EAWAG
SANDEC
Water & Sanitation in Developing Countries

University of Asmara
College of Agriculture

Benefits and Risk of the Use of Organic Matter from Asmara Landfill in Agriculture

Proceedings of the Workshop held on 29. April 2004

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Authors and Project Team:

Silke Drescher, SANDEC

Bereket Abraha, Administration of Maakel Region

Dr. Woldeselassie Ogbazghi, College of Agriculture

Dr. Mehreteab Tesfai, College of Agriculture

Sirak Mehari, College of Agriculture

Tedros Kubrom, College of Agriculture

Cover picture
Farmer applying landfill material as fertiliser on his field

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1 Introduction

Land degradation is one of the major problems for low agricultural productivity in Eritrea (Haile, et al., 1998). Particularly soil degradation, droughts and shortage of rainfall has exacerbated to the low crop production in Eritrea. The average yield for most of the cereal crops (under good rainfall conditions) does not exceed 0.7 tons per ha (World Bank, 1994). The causes of soil degradation among others include soil erosion, deforestation, and over-cultivation of land for several years. Consequently, most of the arable soils in Eritrea are very low in organic matter contents and other essential plant nutrients like nitrogen and phosphorus.

One of the methods to increase crop production will be to apply optimum amount of agricultural inputs in the form of organic and/or inorganic fertilizers into the farmlands. There is a tremendous shortage of organic fertilizers in Eritrea, because a larger part of the organic fertilizers (produced from plants and animals) are used as animal feed, fuel wood, and for construction purposes. Nowadays, farmers of AMR have showed great interest in the use of landfill material as a source of plant nutrients and soil conditioner to their fields. This demand is partly driven by the huge demand of fresh vegetables from Asmara metropolitan area as well as the positive effects of landfill material in improving soil properties and increasing production thereby enhancing food security. At present, the population of Asmara is estimated at 500,000 (AMR, 2003). The population is growing rapidly (at a rate of 2.9% annually) and so does the demand for more fresh vegetables are rising up. A large part of the demand for vegetables is met by the local supply from the small-scale horticultural fields located around the vicinity of Asmara.

It is strongly believed that, the use of landfill material on agricultural fields have many advantages. Similar to compost it has a significant effect in improving crop yields and soil properties because the compost contains, among others, Organic Matter (OM) and plant nutrients such as nitrogen and phosphorus. However, farmers have a concern that fields with compost require more water than fields with no compost. Shortage of water is one of the major limiting factors for agricultural production in Eritrea (FAO, 1994).

Apart from this, it is assumed that the landfill material contains different organic and inorganic pollutants. The materials that deserve special attention include are the visible non-biodegradable pollutants like plastics, metals, glasses, bones, etc. Additionally, high loads of invisible heavy metals were found in the landfill which contaminates the organic matter. Even the sieved material is highly polluted. As long as new organic waste in incorporated into the landfill body a further contamination of organic fraction is inevitable, as the landfill contains various sources of unknown substances which can cause the pollution. Some biodegradable wastes, particularly from industrial areas, can contain high levels of heavy metals such as copper, lead, nickel and zinc (Dalzell, et al., 1987). This material is disposed of with other valuable organic materials in the landfill and cause a contamination of the entire landfill.

Though, the landfill material is believed to add valuable plant nutrients and improve soil properties, it is not yet well known where the heavy metals and/or other toxic elements are left behind in the environment (where organic matter is applied). There are no direct visible effects of

the heavy metals to soils, plants, animals, human beings and the environment as a whole. However, there is the risk of heavy metal accumulation in soils or water resources, which need further assessment efforts.

Hence, the AMR was interested in assessing the quality and content of the compost gained from landfill mining and seek appropriate landfill management practices in order to avoid environmental hazards so that a clean and save materials is delivered to the users (i.e. farmers). To investigate these problems and suggest possible solutions, the AMR, CoA, and SANDEC of EAWAG agreed to carry out a research project on the benefits and risks of organic matter from Asmara landfill for agricultural use in urban and peri-urban agricultural areas of the AMR.

The workshop aimed at sharing the gained information and knowledge of benefits and risks of landfill mining with all stakeholders like farmers, the Ministry of Agriculture, Ministry of Health, other Agricultural Research Institutes, and departments of the Administration of Maakel Region.

After presenting the results, ample of time was allocated for in depth discussions and the exchange of ideas for an integrated solid waste management in Asmara. Strategies and actions were defined to improve the quality of organic material provided to farmers in order to mitigate the risks going along with landfill mining and the use of organic material in agriculture.

1.1 Institutions and Personnel

Administration of Maakel Region

Bereket Abraha, Department of Economic Development

Amanuel Tesfai, Cleaning and Sanitation Unit

University of Asmara

Dr. Woldeselassie Ogbazghi, Dean of College of Agriculture

Dr. Mehreteab Tesfai, Soil Science, College of Agriculture

Tedros Kubrom, Environmental Engineering, College of Agriculture

Sirak Mehari, Agronomics, College of Agriculture

EAWAG

Silke Drescher, Department of Water and Sanitation in Developing Countries (SANDEC)

2 Abstracts of Presentations

2.1 History and Current Activities of AMR in Solid Waste Management

Bereket Abraha, Administration of Maakel Region

1. Historical Background

Year	Sanitation office	Dumping Site	Authority
1930-1935	-	Edaga Hamus	Italian Colonial administration
1935-1941	Behind Cinema Roma	Rear of the present Sanitation Office	"
1941-1946	Present Sanitation Office	Modoshto Area	British military administration
1946-1952	"	Adi Abeyto	"
1952-1953	"	Arbe Rebu (present site)	"
1953-1974	"	"	Imperial government (Ethiopia)
1974-1991	"	"	Military Regime (Ethiopia)
1991-1995	"	"	Municipality of Asmara
1996-2002	"	"	Department of Social Services (Central Region)
2003 -	"	"	Department of Economic Development

- An organised sanitary service of Asmara started in 1930
- The present sanitation service office was constructed in 1935
- During the Italian rule, Haileselase's rule and beginning of Dergue regime 1974, sanitation and cleaning service was run by a private Italian company called AGEA
- The company asked for more service payment. The request was rejected and the government took control of management
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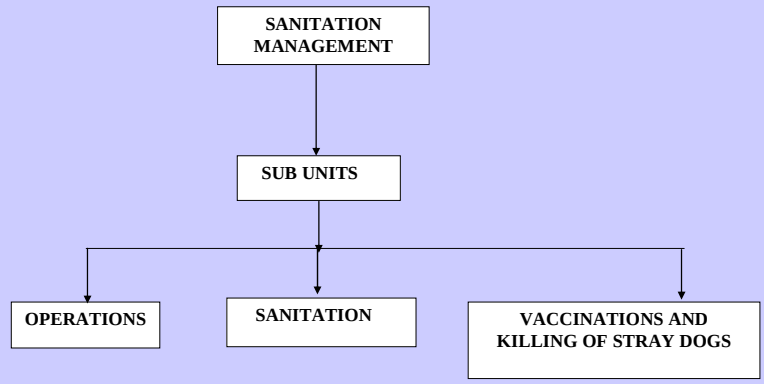
2. Current Organizational Structure of Sanitation Unit



Human Resources:

Male	102	21.5 %
Female	372	78.5 %
Total	474	100.0 %

4. Main Work Accomplished in 2003

636 411	quintals of solid waste refuse were collected and disposed
63 040	Nakfa collected from the sale of decomposed organic landfill material
110	Trees planted near the dumping site and all are in good condition
3 883	stray dogs killed (eliminated)

5. Machinery

Compactors	6
Skip Loaders	6
Ordinary refuse truck	9
Toilet flushing vehicles	3
Vacuum extractors	6
Refuse containers	237

6. Revenue and Expenditure in 2003

Income:	11 736 058 Nakfa	(780 000 CHF)
Expenditures:	6 908 036 Nakfa	(460 000 CHF)
Profit:	4 828 022 Nakfa	(320 000 CHF)

Compost Sales: 46 700 Nakfa (4 600 CHF)

7. Problems encountered

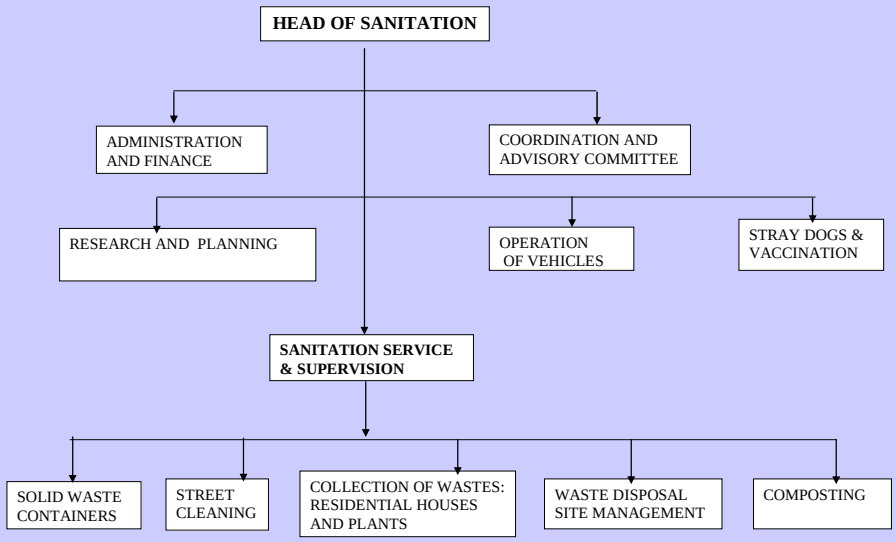
- Delay of purchase of garbage collection vehicles

- The existing trucks are old and depleted

8. Future Plans

- Increase and train its manpower, assign a manager and researchers
- Introduce new and modern machinery, purchase of sanitation vehicles

9. Planned organizational structure



2.2 Successful Stories of Compost Production and its Use in Agriculture

Abstract **Silke Drescher, EAWAG/ SANDEC**

Composting is a natural process, in which micro-organisms biologically decompose organic waste under aerobic conditions in about 3-4 months. The organic matter is transformed into humus and CO2 and the final product can be used as soil amendment in agriculture. Composting is a well known process, widely applied for the reuse of all kinds of organic wastes in agriculture. Municipal Solid Waste also is a source of raw material for compost production, as the organic fraction in the Solid Waste often amounts up to 60 - 70 % - like in Asmara. Currently in Asmara composting is not applied as farmers use the degraded organic matter from the landfill site as soil amendment (so called landfill compost). However, composting is a real option for the case of Asmara due to the existent demand for organic matter. The appropriate scale of a composting scheme depends on the size of the city, availability of space and existing solid waste management practises. During several studies in other countries SANDEC identified three main categories of composting schemes:

- **Centralised Composting** is a highly mechanised scheme treating up to 100 tons of waste per day. Hence, such schemes can treat the municipal waste (mainly mixed) of an entire city. Investments and operation costs are considerably high due to the equipment, power demand and maintenance. The composting scheme of Luxor in Egypt is one example. Mixed organic waste is delivered to the composting plant, where it is sorted into recyclables, organic matter and residues. The organic fraction enters the composting process, while the recyclables are sold and residues are disposed of at the nearby landfill site. The compost is used by farmers of the Luxor region. They apply it before planting season as soil amendment in combination with artificial fertilisers.
- **Medium Size Composting** is a slightly mechanised process, allowing the treatment of 2 - 10 tons of organic waste per day. The investments are moderate due to more manual steps of operation. Hence the process is more labour intensive. Systems like this are suitable for bigger cities where transportation of waste is difficult due to the long distance to the landfill site. The decentralised approach allows a reduction of transportation as up to 60 % of the waste is already treated close to the source of generation and only residues need to be transported to the final disposal. One example of a medium size composting scheme is found in Dhaka, Bangladesh where mixed waste is collected and sorted prior to composting. The NGO Waste Concern does not directly sell compost to farmers as they lack the marketing capacity. The sell the compost to a fertiliser company which amends it with further nutrients and sells it successfully to farmers all over Bangladesh. Planting trials proof the beneficial effects of compost application. The yield could be increased while the amount of artificial fertiliser use was reduced.
- **Decentralised composting** describes composting schemes treating up to 2 tons of organic waste per day. These little schemes are duplicated all over the city and are managed by trained individuals or community organisations. Such systems have a high potential of re-

ducing the waste amount to be transported to the landfill site as more that 60 % of the waste is treated directly where it was generated. The investment costs of one scheme are low as very simple technologies can be applied. Another main benefit is the very low operation cost of such schemes compared to the centralised approach. However, the success of decentralised composting heavily depends on the organisational set up (decentralised) and the awareness of the citizens and continuous motivation and guidance of the municipality.

All system described have in common a high potential in semi-arid countries to

- prolong the lifespan of a landfill site, as more than 50% of waste is already treated before
- improve compost quality due to a controlled process of composting and the elimination of hazardous substances
- contribute to an increase of agricultural production due to the recycling of organic matter and nutrients.

2.3 Quality of Landfill Material used as Compost on Farmers Fields

Abstract

Mehreteab Tesfai, College of Agriculture, University of Asmara

Silke Drescher, EAWAG/ SANDEC

Compost has been used for agriculture in many parts of the world for centuries. In Eritrea, farmers have used to apply compost (produced from Asmara landfill site) into their fields since the early 1940s. Field surveys were carried out in selected farmers' fields in Zoba Maekel to investigate the benefits gained from applying compost and the risks of using landfill compost for agricultural production. In total, 19 soil samples were collected from fields, which have received compost as well as from inside and outside landfill site for physical and chemical analysis. Chemical analysis was made on plant nutrients and heavy metal contents of the samples in the laboratory. The average organic matter, total N and total P contents of the composted soils measured 2.4%, 0.13% and 0.06%, respectively which are much higher than the average nutrient contents of the rest of soils found in Eritrea. By and large, the landfill compost has noticeably improved the physical and chemical fertility of the soils in the farmers' fields. However, the heavy metal concentration of the compost particularly Pb, Cr, Cu and Zn at the landfill site were very high and were above the permissible limits. These metals could cause severe damage to the soils, plants, animals and eventually to human beings (through the food chain) in the long term. Therefore, it is imperative to search for appropriate measures to reduce the heavy metal loads in the landfill compost so that the compost could be used safely for improving soil fertility and productivity without polluting the environment.

Key words: Compost, heavy metals, landfill, plant nutrients, Zoba Maekel.

2.4 Socio-Economic Study on the Perceptions and Use of Landfill Material

Abstract **Sirak Mehari, College of Agriculture**

The agricultural output in Eritrea is low due to intricately interrelated factors including land degradation (decline in soil fertility, drought and other ecological limiting factors) In order to solve these problems, farmers in Zoba Maakel apply landfill organic matter to compensate for the soil fertility decline. In view of this, a research on “The benefits and risks of the use of Landfill Material for Agricultural Purpose” was carried out in Zoba Maakel. Major issues addressed are the contents and quality; the demand and supply; the cost and benefits of landfill organic matter and farmers perceptions and willingness to pay for landfill material.

In this study, data was collected at two levels: landfill site-level and at household-level, using structured questionnaires. At the household level, socio-economic data was collected from 9 villages and 47 households on the merit of landfill application while other seven farmers who do not apply landfill organic matter were selected for comparison. In total 54 farmers were interviewed during the survey period from May-August 2003.

The study shows that the main purpose of the landfill mining from the AMR point of view is to save space on the landfill site, use the landfill organic matter for agriculture and hence increase the productivity. Commercialisation of landfill organic matter is not a new practice to farmers but the total volume seems to have increased after 1997 when the AMR took the initiative to promote its sales to farmers. The annual sales volume is estimated at 4000 m^3 of landfill material. Farmers do not come themselves to pick up the material and hence it was not possible to trace back the farmers using the landfill organic matter.

Farmers apply the landfill organic matter to both rain fed and irrigated agriculture. Nonetheless, they repeatedly pointed out that the application of landfill organic matter demands large quantity of water and hence are not a good choice during periods of moisture stress. There are two main reasons why farmers apply landfill organic matter to their farms. These are either to replace other sources of organic matter or replace both organic and inorganic fertilisers. Besides, farmers apply landfill organic matter to supplement other sources of organic fertilisers. Farmers are obliged to use landfill material as the other sources of organic matter are scarce, unavailable or expensive.

When asked concerning their perception on different aspects of landfill organic matter farmers understand that application of landfill organic matter has many benefits. both small and large scale farmers apply it as it increases the yield of crops, improve soil (conditions) structure and ameliorated the health conditions of leaves of fruit trees. the application rate on a hectare basis of landfill organic matter is difficult to determine. Some farmers with small holding apply more while others with large holding apply less amount of landfill material.

Farmers perceive that landfill organic matter increases yield but not as much as manure, while its availability and price is attractive. However, the price for landfill material is low (60 Nakfa), while the transportation costs increase with the distance (650 Nakfa)

Nevertheless, they think that landfill organic matter is only good for certain crop types. Furthermore, it requires more labour as it contains un-

wanted materials that provoke health and environmental concerns. Farmers do not have clear ideas about the effects of the invisible pollutants present within the landfill. The presence and effects of heavy metals are not known. Overall, the attitude of farmers towards the landfill organic matter is positive with concerns about the presence of unwanted materials that constitutes 60 % of a given volume. Farmers expressed their willingness to pay more if it is sieved and sorted at the landfill site. In view of this, the study recommends to improve the quality of the landfill material before sending it to farmers.

2.5 Assessment of Potential Organic Waste Generators in Asmara and Composting

Abstract

Tedros Kubrom, College of Agriculture and

Christian Müller, SANDEC

Solid waste composting from source separated organic waste (OW) is an environmentally and technically feasible option to improve the quality of compost and supply farmers and other urban users with good quality organic fertilisers. Thus, a research was initiated to assess the major OW generators and the potential for compost production in Asmara. The information and data required for the study was colleted by undertaking interviews, discussions, field visits and measurement (volume and weight of waste).

The result indicate that restaurants, snack bars vegetable markets, vegetable and fruit wholesalers are the most potential generators of OW in Asmara. They generate a minimum of 2100 t and a maximum of 3700 t of OW per year. This can result in a compost production of 712 to 1200 tons of compost which can cover 39- 68 % of the current demand for organic fertiliser in Zoba Maakel. Food factories, bakeries, cafeterias, garden services etc. also generate substantial WO but currently it is used for other purposes such as animal feed and firewood. The study revealed that people were willing to separate their waste. However, they require additional storage equipment and daily collection in the evenings in order to allow them a decent disposal of the organic waste. Especially restaurants and snack bars are very sensitive to a reliable collection in time as they must avoid smell which could distract customers. Asked about their knowledge on composting they were less aware of the benefits of composting.

The separate collection and treatment of OW from the establishment assessed during this study is an opportunity for the municipality to have easy access to the raw material and to gain experience with composting. It is possible to compare the different quality of compost and the landfill material. However to set a pilot composting scheme, some preconditions have to be fulfilled. These include:

- setting up a policy and a strategy for OW collection
- integrating the concern and advice of the addressed establishments
- assign responsibilities within the Sanitation Unit
- set up of a compost sieve and
- allocate time of the front loader to allow the turning of the organic waste.

3 SWOT Analysis – Solid Waste Management and Landfill Mining

The SWOT analysis is meant to identify the Strengths, Weaknesses, Opportunities and Risks of an organisation and its activities in a fast and efficient way. **Strengths and Weaknesses are defined as internal factors** which can be directly influenced by the assessed organisation. The organisation is able to take direct measures in order to eliminate weaknesses or profit from their strengths inside their organisational set-up. **Opportunities and Risks are external factors** which hardly can be influenced by the assessed organisation. However, it is possible to take actions, in order to profit from Opportunities or to minimise potential Risks.

After the presentations, the participants have an idea of the current system and heard about possible perspectives. All participants were invited to give their point of view on the current solid waste management system in Asmara and the Activity of Landfill Mining.

The outcome of the SWOT analysis reflects and summarises the plenary discussion, which already started after the presentations in the morning session. The statements address the following aspects:

citizens, landfill management, collection, waste generation, compost use, current landfill mining, administration and management, knowledge

The statements in bold letters were put forward by several participants and should reflect the importance of the concerns.

3.1 Strengths

- Organisation of the study to find out about the use of landfill material
- Organisation of workshop concerning landfill mining (involve stakeholders)

- **Asmara is a clean city – the Municipality collects the waste in time – well organised waste collection and dumping of waste**
- Collection for households and commercial places
- Citizens are instructed to dispose of their waste correctly and they follow the instructions
- Network and long history / tradition of waste collection and landfill mining
- labour, infrastructure and facilities hold by the municipality (sweepers, collectors, ...)
- **Municipality is aware of recycling potentials**
- Willingness on the side of the municipality to recycle the wastes of Asmara. If helped and funded by donors, it can be easily put into action.
- **Availability of huge amount of organic matter accumulated in the landfill over 60 years**
- Desire to have the landfill site less expanded
- ample space for dumping

- **Municipality has the capacity to sell landfill material and compost**
- Centralised management allows control of the system
- knowledge of farmers about availability of landfill material and demand
- cheap product containing important nutrients N,P,K

- reduces the high costs of mineral fertilisers use
- helps to improve the physical, chemical and biological soil properties
- increase in yield which may positively impact on our food production
- support farmers which cannot afford other commercial fertilisers
- plenty of waste to produce compost

3.2 Weaknesses

- lack of national or regional (publicised) waste management policy supporting integrated waste management and reuse/recycling
- no policy on solid waste treatment in scientific way
- severely centralised management system
- SWM does not separate the organic and non-organic fraction during collection or afterwards
- no spare trucks available for separate collection

- **lack of knowledge on composting process, standards and quality**
- Weak follow up some times
- lack of spare parts
- unskilled persons which cannot analyse the contents of the site
- illegal dumping
- **management problems resulting from low payment (salary) – payment does not reflect the work which is done**
- **lack of trained and skilled manpower**
- **low salary, no insurance, lack of motivation**
- **they don't use convenient protective measures for workers**
- need more investment and human labour
- lack of staff in municipality - work is "laborious"
- high price resulting from application of modern technology
- **old machinery, depreciated material - not enough transportation to collect the garbage - poor equipment installation in landfill mining**
- budget constraints
- dumping in one site
- burning landfill due to insufficient landfill management (compaction and cover)

- **composition of the unused waste unknown - all wastes are combined together**
- **non degradable materials (60 %) (heavy metals, plastics, metals large quantities)**
- old landfill material has already lost a lot of its potential benefits
- **high transportation cost, as also rejects (60 %) are transported to the fields**
- landfill material is heterogeneous with large percentage of none soil material - distribution of waste to farmland!
- **the don't use special equipment to the purification/ sorting of the landfill material before sale**
- It has got a disadvantage because of the environmental pollution problems
- health treat for farmers due to the effect of heavy metals
- **Municipality does not identify the side effects of the landfill compost - lack of knowledge of the impact of contaminant - its environmental impact is not properly addressed**

- need more land
- increasing transportation cost with increasing distance
- they don't have their own cars for transporting the compost for the place of duty
- lack of awareness from farmer side
- lack of public awareness

3.3 Opportunities

- **Asmara is clean enough to maintain the system and introduce recycling, room for improvement of solid waste management (integrated management)**
- citizens react on new instructions, when it is explained and supervised
- short transport distance from city to landfill (6 km - try to keep the site)
- Influence/ train workers to improve their work performance, train manpower on the field (farmers)
- decentralisation of the Sanitation Unit and management system
- **define a strategy to minimise the negative effects of heavy metals**
- **improvement of quality of landfill material - sorting and use as fertiliser**
- **create jobs and cash/ income to the municipality or the enterprise who will run the system**

- **high demand and large market for organic fertiliser/ landfill material**
- **no competing products (animal manure, agricultural products)**
- steadily increasing demand due to good quality and **good acceptance of the farmers**
- start composting of incoming organic waste
- **low cost natural fertiliser** - shortage of foreign currency for importing fertilisers -> recycling of waste products to be used as local fertiliser is a good opportunity for Zoba Maakel
- save foreign currency for other projects

- **organic waste will be used as a source of improvement of soil fertility**
- **compost production from organic waste - test of composting in a pilot plant**
- **bulk generators of organic waste are identified (markets, restaurants,)**
- separated waste collection, advanced techniques for compost production
- provide good quality and mature compost to farmers
- further study will bring knowledge on compost production and its application
- **land consumption for solid waste management can be reduced – space saving in the landfill**
- prolong the life span of the landfill (with both - mining and composting)
- Municipality can use the same site for years by recycling the existing/ incoming waste

- **increase productivity in agriculture – farmers can increase income**
- improve environmental protection
- interaction with other stakeholders (EAWAG, NRI, University)
- open for research results
- University & other educated parts of the society are exposed to education, research and application to modern waste management concepts

3.4 Threats

- landfill is filling up too quickly and continues burning

- untrained workers are exposed to waste
- **lack of national policy and strategy**

- **lack of composting skill it is a health threat to the people, water and soil**
- lack of knowledge on composting, standards and quality

- **visible pollution in landfill material (has to be sieved)**
- potentials for health risks (invisible pollutants)
- **heavy metals and toxic chemicals in landfill material endanger the human health and lead to environmental pollution (water, soil, plants, human)**.
- **unknown effect of heavy metals on plants and consumers (distribution chain not clear)**
- affect the ground water quality, the environment in general through evapotransition
- farmers have direct contact with compost/ landfill material – danger to inhale landfill material (HM) during spreading
- landfill material causes contamination to water sources during rain seasons

- **cost of transport for landfill material (must be decreased)**
- lack of awareness in the community
- **acceptance of the landfill material may be decreased**
- the compost may not be cost effective
- imported cheaper fertiliser in the long run

4 Group Work and Discussion

4.1 Solid Waste Management Strategy of Administration of Maakel Region

Policy of AMR regarding Landfill Mining and SWM

- How can the AMR policy address the weaknesses and threats of landfill management?
- What are the country's policies towards landfill management in general and composting in particular?

Although good practices and guidelines are in place, there is no well thought out all embracing policy.

Recommendation

Formulation of the policy guidelines on waste management including upper limits of concentration for heavy metals and other toxic chemicals.

For better management, decentralization of the sanitation unit is essential

1. Introduction of segregation at origin.
2. Re-use and re-cycling of recoverable materials (The three Rs: Recovery, Reuse and Recycling
3. Continue research on products produced using landfill composting to ensure safety.
4. Sorting and sieving of the landfill compost before distribution to the farmers.
5. On the basis of research, produce guidelines on how much and how often landfill compost should be used.
6. On the basis of research, produce guidelines on the types of crops for which landfill compost is not recommended.

4.2 Measures to Mitigate Risks of Landfill Mining in Asmara

The group discussed the question:

How to mitigate the risks of landfill compost?

The group was composed of people from Ministry of Agriculture, Research Centres, extension agents, Ministry of Health and Environmental Health, Geologists, farmers' representatives and sanitation experts from Administration of Maakel Region.

All members expressed their views towards landfill material use in agriculture from their professional point of view. Especially the issue of the high heavy metal content was intensively discussed:

- Farmers expressed their need for organic fertiliser again. For them landfill material it is an important source of fertilisers. If they have not access to the material the crop yield is diminished. They have no alternatives. (currently, AMR stopped the distribution due to the study)
- Experts from the Ministry of Agriculture strongly stressed that the nutrient contents must be known and then judged if the material is applied onto fields.

- The Environmental Health expert was concerned about the possible effect of the landfill material on human and animal health. He proposed further studies on plants which were grown on the landfill material.

The group defined risk factors divided in risks on the landfill site and on agricultural land. Finally they developed mitigation measures addressing the risks. The results are listed below:

Risk 1: Great percentage of visible impurities in organic matter

- Farmers and animals could be injured by scrap materials (fear of HIV infection)
- Residues create now dump sites in rural area
- Pollution of water bodies (along rivers)
- Sorting increases working time, labour and energy

Mitigation measure:

- sieve material on the landfill site through a 10 mm sieve
- collect industrial waste and municipal waste separately
- dispose industrial and municipal waste separately on the landfill site

Risk 2: High heavy metal content in organic matter

- farm land might be polluted over time
- toxic effects to plants and humans is not known
- health problems for humans trough uptake via respiratory system
- penetration of heavy metals into the groundwater system and pollution of wells

Mitigation measure: Eliminate Heavy Metals by

- separate collection of wastes which contain high amounts of pure organic waste (e.g. snack bars, restaurants, vegetable markets and nurseries)
- separate disposal of waste with high organic compounds
- better landfill management
- start composting

Risk 3: Lack of detailed information on heavy metals

Mitigation measure:

- carry on research on behaviour of heavy metals in soils and water
- study the advantage of compost versus landfill material
- investigate amounts for efficient compost application

4.3 Plenary Discussion

What about existing studies on the risks of heavy metals?

Why do you want to implement segregation?

What is happening to the segregated material?

- Segregation is generally good. At least the organic part can be disposed of separately for scrap and hazardous waste.
- Landfill compost from segregated waste will have a better quality
- One can think of establishing other technologies or setting up a new modern landfill (then start using methane coming from landfills)
- It doesn't matter which system is chosen (biogas, compost) but segregation should be phased in.

Several participants consider the landfill as a resource of organic matter. However, it was acknowledged that landfill material contains hazardous loads of heavy metals even after sieving, which are a health risk to farmers and animals. Some suggested banning landfill material on their fields. The present farmer stated that farmers need the landfill material as they don't have another choice. Hence it is necessary to find immediate actions how to reduce the risks of landfill compost. Apart from sieving, the following suggestions were made:

- avoid to touch the landfill material
- prevent children from playing with the landfill material
- protect mouth and nose while spreading the landfill material
- continue research on effects of landfill compost on human and animal health

There is a discrepancy between the existing knowledge and the recommendations of the use of landfill material. On the one hand they fear the risks on the other hand they recommend the use in agriculture. Discussing about composting organic waste prior to landfill disposal, several participants doubted and improvement of quality and requested further studies. This issue was not critically discussed in the case of landfill material.

The issue of compost production from organic waste was taken up reluctantly from several participants. It became clear that the process of composting is not well known in Eritrea

The long-term measures are to general and theoretical. What are the immediate actions necessary, to improve the current system? (not only long term measures)

- Establish Sieving Equipment
- Develop Strategy for separate collection of organic waste from bulk generators
- Start the Pilot Composting Project

A Change in Solid Waste Management is a long process but it has to be started!

Zoba Maakel should try to establish partnerships with NGO to start policy to allow cooperation and to look for assistance (even from the private sector).

(Bangladesh case was mentioned)

Separation of waste at household level is difficult to establish, one initia-

tive in a colony failed due to the lack of awareness. CSU has different priorities at the moment.

- Improve management in general
- capacity building and training
- purchase of new machinery and trucks

4.4 The Way Forward

The workshop went well; participants actively contributed to the workshop and expressed their ideas on how to manage the landfill compost in the future.

Farmers are confronted with immediate soil fertility decline, which results in the reduction of the crop output. It is more likely that farmers will continue to use landfill fertilizers for crop and fodder production, though the risks are known:

There is high concentration of certain heavy metals in the landfill site.

The study shows that there is low level of the metals in the farmers' field. But it is not yet known where these metals end up in the ecosystem?

Considering this, it is essential to design strategies to mitigate risks and find long-term solutions to the environmental and health issues raised. Based on this, the workshop has come up with the following strategies.

1. Need for research in material flows. Where do the hazardous substances and nutrients go?
2. Conduct pilot project to study the feasibility of organic matter composting under aerobic conditions
3. Introduce sieving equipment to sort out the unwanted materials (both from landfill material and solid waste compost)
4. Phase- out the landfill mining and replace it by new techniques (e.g. composting)
5. Monitoring and evaluation of the organic matter in comparison to the landfill compost.

Policy Formulation

1. Formulation of the policy guidelines on waste management
2. Including upper limits of concentration for heavy metals and other toxic chemicals.
3. For better management, decentralization of unit is essential
4. Introduction of segregation at origin
5. *(Advice the municipality on solid waste management)*
6. Re-use and re-cycling of recoverable materials (The three Rs:

Recovery, Reuse and Recycling.

Landfill Use (Short Term)

7. Use landfill material in the short-term by sorting and sieving of the landfill compost before distribution to the farmers.

    a. Immediate measures (home work to the Zoba), action plan in the short-term:

    b. Improve management

    c. Recruit qualified personnel in landfill

    d. Set up separate collection for specific organic waste from bulk generators

    e. Set up pilot project on organic waste composting

    f. Gradually phase out the current landfill management by environmentally friendly management system

Research:

8. On the basis of research, produce guidelines on how much and how often landfill material or compost should be used.

9. Continue research on products produced using landfill composting to ensure safety.

10. On the basis of research, produce guidelines on the types of crops for which landfill compost is not recommended.

Establish partnerships with other stakeholders

5 Annexes

5.1 Programme

Session 1	**Introductory Remarks**	
9:00 – 10:00	**Chair: Dr. Woldeselassie Ogbazghi**	Mr. Semere Resom, Governor
	Opening Remarks and Introduction of Participants	Mr. Bereket Abraha, Head of Dept. of Economic Dev.
	Current Status of Asmara Solid Waste Management and Planned Activities	Mrs. Silke Drescher
	Successful Stories of Composting and Compost Use	
	Discussion	
Session 2	**Research Results**	
10:00 – 12:00	**Chair: Dr. Iyassu G/ Thatios**	Dr. Mehreteab Tesfai
	Analysis of Landfill Compost	Mr. Sirak Mehari
	Farmers Perception and Willingness towards Landfill Material	Mr. Tedros Kubrom
	Assessment of the Potential of Organic Wastes & Treatment Option in Asmara	
	Lunch Break and Video Show	
Session 3	**Group Work and Discussion**	
14:00 – 16:30	**Dr. Woldeselassie Ogbazghi / Silke Drescher**	
	SWOT Analysis	
	Waste Management of AMR and Landfill Mining	
	Group Discussion	
	Group 1: AMR Policy towards Landfill Mining	
	Group 2: How to Mitigate Risks of Landfill Material?	
	Group Presentations and Plenary Discussion	
Session 4	**Plenary Session**	
16:30 – 17.30	**Chair: Dr. Mehreteab Tesfai**	Dr. Woldeselassie Ogbazghi
	The Way Forward	Mr. Semere Resom
	Closing of the Workshop	

5.2 List of Participants

No.	Name	Department/Unit	Responsibility	Telephone
1	Ainom T. Yohannes	AMR	Research & Planning, Sanitation Unit	11 64 57
2	Asrat Haile	MoA Zoba Maakel	Unit Head	12 63 33
3	Bereket Abraha	Economic Development, AMR	Dept. Head	18 95 27
4	Dr. Berhane Girmay	UoA Chemistry	Ass. Professor	16 19 26
5	Dr. Kasete Araia	MoH Environmental Health	Head	12 02 97
6	Efrem Mathewos	Zoba Maakel, Economist.	Head of Prod. Plants	18 45 26
7	Tsehaye Sbahtu	Farmer form Serejeka	Farmer	15 90 70
8	Habtom Araia	UoA College of Agriculture	Student, Land Resources & Environment	15 93 43
9	Haile Ghide	MoA Zoba Maakel	Head, Agriculture	20 94 63
10	Haileab G/Egziabiher	MoA Zoba Maakel	S/Branch Head	1263 33
11	Dr. Iyassu G/Tatios	MoA Research	Senior Soil Expert	15 98 41
12	Kiflemariam Abraha	MoA Research	Senior Soil Research	15 98 41
13	Mattia Wegmann	ETH/IRL	Project Officer	+411633 48 74
14	Mebrat Gebreab	Water Resource Dept.	Water Quality Lab.	1162 65
15	Dr. Mehretab Tesfai	UoA Dept. Land Resource & Environment	Ass. Professor	151343/162607
16	Dr. Mengist Teklay	UoA Earth Science Dept	Asst. professor	16 1926/11 49 97
17	Mulubrhan Yohannes	Environment	Env. Representative of AMR	11 91 07
18	Mulugeta Asmelash	Dept. of Land, MoLWE	Land Use Planning	1178 81
19	Negusse Abraha	MoA Researcher	Senior Researcher	15 96 01
20	Rahel Girmai	UoA Chemistry Dept.	Lecturer	16 19 26
21	Robert Zekristos	MoH environmental health	Ph.D	12 92 97
22	Sebhatu G/Micahel	IT Unit	Municipality of Asmara	12 49 22
23	Semere Resom	Governor of AMR	Governor	189527
24	Senayt Tekleab	MoH	Sanitation	12 10 45
25	Silke Drescher	EAWAG/SANDEC	Project Officer	+4118235025
26	Sirak Mehari	UoA, College of Agriculture	Lecturer, Head Agri. Economics Unit	16 26 07
27	Solomon Mebrahtu	UoA College of Agriculture	Student Land Resources & Environment	15 93 43
28	Solomon Tesfamaraim	MoTI, Dep. Industry	Desk Head Food In.	11 62 10
29	Teberh Gaime	MoA Zoba Maekel	Horticulture	12 63 33
30	Tedros Kubrom	UoA, Dept. of Land Resources and Environment	Lecturer	15 93 43
31	Dr. Weldeselasse Ogbazgh	UoA, Dean College of Agriculture	Ass. Professor	1626 07
32	Yemane Abraha	MoA Zoba Maekel		20 24 63

5.3 Power Point Presentations

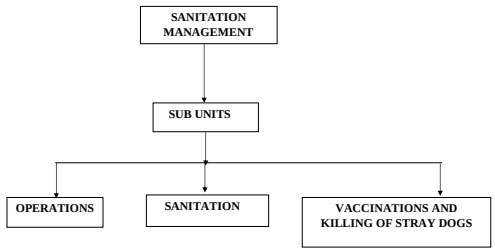
Historical Background of Sanitation and Cleaning Services of Asmara

1. Historical Background of Sanitation and Cleaning Services of Asmara

Year	Location or Site		Authority / Government
	Sanitation Office	Dumping Site	
1930-1934	-	Edaga Hamus	Italian colonial Administration
1935	Behind Cinema Roma	Rear of the present Sanitation Office	" "
1935-1941	Present Sanitation Office	Modoshto Area	British military administration
1941-1946	" "	Adi Abeyto	" "
1946-1952	" "	Arbe Rebu (Present Site)	" "
1953-1974	" "	" "	Imperial government of Ethiopia
1974-1991	" "	" "	The Military Regime of Ethiopia
1991-1995	" "	" "	Municipality of Asmara The State of Eritrea
1996-2002	" "	" "	Department of Social Services (Administration of Central Region)
2003-2004	" "	" "	Department of Economic Development (Administration of Central Region)

* An organized sanitary service of Asmara started in 1930.
* The present sanitation service office was constructed in 1935.
•During the Italian rule, Haileselase's rule and beginning of Dergue's regime 1974, sanitation and cleaning service was run by a private Italian company called AGEA
* The company asked for more service payment. The demand was rejected and the government took control of management

2. Current Organizational Structure of Sanitation Unit



3. Human Resources

Sex	Number	Percentage
Male	**102**	**21.5**
Female	**372**	**78.5**
Total	**474**	**100**

4. Main work accomplishments of the year 2003

636,411	Quintals of solid waste refuse were disposed (collected).
63,040.00	Nakfa collected from the sale of decomposed organic material.
110	Trees planted near the dumping site and all are in good condition
3,883	Stray dogs killed (eliminated)

5. Machineries

Type of Machinery / Equipment	Number
Compactors	6
Skip Loaders	6
Ordinary refuse truck	9
Toilet flushing vehicles	3
Vacuum extractors	6
Refuse containers	237

6. Revenue and Expenditure for the year 2003

Income: 11,736,058.63 Nakfa.

Expenditure: 6,908,036.52 Nakfa.

Profit: 4,828,022.11 Nakfa

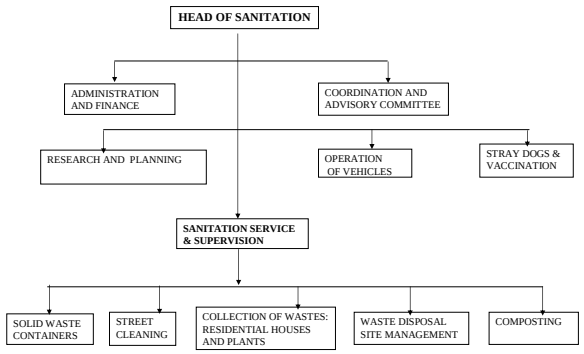
7. Problems encountered

* Delay of purchase of garbage collecting vehicles.
* The existing trucks are old and depleted.

8. Future plan

- ncrease and train its manpower, assign a manager and researchers.
- ntroduce new and modern machinery,purchase of sanitation vehicles.
-

9. Planned organizational structure



Assessment of Major Organic Waste Generators and Potential Treatment Options in Asmara

Christian Muller and Tedros Kubrom
April, 2004

Introduction: Why composting from source separated organic waste (OW)

- presence of contaminants in MSW
- scattering of waste (scrap) to farm fields
- lack of suitable technologies to refining the landfill compost
- an increased concern about heavy metals
- consequent lack of confidence among farmers and other potential users

Cont...

- Reduce inconvenience during landfill operation (smell, fire & lechate)
- It is an environmentally sound and technically feasible way to improve the quality of final compost

Objectives of Project

- **General**: to aid in facilitating decision-making and strategic planning for investments and project development in SWM of Asmara.
- **Specific**: Assess the amount and location of OW generated in Asmara, as well as treatment options for OW on the landfill site.

Activities

- identify main sources of OW
- assess the amount of OW from these sources
- assess the awareness and willingness of people, in these source, to separate OW
- identify problems associated with source separation of OW
- identify feasible options to collect and transport this source separated OW
- assess feasible options for establishment of a sieving machine.

Methodology

- Literature review (local & International)
- Interview (semi-structured questionnaires)
- Discussion (formal& informal)
- Measurement (volume and weight of separated waste)
- Qualitative and quantitative analysis

Problems during study

- Some people did not want to talk about waste
- Some SB used the buckets for water collection
- Some did not separate timely & properly
- Miscommunication B/N managers and workers (affect separation)

Result and Discussion

Table 1: Priority List of OW generators

Priority one	**Priority two**	**Priority three**
Restaurants	Wholesalers of flower shops	Wholesale & retail engera
Snack bars	Food factories	Fast food
Flower shops	Bakery	Coffee shop
Vegs. & fruit wholesalers	Carpenter's shop	Grain mill
Gardening service	Slaughter House	Wholesale grain & cereals
Vege. markets	Fish market	Pastery

Restaurants and Snack bars

- **Restaurants**
- Total No: 192
- Sample (interview):26
- Sample (measured):17
- Duration: 1-2 days
- 79% of OW goes: CSU
- 21% of OW goes: animal feed
- generate: 41.1t-61.1t/month OW

- **Snack bars**
- Total No: 178
- Sample (interview): 23
- Sample (meas.):13
- Duration: 1-2 days
- 74% of OW goes: CSU
- 26% of OW goes: animal feed
- generate: 77.1t-124.7t/month OW

Vegetable market

- **Centralized**
- Piasa, Meda-Eritrea, & Edaga-laka.
- Special route:1 truck, twice
- weight bridge
- Amount/day**:**1.2-1.48t = **1.34t**
- **Amount/month:40.2t**

- **Decentralized**
- Enda-Selassie area
- skip, emptied and filled (in 16days)
- weight bridge
- Amount/16days:**3.3t**
- **Amount/month:6.2t**

Vegetables and fruits wholesalers

- Total No.: 78
- Samples: 5
- Amount/day: 5-30 kg/shop
- Amount/month: 0.15-0.9 t/shop
- Total amount/month: **11 - 66.6 t**
- exceptional days {holidays}: 0.7-1.2 t/day/shop

Flower Shops

- **Retail:**
- number is small (12) – waste generation is also small – some reuse their green waste already

- **Wholesale**
- Number is small (3) – reuse of their own green waste
- Sarina Nursery already tried to start composting their green waste

Other Generators assessed

- Gardening Services – other reuse of OW
- Food Factories – OW reused for animal feed
- Cafeterias – OW reused for animal feed (up to 9 t/ day)
- Bakery – little OW – for animal feed
- Carpentry – sawdust used for other purposes
- Slaughterhouse - not very suitable for composting

Summary of OW Generation

Establishment	Weight of OW (Min) [t/month]	Weight of OW (Max) [t/month]	Weight of OW(min) [t/year]	Weight of OW (Max) [t/year]
Rest.	41.1	67.9	500.1	826.1
SB	77.1	124.7	938.1	1,517.2
C. Vege. Market	40.2	40.2	489.1	489.1
D.Vege.market	6.2	6.2	76.7	76.7
Veg & fruit WS	11	66.6	133.8	810.3
Total OW	**175.6**	**305.6**	**2137.8**	**3719.4**
Potential of compost	**58.5**	**101.9**	**712.6**	**1239.8**

Awareness & Willingness

- 54% of Res & 35% of SB heard of composting
- 92% of Res & 100% of SB willing to separate Org & Inog waste.
- Concerns (separation):
  - require for additional storage equipment
  - waste is already separated for animals, thus no enough space for additional bucket
  - require everyday collection
  - workers require incentive for additional work

Sieving Equipment

Sieving Equipment

- Separate compost from scrap and residues
- Concern: affordability & effectiveness (simple and low-cost available in LDCs)
- Capacity 20-30t/day to satisfy current demand
- 3 Options discussed:
  - can build the drum: detailed design neccessary& import most materials
  - can build with the support of foreign expert: finding expert might be difficult and expensive; imported materials.
  - Import the whole drum: expensive; maintenance

Conclusion – Compost Potential

- Restaurants, Snack Bars, Veg.Market, Veg & Fruit Wholesalers generate up to 270 t of organic waste per month (2700 t/ year)
- Most of them are located in the centre of Asmara
- This waste can be easily collected and composted
- Compost production in a pilot plant would generate **712.6t** (min) up to **1239.8t**(max) of compost.
- Cover **39%-68%** of the compost demand in 2002

Concl. – Collection/ Composting

- Gaining first experiences with composting
- Waste collection need to be adjusted to the needs of compost production
- Concerns of the people should be considered when implementing the separate collection
- OW Compost quality can be compared to Landfill Compost
- Source separation of OW can be a good start for other schemes (e.g.plastic,paper…)

Conclusions - Policy

- policy and strategy on source separation and composting should be established
- an urgent decision should be made and action should be taken on either to import or built a screening machine
- awareness of the people should be increased using guidance information and public media
- people are willing to separate waste if they are advised and guided

Final Remarks

- While phasing in composting, landfill mining can be continued but phased out in the long run.
- In the long run clean OW compost can substitute landfill compost

- **Recommendations:**
  - Further studies should be made to see seasonal fluctuation of waste generation and other potential generators (households)

Physico-Chemical Analysis of Asmara Landfill Compost

Mehreteab Tesfai*

*University of Asmara, College of Agriculture, Department of Land Resources & Environment, P.O.Box 1220, Asmara, Eritrea.
E-mail: mehreteabt@yahoo.com

Outline

1. Introduction
2. Objectives of the Project
3. The Project area
4. Activities and Methods
5. Descriptions of Landfill components
6. Physical analysis of Landfill compost
7. Chemical analysis of Landfill compost
8. Concluding Remarks

1. Introduction

K Agriculture (in Eritrea) provides the largest labor force. However, agricultural productivity is low.

- Soil degradation: soil fertility and productivity decline

KImproving soil fertility & increase crop production

- Organic fertilizers (e.g. Asmara Landfill compost)

K Benefits of Landfill compost

- Source of plant nutrients (OM, N, P) and soil improvement.

1. Introduction (Cont.)

K Risks of Landfill Compost

- Heavy metals contamination (Pb, Cu, Cr, Zn, etc)
- Toxic chemicals (EC salts, Na^+, etc)

∴ Assessing the Benefits and Risks of Asmara Landfill Compost becomes very important.

2. Objectives of the Project

- Determine the contents and quality of landfill compost;
- Assess market demand of landfill compost;
- Assess farmers' perception and willingness towards landfill compost; and
- Suggest recommendations for improvement of the quality of compost.

3. The Project Area: Zoba Maekel

Sub region	Villages/sites	Soil samples
Asmara city	Landfill site (Skarico)	12
	Kehawata	4
	Bar-Jima	2
Serejeka	Aditekelzan	4
	Embaderho	8
	Adi-Nefas	8
Total	6	38/19 = 50%

4. Activities & Methods

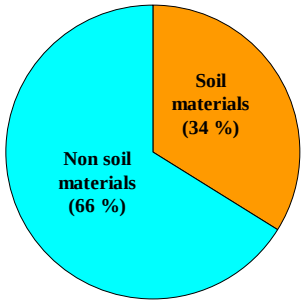
Activities	Methods
Description of landfill segments	• Interviews, field survey and mapping
Descriptions of landfill components	• Compost sorting/sieving • Sensual analyses: odor
Physical analysis of compost	• Compost sampling • Field and laboratory analysis
Chemical analysis of compost	• Sampling • laboratory analysis

5. Descriptions of Landfill Components

Organic wastes
- ◆Woods
- ◆Bones
- ◆Papers
- ◆Rags
- ◆Leathers

Inorganic wastes
- ◆Metals
- ◆Plastics
- ◆Glasses
- ◆Ceramics
- ◆Pebbles

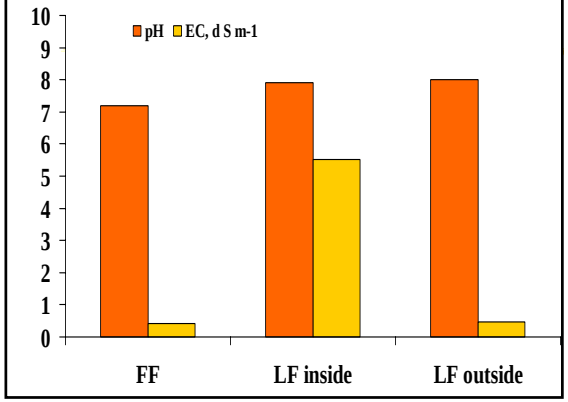
Landfill Compositions (Cont.)



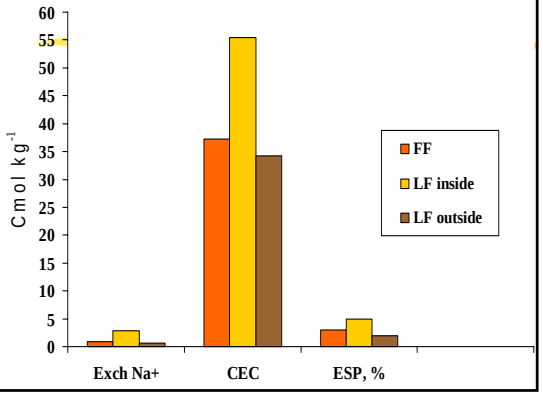
6. Physical Analysis of Compost

Parameter	Average value	Interpretation
Sand, %	25	Clay loam
Silt, %	44	
Clay, %	31	
Soil color, Munsell notation	2.5Y 3/2	V.dark grayish brown
Bulk density, g cm^{-3}	0.87	Low (high OM)
Moisture content at FC, %	24	Medium

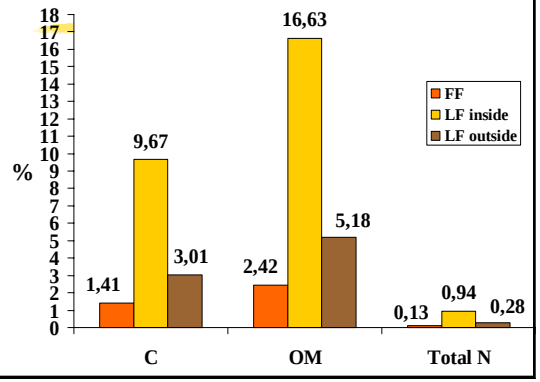
Average pH and EC values



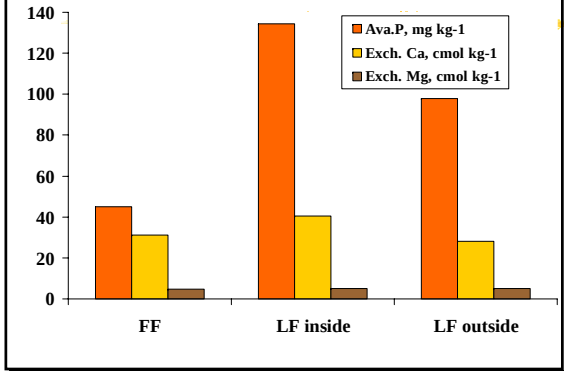
Exchangeable Na+, CEC and ESP values



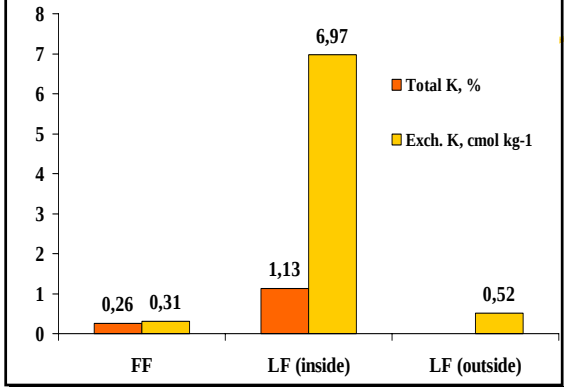
Organic Carbon, OM & Total N content



Available P, Exch. Ca^{2+} & Mg^{2+}

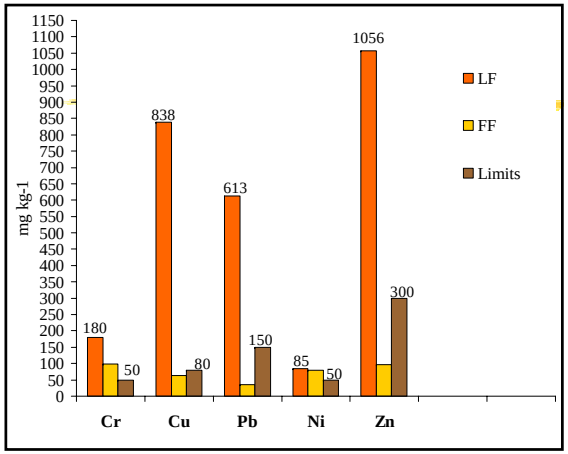


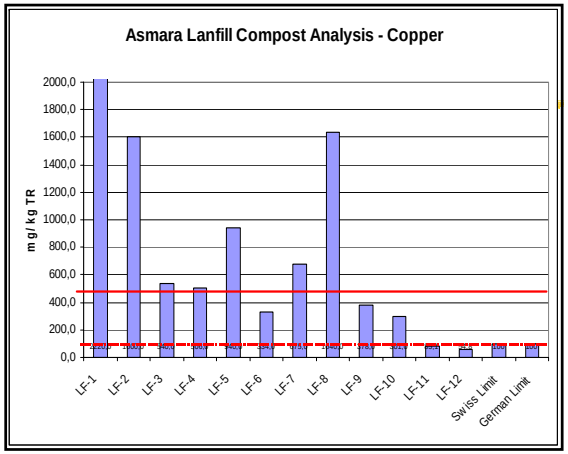
Total K^+ and Exch. K^+ contents

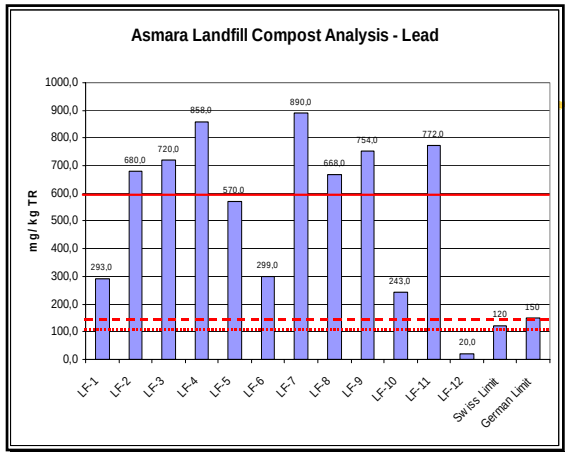


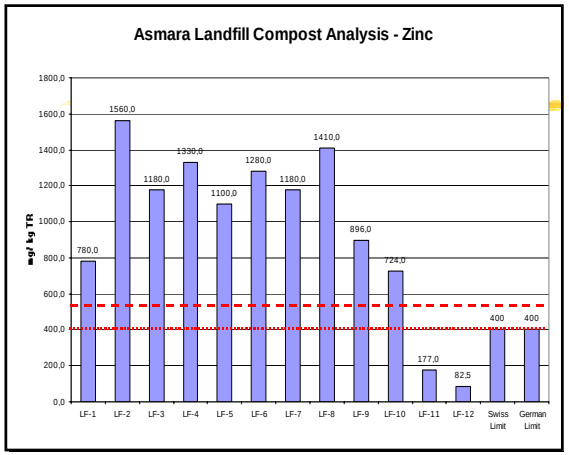
Heavy Metals Analysis

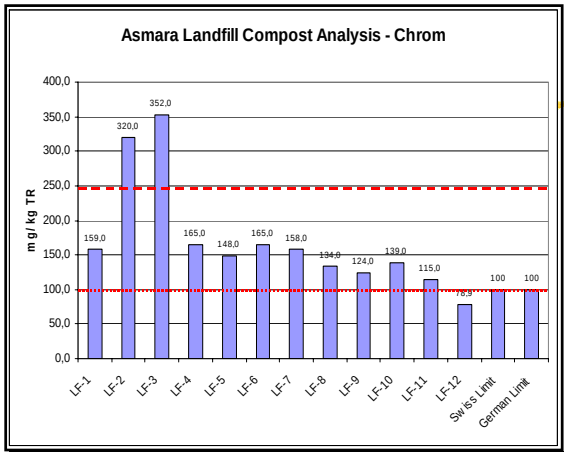
Metal	Landfill site (mg kg^{-1}) n=12		Farmers' fields (mg kg^{-1}) n=7		Permissible limits
	Min	Max	Min	Max	Europe
Cd	1.0	6.8	1.0	1.0	1-1.5
Cr	78.9	352	28.8	103	100
Cu	54.8	2,220	22.5	146	100
Pb	200	890	20.0	126	120-150
Hg	0.1	2.1	0.05	0.10	1
Ni	48.5	108	24.2	201	30-50
Zn	82.5	1,560	47.9	215	400











8. Concluding Remarks

- The landfill compost has improved the physical and chemical fertility of soils in the farmers fields.
- On average, the concentration of Cu, Pb, Zn and Cr in the landfill site was almost 10, 4, 3× higher the allowable limits, respectively.
- The very high heavy metal concentration of compost at the landfill site could pose problems to soils, plants, animals and humans.
- Therefore, it is imperative to search for appropriate measures (e.g. separation of organic wastes from inorganic wastes) to reduce heavy metals loads.

Farmers Perception & Willingness Towards landfill Organic Matter

Socio-Economic Part of the Research On Risks & benefits of Land Fill mining

April 2004

OBJECTIVES

- Gaining Knowledge about market demand

The perception and concern of Farmers

Assess

- seasonal demand
- Cost (material + transport)

Methodology

- Data collection (May-August 2003)
  - **A. landfill site**
    - Frequency
    - Cost (loading+ landfill material)
    - Destination
  - **B. Farm household level**
    - general background information
    - demand of landfill
    - perception
    - willingness to pay
    - usage & application of artificial fertilisers & manure

.....Methodology

- How?
  - Reviewing documents
  - Structured questionnaire
    - Nine villages
    - 57 households (47 males & 7 females)
    - 16-90 years (mean 49.9 years)
  - On the merit of landfill application
- **Descriptive Analysis**

Result

- >24 villages
- Market diameter (4-60 Km)
- Cost of loading 25 Nakfa/truck=5m3
- Cost of Landfill material 35 Nakfa/5m3 (truck)
- Landfill material (purity level is 40%)
  - Biodegradable & Non Degradable

.....Result

- Temporal Variation
- inc. Dec-March
- Declines up to the end of May = Peak June
- two peaks - March & June
- Spatial variation
  - function of transport cost

of the	Distance from city center (Km)	Average cost of transportation (nakfa*)
a	4	150.00
derho	12	400.00
ontsi	15	475.00
i	16	448.00
fas	8	500.00
nashim	28	650.00
eru	28	650.00

....Result

- Rainfed+Irrigated (61.1%)
- Irrigated only (24.1%)
- Rainfed only (14.8)
- Landfill organic matter is not new practice (28%)
- Farmers to farmers dissemination (54%)
- Rainfed+irrigated agr.

...Result

- **Why?**
  - Other sources of organic matter are scarce, unavailable or expensive
    - ⇓
  - Not by will but compulsion
- To replace
  - other sources organic matter
  - both organic and inorganic fertilizers
    - supplement other organic fertilizers

...Result

- Benefits observed
  - Increase crop yield (not comparable to manure)
  - Improve soil condition
  - Ameliorates leaf

Perception

- Increases yield (68.5%)
- Cheaper than other sources (64.8%)
- easily available
- But
- Health threat (48.1%)
- Requires more labor

Willingness to pay more

- Availability (88.9%)
- effect on crop & soil (64.8%)
- cost
- Concern
- presence of impurity
  - health & environmental impact

.....

- BUT
  - Visible impurities only
  - hardly understand invisible impurities

Concluding Remark

- Landfill application long history
- extensive use revived in1997
- scale independent
- farming system independent
- obligatory application
- spatial & temporal variation of demand
- positive perception
- cheaper & easily available

...con

- Willingness to pay & consume more (conditional)
- Concerns
- Difficult to work
- Requires more water
- Not equally good for all crops
- unwanted materials
- Threat for health & environmental

...con

- Suggestions
- stop salling during rainy season
- Sieving and sorting

Successful Stories of Composting and its Marketing

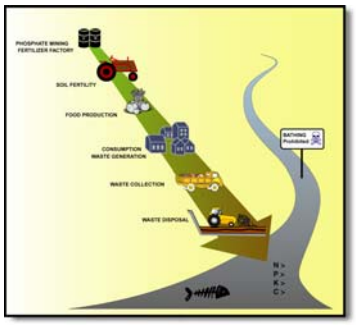
Asmara, 29.04.2004

presented by
Dipl. Econ.-Eng. Silke Drescher
Swiss Federal Institute of Environmental Science and Technology (EAWAG)
Dep. Of Water and Sanitation in Developing Countries (SANDEC)

Content

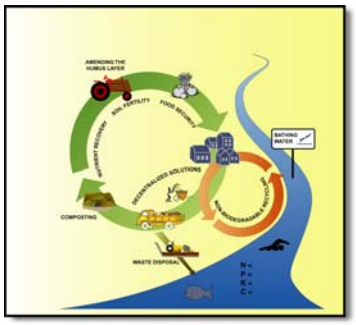
What is our goal ?

Resource sink



What is our goal ?

Resource recovery



Definitions

Background

Municipal Solid Waste
All sorts of waste generated in an urban system, comprising households, restaurants, shops, markets

Organic Waste (biodegradable Waste)
All waste types which origin from natural products and which are biodegradable

Composting
Is a natural process during which organic waste is biologically decomposed by micro-organisms under aerobic conditions in about 3-4 months

Landfill
Is the final disposal of waste, which is slowly degrading under anaerobic conditions

Effects of Compost in Agriculture

Background

The use of compost is always a success for agriculture if

- the quality is right (maturity, pollutants)
- the amount is right (approx. 30 t/ hectare within 3 years)

Effects

- Increase the organic matter content
- Increase nutrient availability in depleted soils
- Improvement of soil structure
- Improvement of water retention time
- Fixation of nutrients
- Increase of crop yield
- Partly suppression of plant diseases

Definitions

Background

Landfill Compost
Organic Matter derived from degraded landfill material. The Municipal Waste stays 10-20 years under anaerobic conditions in the landfill before excavation

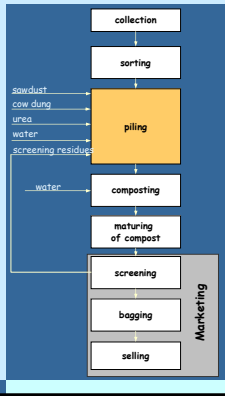
Municipal Waste Compost
Compost derived directly from Municipal Organic Waste by the process of controlled aerobic Composting
Duration: 3-4 months

Comparison of Composts

Composting

	Landfill Compost	MSW Compost	Soil Eritrea
Organic Matter	15 %	20 - 40 %	< 10 %
Nitrogen	0.73 %	1,2 %	< 0.3 %
Phosphorus	0.49 %	1-2 %	< 0.2 %
Lead	613 mg/ kg	360 mg/ kg	
Copper	838 mg/ kg	230 mg/ kg	

Composting Process



Windrow Technique allows
- process control
- fast degradation
- easy turning

Roof often suitable to protect compost from sun and rain

Composting Technology

Background

Centralised Composting
100 tons of organic waste per day
highly mechanised, high investments,
operation and maintenance requirements

Medium Size Composting
2 - 10 tons of organic waste per day
slightly mechanised, medium investments
medium operation and maintenance

Decentralised Composting
up to 2 tons of organic waste per day
mainly manual work involved
little schemes on neighbourhood or household level
(windrow or box system)

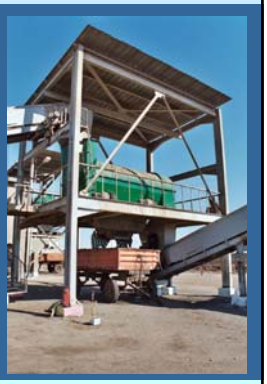
AGET – Luxor, Egypt

Successful Composting

City
200 000 inhabitants served
120 tons of mixed waste per day
30-40 % organic waste

Composting
30 – 50 tons organic waste per day
Output: ~ 15 tons compost/ day

Marketing/ Use
6 US$/ ton compost
Fluctuating Demand (November)
Farmers from Luxor



AGET – Luxor, Egypt

Successful Composting

Process Steps

weight bridge – waste distribution

manual sorting (glass, metal, plastic)

30 mm sieve – 1st class material

shredder drum

30 mm sieve – 2nd class material

1.5 m windrows

3-5 months composting

10 mm final sieving & storage

Waste Concern – Dhaka, Bangladesh

Successful Composting

City of Dhaka
6.5 Mio. inhabitants
3000 tons of waste per day
50 % organic waste

Composting - Mirpur
1400 households
3,5 tons mixed waste per day
80 % organic
1 ton compost/ day

Marketing/ Use
10 US$/ ton compost
Frequent Demand – Fertiliser Factory
Farmers all over Bangladesh
Positive effects on crop yield and reduction of artificial fertiliser proofed

June 2002

Waste Concern -Composting Process

Successful Composting

June 2002

Decentralised Composting, Bangalore, India

Successful Composting

Composting - CEE
3800 households
3 composting sites – bin composting
650 kg organic waste/ day

Process
roofed compartments
alternate filling
in layers
no turning
duration 6 months

Marketing/ Use
10 US$/ ton compost
Frequent Demand
Retailer
Gardens / Nurseries

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Solid Waste Management

Strategy

Why should a municipality support composting?

- Minimise waste amounts in the landfill
- Reduce environmental impact of uncontrolled rotting waste
- Improve nutrient, humus content and soil condition of agricultural land
- Organic waste is an important and valuable resource if treated properly

Important Considerations:

- Adjusted policy is necessary – Actions taken
- Segregate organic waste in order to avoid unwanted pollution in the final compost (glass, plastic, heavy metals, PCB)
- Start with bulk generators of organic waste – easy to approach
- Raising awareness in the community

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Composting - A Flourishing Business

Thank you for your attention

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The Role of Marketing

Market Analysis

⇨ Marketing is a crucial factor for success

⇨ The marketing influences the process

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Sources of Organic Waste

Background

50 – 70 % of municipal solid waste is biodegradable

Asmara: average: 52 % markets 80 – 90 %

Sources:

- ⇨ Households
- ⇨ Restaurants/ Bars
- ⇨ Markets
- ⇨ Public Gardens
- ⇨ Factories
- ⇨ Carpentries

Waste Types:

- ⇨ Flowers, Vegetable Peelings, Food
- ⇨ Food, Vegetable Peelings, Bread
- ⇨ Vegetables, Leafy Materials, (Fish)
- ⇨ Leafs, Twigs, Grass Clipping,....
- ⇨ Various solid organic leftovers
- ⇨ Sawdust

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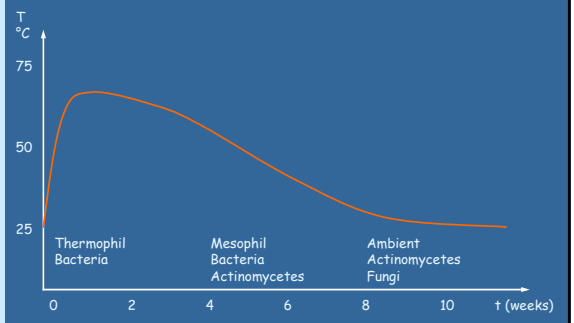
Composting Process

Composting



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Composting Process

Composting

1. Aerobic Process – requires oxygen
2. optimal C/N ratio (20 – 35) in the beginning
3. various aerobic micro-organisms digest organic matter into humus and emit CO_2
4. Moisture Content is an important factor (50 – 60 %)
5. Microbiological activity sets energy free (high temperature)
6. High temperature (60 °C) leads to the elimination of pathogens in the compost product

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Asmara?

Successful Composting

~ 5000 tons mixed municipal waste per month

theoretical potential: ~ 2500 tons of organic waste per month

up to 270 tons of organic waste per month from bulk generators (restaurants, markets, wholesaler,...)

Pilot Composting Plant – Windrow Technique and Sieving Equipment

- adjustment of collection to allow the selected collection from bulk generators

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