chairman of the Yatinuwara Pradeshiya Sabha has inquired whether polythene also can be separated. The committee members were in the opinion that the polythene separation can be included in a later stage of the programme.

01:03:03 Amended source separation programme

Dr. Basnayake, The Head-SWMRU proposed that the dates scheduled for the distribution of leaflets should be postponed as to 23rd, 24th and 25th of October, 2001 since waste characterization should be done prior to the distribution of leaflets. The dates were confirmed by all members.

01:03:04 No.of Leaflets needed for the programme

It was decided that the no.of leaflets needed are 500 for Yatinuwara Pradeshiya Sabha, 1000 for Gangawata Koralaya Pradeshiya Sabha and 1500 for the Udunuwara Pradeshiya Sabha consequently.

01:03:05 No. of Participants for the leaflet distribution programme

It was agreed that the undergraduate, postgraduate students, members of the Hantana Conservation Society and the environmental officers of three pradeshiya sabhas will be present for the distribution of leaflets.

01:03:06 Questionnaire

The Head-SWMRU pointed out that the questionnaire to evaluate the programme should be distributed together with the leaflet. But, ultimately, it was agreed that the questionnaire could be distributed after giving the people sometime to evaluate the programme.

01:03:08 Identity cards for the participants

Hantana conservation society proposed that every member should wear a identity card indicating that they are representing a recognized institution/organization. It was decided to make a separate Identity card for Solid Waste Management Research Unit.

01:03:11 Posters

Representatives of the Hantana Conservation Society proposed that it is better to have a poster displayed before the distribution of leaflets. All the members agreed on that and the designing of the posters was handed over to the Hantana Conservation Society.

01:03:12 Dates for the collection of separated Waste

It was agreed that the dates of collection of separated waste will be Monday of the first and third week of the month for the Udunuwara and Yatinuwara Pradeshiya Sabha and every 15th and 30th of the month for the Gangawata Koralaya Pradeshiya Sabha.

01:03:10 Disposal of clinical Waste

Dr.Basnayake apologize for the delay in sending the letter to the Director(Health) and promised that the letter will be sent as soon as possible.

01:03:12 Future plans

- It was agreed that the polythene manufacturers in the area should be invited for the next meeting.

- Dr. D.R.I.B. Werellagama should be invited as a member for this technical committee.

- Environmental Protection License for SWMRU

  Dr.Basnayake suggested that the composting unit should go for Environmental Protection License (EPL) with the coordination of Central Environmental Authority.

01:03:13 Workshop on Source separation programme

It was decided to hold a workshop to discuss the problems with tractor drivers, waste collectors and Public Health Inspectors etc. The date was confirmed as at October 11, 2001. It was requested from the three Pradeshiya Sabhas to accompany the Public Health Inspectors, tractor drivers, waste collectors with them for the workshop. The Chairman of Udunuwara Pradeshiya Sabha will be chairing the meeting.

01.03.14 Workshop on source separation programme

A workshop was organized to discuss the problems pertaining to source separation of wastes. Environmental officers of the three pradeshiya sabhas, labourers, tractor drivers and public health inspectors were present at the meeting.

Mr. Wanigarathne made the introduction and welcome speech on behalf of Dr.B.F.A.Basnayake. The Chairman of Udunuwera Pradeshiya Sabha chaired the meeting.

Public Health Inspector of the Yatinuwara Pradeshiya Sabha told that it is better to keep waste bins in different colours and they should be properly constructed.

There was a problem came up since people might not keep the separated waste till pradeshiya sabha tractor comes in two weeks time. Labourers suggested that the separated waste can be collected every day. It was decided that the leaflet should be modified to express that the public can handover the separated waste everyday to the Pradeshiya Sabha tractor other than in two weeks time.

The secretary of the Udunuwera Pradeshiya Sabha suggested that a model sample can be done in a major city to take better results. Further she added that they can include the source separation activity to their license issuing criteria (for commercial activities). The labourers proposed it is better to use urea bags to collect bottle and glasses rather than a wooden box.

The posters were handed over to the three Pradeshiya Sabhas to be displayed in public places before 20th October, 2001.

Secretary/ Technical Committee Date :

APPENDIX 5

Table 11: Results of the Questionnaire

Number	PS	Age	Sex	Edu	Job	Disposing	Separate	Frequency
1	Y	30	M	year 8	business	cart	no	daily
2	Y	21	F	A/L	business	cart	no	not daily
3	Y	25	F	A/L	business	cart	no	two times per week
4	Y	60	M	Year 10	business	cart	no	one times per week
5	Y	26	M	Year 10	business	fire	no	three times per week
6	Y	58	M	A/L	business	fire	no	daily
7	Y	53	M	O/L	business	cart	no	daily
8	Y	51	M	O/L	business	cart	no	daily
9	Y	21	M	O/L	business	cart	no	day after day
10	Y	31	F	A/L	business	cart	no	daily
11	Y	28	M	A/L	business	cart	no	not daily
12	Y	50	M	A/L	business	cart	no	daily
13	Y	39	M		business	cart		not daily
14	Y	27	M	A/L	business	cart	no	not daily
15	Y	31	M	A/L	business	cart	no	
16	Y	35	M	A/L	business	cart	no	daily
17	Y	36	M	O/L	business	cart	no	four times per week
18	Y	47	M	O/L	manager	cart		daily
19	Y	40	M	O/L	business	cart	no	daily
20	Y	47	M	Year 10	business	cart	no	daily
21	Y	62	M		business	cart	no	two times per week
22	Y	28	M	Year 8	business	cart	no	daily
23	Y	50	F	O/L	business	cart	no	daily
24	Y	39	F	O/L	business	cart	yes	day after day
25	Y	23	M	A/L	business	cart	yes	not daily
26	Y	25	M	A/L	business	cart	no	two times per week
27	Y	52	F	A/L	business	cart	no	daily
28	Y	65	M	O/L	business	cart	no	daily
29	Y	48	M	Year 8	business	cart	no	daily
30	Y	21	M	O/L	business	cart	no	daily
31	Y	57	F	O/L	business	cart	no	daily
32	Y	42	M	A/L	business	cart	no	daily
33	Y	43	M	O/L	business	cart	no	four times per week

Number	Ps	Age	Sex	Edu	Job	Disposing	separation	frequency
13	G	48	M	O/L	business	tractor	no	daily
14	G	50	M	O/L	business	tractor	yes	daily
15	G	27	M	O/L	business	tractor	no	daily
16	G	47	M	O/L	business	tractor	no	daily
17	G	42	M	O/L	business	tractor	no	three times per week
18	G	44	M	A/L	business	tractor	no	daily
19	G	32	F	A/L	business	tractor	no	daily
20	G	20	F	A/L	business	tractor	yes	not regular
21	G	40	M	A/L	business	tractor	yes	day after day
22	G	32	M	O/L	business	tractor	no	daily
23	G	48	F	A/L	business	tractor	no	
24	G	25	F	A/L	business	dustbin	no	not regular
25	G	30	M	A/L	business	tractor	no	daily
26	G	33	M	O/L	business	tractor	no	daily
27	G	42	F	O/L	No	dustbin	yes	not regular
28	G	34	F	O/L	No	dustbin	no	daily
29	G	32	F	Year 10	No	dustbin	no	daily
30	G	22	M	O/L	business	tractor	no	two times per week
31	G	53	M		business	tractor	no	daily
32	G	45	M	A/L	Surveyor	tractor	no	daily
33	G	51	M		business	tractor	no	daily
34	G	18	F	O/L	business	tractor	no	day after day
35	G	41	M	O/L	business	tractor	no	daily
36	G	35	M	A/L	Pharmacists	tractor	no	daily
37	G	47	M	Year 9	business	tractor	no	two times per week
38	G	56	M	Year 10	business	tractor		daily
39	G	24	M	O/L	business	tractor	no	daily
40	G	50	F	O/L	No	dustbin	no	daily
41	G	30	M	O/L	business	tractor	yes	daily
42	G	31	M	A/L	business	tractor	no	daily
43	G	22	M	A/L	business	tractor	no	daily
44	G	21	M	A/L	business	tractor	no	daily
45	G	40	M	O/L	business	tractor	no	daily

PS-Pradeshiya Sabah
Separation-Whether public
separate or not the waste
Disposing-The place they use for disposing waste
Edu- Education level

APPENDIX 6

Rows: sep Columns: psaba

	1	2	3	All
1	3	3	7	13
2	33	31	38	102
All	36	34	45	115

Chi-Square = 1.337, DF = 2, P-Value = 0.513

2 cells with expected counts less than 5.0

Cell Contents --

Count

Tabulated Statistics

Rows: sep Columns: age

	1	2	3	All
1	8	2	3	13
2	42	42	18	102
All	50	44	21	115

Chi-Square = 3.290, DF = 2, P-Value = 0.193
2 cells with expected counts less than 5.0

Cell Contents --
Count

Tabulated Statistics

Rows: sep Columns: edu

	1	2	3	All
1	0	10	3	13
2	20	50	32	102
All	20	60	35	115

Chi-Square = 4.530, DF = 2, P-Value = 0.104
2 cells with expected counts less than 5.0

Cell Contents --
Count

Tabulated Statistics

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