Sustainable valorisation of organic urban wastes

Insights from African case studies

WAGENINGEN UR
For quality of life

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This publication is dedicated to project team member Paul Kirai, who passed away suddenly as we were going to press. Paul was an extraordinary professional, one whose competence and creativity were exceeded only by his commitment to a sustainable future for Kenya and the planet. The participation of the firm he directed – Environmental Cost Management Centre, Ltd – boosted both the quality and the profile of the project and contributed to its success in ways both seen and unseen. His passing is a profound loss to his colleagues and the project team. Our memories of him will continue to inspire us.

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Preface

Waste management is a growing challenge in Kenya and other countries in East Africa, as well as in western, southern and northern Africa. The increase in solid waste generation has not been accompanied by an equivalent increase in the capacity of relevant urban authorities to deal with it, nor with a particularly evident expansion of the demand from industrial or agricultural value chains. In a dry continent where soils are seriously depleted and countries like Kenya are facing serious fertiliser shortages, the recovery and valorisation of organic waste in agricultural systems is astonishingly underutilised. Managing organic waste separately is not yet part of the experience – or of the accepted work package – of most African city councils and waste officials, despite the fact that increasing the beneficial use of organic waste as animal feed, compost or energy would contribute to closing the rural–urban nutrient cycles in a sustainable manner.

Understanding the problems and potentials of the organic waste stream is perhaps the single most important step that city authorities could take in moving towards sustainable, affordable, effective and efficient waste management. This publication presents four examples of recent attempts to manage organic waste sustainably in the African context. The participants in the 'Nairobi organic urban waste' project have structured this case exercise in order to use the case studies as object lessons, to harvest genuine insights into the feasibility of a variety of ways to successfully and sustainably valorise urban organic waste streams.

We present three contemporary case examples of compost production. These include composting by a community-based organisation in the Kenyan private sector and by a public-private partnership in Malawi. In all three cases, the project and case study focus is on the relations between city waste and the agricultural supply chain. A fourth case study describes the technical and economic potential to produce and use biogas from urban organic waste.

We hope that the information presented here will be useful for your work, whether you are a policy maker, a practitioner or an entrepreneur. We also hope that it will contribute to the financial and environmental sustainability of new and existing initiatives to close urban–rural nutrient cycles and to use organic urban waste for biogas production in Africa.

Prof. Dr R.B.M. Huirne
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From the editors

We present this document as a work in progress, and as an invitation to other initiatives to valorise and manage organic waste sustainably to and close precious nutrient loops in Africa. The template used to gather and organise the information and present the cases is open source (see Appendix 1). Please feel free, as a stakeholder in organic waste, to use this template to profile your own initiatives and submit them to WASTE (via www.waste.nl) for inclusion in a later edition of this document.

Contents

Chapter 1

Introduction[1]

Anne Scheinberg, WASTE
Yuca Waarts, LEI, part of Wageningen UR

Nairobi calls itself 'The Green City in the Sun', and is the political and administrative capital of the Republic of Kenya. It has a population of 4 million and an area of 696 km^2, making it is the largest metropolitan area in East Africa. The city hosts two UN agencies: the UN Human Settlements Programme (UN-Habitat) and the UN Environmental Programme (UNEP).

The purpose of this publication is to provide policy makers, practitioners and entrepreneurs with genuine insights into urban organic waste management that is connected to composting and biogas production in East Africa. The information on the case studies in this publication is presented in order to contribute to the development and implementation of the ISWM Plan for Nairobi, which is currently being developed under the auspices of the City Council of Nairobi (CCN), UNEP and JICA (Japan International Cooperation Agency).

This publication contains both qualitative and quantitative information about feasible approaches to connect urban organic waste streams to the agricultural supply chain. The guiding framework for the development of the case studies is the Integrated Solid Waste Management framework, as it was presented in the Habitat book *Solid Waste Management in the World's Cities*. The case study template can be found in Appendix 1.

1.1 Challenges of waste management in Nairobi

Solid waste management in Kenya is an issue of primary concern to policy makers and the public at large. The significance of this issue is underscored by the rapid population increase, which has resulted in the generation of increased quantities of waste. Thus, the need for an integrated framework that recognises the key aspects of the waste hierarchy – reduce, reuse, recycle and recover – has become absolutely imperative to concerned policy makers. Although numerous institutions play a role in the formulation and implementation of waste management policies and action plans, the main responsibility for waste management lies with the municipal and county councils.

The current generation rate of waste in the city of Nairobi alone is 760,000 metric tonnes per year, or about 3,000 tonnes per working day. The waste consists mostly of wet, partly decomposed kitchen, garden, and agricultural and commercial biomass, with smaller quantities of textile, plastic, paper, glass and metal. This represents about 219 kg per person per year, which is a low figure even for many African cities. Some 60-70% of this waste is collected, mostly by about 200 private and community-based waste contractors of varying sizes that contract with individual households and businesses, as well as with housing estates and communities. 60% of the waste that is collected currently ends up on partially controlled dump sites, as it has for more

than 20 years. The most important disposal site is Dandora in the centre of Nairobi; attempts to close Dandora and reclaim the land for additional housing have consistently failed due to the lack of an alternative. A site in Ruai, in south-eastern Nairobi, has been proposed continuously since the 1990s as a new landfill site. In November 2010, an international tender was issued on decommissioning the Dandora dump site. Recently, another tender was issued regarding the opening and development of a dump site in Ruai. Dumping is to start in Ruai after a three-year decommissioning process at Dandora. At the moment of writing, we have no information about the responses to these tenders.

Waste that does not get collected or delivered to a dump site is 'managed' via open burning or is discharged into water or littered on streets. Informal burning and decomposition, combined with animals grazing on informal transfer sites, result in water, soil and air pollution and to presumed health problems for Nairobi's citizens.

Nairobi has been the site of a series of initiatives to modernise and upgrade its waste system, starting with the Japan International Cooperation Association (JICA) initiative in the 1990s, and most recently a UNEP-International Environmental Technology Centre (UNEP-IETC) planning exercise concurrent with this project. In these 15 years, little has changed on the ground. The best that can be said about waste management in Nairobi is that although it is a challenge, the private sector has both opportunities and has had successes that are hardly equalled elsewhere in Africa. Another positive sign in the face of the enormous challenge of collecting and managing 3000 tonnes per day of waste without a modern disposal site, is that many sections of the city are rather clean. The heaps of waste on streets that were common in the 1990s have disappeared. Also, in many places payment by the bag or by the household works rather well. In some ways, the fact that Nairobi city itself offers waste management through a rather weak institutional framework has opened up a set of opportunities for private sector, community-based organisations (CBOs) and non-state actors to fill the gaps in creative ways. There is a lot of interesting activity, but the challenge remains enormous and there is still a long way to go.

As the Nairobi organic urban waste project was starting, the City Council of Nairobi and Kenya's Ministry of Environment and Mineral Resources commissioned the development of a new comprehensive Integrated Solid Waste Management (ISWM) Plan for Nairobi. The activities for this ISWM Plan were launched in March 2009. This plan is designed to help Nairobi to overcome its solid waste management challenges, with a focus on solving the public health issues related to the lack of consistent, efficient and effective waste collection and disposal, and to reduce waste streams by at least 50% through recycling. To achieve these objectives, the ISWM strategy foresees the development of public-private partnerships for all activities (collection, separation, recycling and disposal) related to waste management.

1.2 Recycling and organic waste valorisation in Nairobi

Like most cities in low- and middle-income countries, the recovery and recycling of waste in Nairobi is the work of informal metal, paper and plastic recyclers. There is a partially functioning informal organic waste valorisation system based on the transport of selected varieties of market waste and animal manures to subsistence or commercial agriculture around and outside the city. The percentage of the waste that is recovered is reported to be around 24% of the total generated, or 210,240 tonnes per year as reported in the profile of Nairobi in UN-Habitat's 2010 publication, Solid Waste Management in the World's Cities (Scheinberg, Wilson and Rodic 2010).

This recovery happens entirely through private channels, in private-to-private transactions. The City Council of Nairobi (CCN) – the main institutional anchor for public cleansing and waste management in Nairobi – has no comprehensive system for segregation at source, nor are there any formal transfer stations or other forms of publicly financed infrastructure to divert materials for valorisation or recycling. In addition to private waste collecting companies, the city has many

CBOs and non-governmental organisations (NGOs) that collect waste and engage in some recycling and composting on a semi-commercial basis. This was an unregulated activity until 2006, when the city council introduced a registration requirement to regularise these practices and introduce some level of quality and administrative control.

The reuse and valorisation of organic waste is limited to semi-formal concession-like claims to waste from markets: the marketeers themselves or others claim and collect the waste and use it for feeding livestock or as direct nutrients for crops. Composting is a recognised activity in one market, and has been attempted in several NGO and CBO projects, but to say that compost is recognised as a commodity or product would be going too far. However, the 'Nairobi organic urban waste' project did uncover a rather lively trade in manure from the Masai area. The manure is brought to the edge of the city and sold partially composted for fertiliser.

1.3 Organic waste: a sustainable solution for tackling fertiliser and energy shortages in Nairobi

At a time when Kenya is facing serious fertiliser and energy shortages, organic waste is not being recovered and recycled. If fertiliser shortages are solved by applying chemical fertilisers, there is also a danger of eutrophication of all open water in the Great Lakes region. Compost would contribute to closing the rural-urban nutrient cycles and improve the poor African soil structures in a very sustainable manner. And biogas generation from organic waste could, if implemented on a large scale, decrease the dependency on energy from other sources.

The organic fraction of municipal solid waste in Nairobi is estimated to be at least 50% of the total daily waste generated in the city. A similar ratio is likely to be the case in other large urban centres in East Africa. Given the large quantities involved, the project was formulated to explore additional opportunities for segregating and using the organic waste stream as a renewable resource in the agricultural value chain, namely as animal feed or compost, and for energy generation.

Because of the waste management challenges and the perceived potential of organic waste recycling, the project conducted an evaluation of compost and biogas production initiatives. This evaluation took the form of an investigation into four composting initiatives, each of which had a distinct organisational form. The data from three of these were good enough to consider the initiatives case examples. We also conducted one study to evaluate the feasibility of a relatively new technique for biogas production from organic urban waste.

Only a very few local composting initiatives are operational to date in Nairobi. Most of the initiatives that started have shut down or are operating based on subsidies or donations, or are unable to upscale their compost production. Nairobi's organic waste is also sometimes sought after for animal feed purposes, but this occurs on a very limited scale. Next to composting initiatives, quite a large number of biogas initiatives have been started in Kenya, but these focus mostly on biogas generation from manure in peri-urban and rural areas.

1.4 The Nairobi organic urban waste recycling project and partnership (2009-2010)

In 2009, Wageningen UR received funding from the Netherlands Ministry of Economic Affairs, Agriculture and Innovation to explore options for the valorisation of organic urban waste in Nairobi. This action research activity was to be connected to the development of the Integrated Solid Waste Management (ISWM) Plan for Nairobi. The conclusions and recommendations were to inform the implementation of organic waste management in major cities in East Africa.

In order to effectively and efficiently implement this action research project, Wageningen UR formed a partnership with WASTE advisers on urban environment and development, and with local partners in Kenya, that is, the ECM Centre, ETC-East Africa and Carbon Africa. Carbon Africa was included in the partnership at the end of 2009. The reason for this was that the project focus had shifted. It appeared valuable to look into the production of both compost and biogas from organic waste, instead of focusing only on compost production.

In 2009, members of the team assessed the generation of organic waste in Nairobi and made an inventory of the users and producers of and markets for compost, biogas and livestock feed. We also made a long-list of potential pilot projects to be supported by the project, and evaluated them as to their usefulness and replicability. Based on these assessments, we designed two pilot projects to be implemented in 2010.

The first pilot project addressed the institutional barriers to sourcing organic waste from a market in Nairobi for compost production purposes. The project involved cooperation with a compost business and CCN and is presented as a case study in Chapter 2. The second pilot assessed the technical and economic potential of the ARTI biogas system, which is dealt with in Chapter 5.

In order to put the two pilots into perspective, the team went searching for other sub-Saharan African examples of composting or organic waste valorisation. While there are many anecdotes, it was surprisingly difficult to find real cases of something that was happening in practice and could therefore be evaluated. We began with three other compost production initiatives, ranging from a self-help group (SHG) to a CBO. While the SHG proved to be non-operational at the time, and is therefore finally not included in this publication, the other two have been profiled as the remaining two case studies. A brief report on a visit to the SHG initiative in 2009 by project staff is included as Appendix 2.

For more information on the partners in the partnership, and where to find the outputs of this project, please see Appendix 3.

1.5 Structure of this publication

The core of this publication consists of the following four case studies:

- The composting company: a case study of ECoH Holdings Ltd., Nairobi, Kenya (Ch. 2)
- Composting by a community-based organisation: a case study of the Women's Group Lilongwe, Lilongwe, Malawi (Ch. 3)
- Commercial organic waste recovery by a cooperative society: a case study of NAWAKOM, Nakuru, Kenya (Ch. 4)
- Biogas from urban organic waste: a case study about the technical and economic potential of the ARTI technology, Nairobi, Kenya (Ch. 5).

Chapter 6 presents reflections and conclusions based on these four case studies.

Chapter 2

The composting company: a case study of ECoH Holdings Ltd., Nairobi, Kenya

Nathalie Agathos, WASTE

2.1 Context

Table 2.1 Basic benchmarks

City	Nairobi
Population	4 million
Amount of solid waste generated	3,000 tonnes per day[3]
Amount of organic waste generated	1,800 tonnes per day (60% of total)
Types of organic waste	Green waste, meat, bone and fish remains from market, hotels, schools, hospitals and other institutions, kitchen waste, farmyard manure, crop residues and yard trimmings, slaughterhouse remains
Amount of compost produced by private companies	24-180 tonnes/year[4]
Amount of compost produced by NGOs	60-120 tonnes/year
Amount of compost produced by CBOs	5-84 tonnes/year

2.2 Introduction

ECoH Holdings Limited is a privately owned, Nairobi-based composting company that was established in 2007. The company has now been in operation for three years, under the management of its two directors. It has a workforce of six permanent staff and six casualworkers, who are actively involved in the composting process. The company is licensed by the National

Environmental Management Organization to handle waste and undertake recycling activities. The company collects organic wastes from municipal markets and composts it at its site in Athi River, which is 25 km from Nairobi city centre. One of the competitive advantages of the company is the fact that it sells compost in the form of pellets, rather than soil. The pellets are branded under the name 'YAD Biovitalizer'.

2.3 The stakeholders

A stakeholder is a person or organisation that has an interest in a specific systems[5]. Based on this definition, ECoH Holdings has a wide variety of stakeholders, ranging from local communities to the City Council of Nairobi. The relationship developed with each of the stakeholders takes the form of a bilateral exchange of resources and benefits. The main stakeholders identified in the case of ECoH Holdings are presented below.

The initiators–owners

Edwin Kamau and Collin Mwenda, two chemists by profession, decided to venture into composting organic city waste. Using their expertise in biochemistry, they identified a good balance of materials that in their view would allow the best quality compost. After four or five years of research and development, they used their own start-up capital to open a composting facility. They are the owners, financiers and operators of their facilities.

The company's start-up capital originated from the personal equity of the two owners and the company has operated without support from any external financial institution. However, the company is currently seeking to expand its operations and has approached certain banks in Kenya and other financial institutions that could be interested in financing them. Some of these are K-Rep, Family Bank, Equity Bank, Commercial Bank of Kenya, Development Bank of Kenya and the National Bank of Kenya.

Local communities

ECoH Holding's operations are highly dependent on cooperation with local municipal councils, primarily for sourcing the organic waste that is generated at various communal or private locations. These locations include the Nairobi Kenyatta Airport, local fruit and vegetables markets (such as Wakulima and Makovo city markets), and fresh produce companies that generate a

considerable amount of organic waste after processing food-based products. The company has ensured its access to these sources primarily through the interpersonal relations of the owners with the individual employees working at those specific locations. Kitchen waste from households is occasionally also collected.

Local communities not only provide ECoH Holdings with resources but also benefit from the actual operations of the company within their region. ECoH's philosophy is to provide both environmental and social benefits by reducing the amount of organic waste that ends up in local landfills, providing a sustainable soil-conditioning product that benefits the agricultural soils and thus ensures that the local fresh produce is of good quality. Also, they aim to provide employment opportunities for idle neighbour boys, in order to help them rehabilitate and reduce their drug addiction and crime involvement.

The City Council of Nairobi (CCN)

The fact that the ownership of all urban waste in Nairobi lies with the CCN makes the council one of the most important stakeholders in the company. ECoH Holdings recently got permission from CCN to access and recover organic waste from Wakulima city market, as a first step towards a public–private partnership between the company and the CCN. Once again, the various shareholders will enjoy mutual benefits: ECoH will gain access to a source of large volumes of organic waste and CCN will minimise the amount of waste to be collected and sent to the landfill.

The farmers

The local agricultural sector maintains a high level of interest in the company's operations since it is the farmers who buy and utilise the compost pellets. The composition and nutrient balance of the pellets is to correspond to the needs of the local soils, thus ensuring the operational sustainability of ECoH. The company's has around 200 customers. ECoH Holdings is currently distributing its products through two farmers' associations, namely the Kilgoris farmers' association and the Bomet farmers' association.

The company's stakeholder base is now international, as it also receives orders from farmers in Uganda.

2.4 The system elements

ECoH Holdings business model includes the following elements of a typical waste management system: generation/sources, collection/transport and treatment.

Generation/sources

The main input sources are the city airport, the city markets and processors of fresh produce. ECoH Holdings sources organic waste from twenty collection locations spread around Nairobi. It is most probable, however, that there are more than twenty actual sources, since it is very likely that one collection location represents more than one supplier of organic waste. In any case, 95% of all organic waste accumulated for ECoH Holding's use comes from sources and stakeholders within the Nairobi area.

The diversity of the sources means that ECoH receives many types of organic waste, including green waste, fruits and vegetables, animal manures, and other wastes. This gives them a balanced carbon-nitrogen (C-N) ratio, which is what is needed in order to produce compost with the desirable nitrogen-phosphorus-potassium (NPK) values. An important element in the interaction with the suppliers (apart from the diversity of waste) is the fact that the suppliers are paid for the organic waste they supply. By paying for the organic waste, ECoH Holdings creates a financial incentive to the generators, which contributes to the stability of the flow of input materials it needs to make its pelletised compost product.

Collection/transport

The collection/transport model used by ECoH is based on renting a truck and collecting the materials at each of the individual points of generation or storage. The truck is rented at ECoH's expense. The collection system is based on orders: ECoH requests specific volumes from a supplier and then hires a truck. Once the order is ready, the truck picks it up. The average distance from the supplying sources is 10-30 km. Once collected, the organic waste fractions are transported to the open-air facility for composting. The open site is located approximately 28 km from the processing facility.

Specifications and conditions of purchase

The conditions of purchase for the suppliers are basically to deliver the agreed volumes and to store or shelter the food or green waste at an agreed-upon location that is known to ECoH and to which it has access. Such storage must be protected from the wind and excess water until the moment of collection. There are rare occasions on which the suppliers deliver the organic waste materials themselves.

Treatment

The treatment or processing process is currently performed at two locations. An open-air location hosts the biological processes of composting and all the manual processes, including pile formation, watering, and turning. The composting technique used is windrow composting and it is done in batches. Certain types of bacterial inoculant are added to facilitate the process. The staff state that the types of bacteria used are selected based on phytosanitary mechanisms and observed nutrient balances. More specific information is not available because this company operates on a commercial basis and considers this information proprietary.

The curing (maturing after the period of active composting is complete), blending or mixing of different types of organic waste, and pelletising of the final compost takes place in a 150m^2 enclosed industrial building, or warehouse, which is equipped with processing machines for transforming the compost into pellets. The correct mixture is based on the different NPK values of the materials. The final product has an NPK value of 2-2-3 and is primarily intended to meet farmers' requirements. Once pelletised, the product – YAD Biovitalizer – is packaged in 50 kg bags and stored until sent to the client.

The complete cycle takes approximately three months, depending on the materials processed. The company adjusts its processing to accommodate a variety of input conditions: different moisture content or a different combination of carbon and nitrogen. The planning of the process is done four months in advance in order to ensure that the production phase coincides with the dry and wet season in Kenya. Composting at ECoH Holdings occurs during the dry season, which means that between March and September the company pauses the biological composting process and limits its operations to the mechanical treatment necessary to produce the pellets.

ECoH Holdings provides quality control by having every batch of compost and its leachate tested. The tests are carried out at KARI (Kenya Agricultural Research Institute).

2.5 The sustainability aspects

Technical

The technical characteristics of ECoH's operations refer to the indicators that represent the technical performance of the company.

Product types: The company's compost is packed in 50 kg sacks; branded YAD® (a registered trademark, with the Kenya Industrial Property Institute). The leachate harvested from the composting process is also packaged and branded as ECoH Balance.
Production volumes: 3-4 tonnes per day of compost pellets.
Product buffer: 500 bags of YAD on a constant basis.
Maximum machine output: 300 kg/hour
Processing time: On average, less than 7 days/month; the main reason is the pelletising machine breaking down because of overuse.

The main technical challenge for ECoH is related to the inbuilt capacity of the pelletising unit, which is quite limited. However, it would be quite costly to replace the machine, and the company cannot afford to do so with their own financial means

Financial

The financial aspects refer to the financial performance of ECoH Holdings as a limited liability company. The company was founded with the owners' private equity. The company has reached its break-even point (after three years of operation), but has not yet realised any profits. All revenues are used to cover daily operations and research & development activities.

Annual turnover: approximately 1,000,000 Ksh
Product price: 2,000 Ksh/bag of compost
External sources of finance: none so far.

The main challenge the company faces with regards to the financial aspects of its operation is accessing loans. As mentioned, the company has not received any type of external financing, such as loans or grants, although they have applied for a loan to buy a new pelletiser. The underlying reason for this is the aversion of financial institutions to support companies operating in a sector of which they have no knowledge. Local financial institutions and in particular local banks are often not in a position to understand and evaluate the true risks of the compost product. According to ECoH, they consequently regard YAD as a highly risky investment, unlike the well-established chemical fertiliser industry, which has a proven track record of profitability.

Another reason for the restricted access to finance is the false perception that ECoH Holdings is not significantly different from CBOs, which are often seen as unlikely to reach a profitability point and often have no significant legal standing. Local financial institutions are not yet convinced about the particular business model of ECoH holdings.

Sociocultural

Farmers' have mixed attitudes towards using compost. But those farmers who do use YAD are quite positive and there is a common understanding of its positive impacts on their soils. One of the challenges for ECoH is that farmers have not yet realised the potential of the product. Farmers also believe that they lack the technical guidance on how to use the YAD compost in their fields, or what quantities to use. They currently apply two bags of YAD per acre. ECoH is therefore investigating what application rates should be used in various circumstances (soil types, climate). The owners of ECoH believe that barriers related to farmers' perceptions could be dealt with easily: one only needs to present them with tangible results and they will not hesitate to go for compost.

An important sociocultural aspect that could be investigated with regard to the use of compost for agricultural use is the potential effects not only on the crops themselves but also on the wider environment (e.g. soil quality and biodiversity) and the agricultural value chain. Were all the costs and benefits of compost made clear to the farmers, in comparison with the costs and benefits of chemical fertilisers, farmers would be able to make a better decision about which type of fertiliser to apply.

Institutional

The involvement of public institutions in the operations of ECoH Holdings is currently restricted to the licensing stage. The City Council of Nairobi has recently issued a license for the company to collect organic waste from Wakulima city market. As mentioned, the ownership of the organic waste fractions produced within Nairobi lies with the municipal council. Therefore, the institutional barriers faced by the company every time it wants to access more fractions of organic waste are quite high. The lack of a focal strategic plan for solid waste management in Nairobi is making it harder to interact with the town council. Even though the CCN is currently planning its solid waste management activities, it is unclear whether a centralised, privatised or a community-based approach will be adopted for organic waste.

The company is considering partnering with municipalities if that would allow it to expand its operations and construct a solid base of sources and customers.

In terms of academic institutions, ECoH Holdings receives support from the Kenyan Agricultural Research Institute (KARI). The institute has recently completed, on behalf of ECoH Holdings, research evaluating the effects of YAD Biovitalizer on crop growth, productivity and microbial populations in the greenhouse. The owners of the company invested around four years of work in

personal research and experimenting in order to create a product that is appropriate for Kenyan soils. However, the lack of adequate scientific and academic research on composting and soil biodiversity is an additional challenge to the company in its effort to expand and promote YAD. Scientific communities in the country do not seem to truly understand compost and tend to evaluate it as chemical fertiliser. ECoH stated that academics are confused by the fact that a chemical fertiliser might have a higher NPK value than compost. This apparently results in academics failing to value the use of compost. However, the owners are trying to promote research on the topic and prove that compost is a sustainable product.

Environmental

There are two main types of environmental aspects related to the activities and operations of ECoH Holdings, namely the positive and the negative externalities. The positive externalities are linked to the environmental benefits of diverting organic waste fractions from the landfill, which implies less volume to be burned at the site and consequently less air and ground water pollution. The negative externalities are linked to the actual environmental pollution the company creates by operating its facilities. The owners are considering conducting an environmental impact assessment to calculate the net environmental benefits of their operations.

ECoH Holdings is licensed by the National Environmental Management Association (NEMA), the main environmental regulatory institution in Kenya, to handle waste and undertake recycling activities.

Governance, policy and legal

ECoH Holdings is registered under the Private Companies Act as a limited liability company. It has fully legal operational permission and pays the appropriate corporate/income tax as required by the national laws of Kenya. The main policy challenges ECoH is facing are related to the current limitations laid down in the solid waste management by-laws, which prevent the large-scale diversion of waste from the source, to either recycling or reuse, without the explicit permission of the City Council of Nairobi. This has prevented the adequate recovery of organic wastes from the municipal markets.

The City Council of Nairobi has two operational structures: the decision-making (political or policy) structure, which is run on a committee-based system and is headed by the mayor, and the administrative or management structure, which is run on a department-based system and is headed by the city clerk. The management team consolidates departmental recommendations to be presented to the relevant sectoral committees for consideration. The CCN had monopolistic control over sanitation and waste management prior to the Environmental Management and Coordination Act (1999). Other agencies require authority from the CCN to handle waste materials and/or provide waste management services. The CCN provides solid-waste collection services under the Local Government Act (CAP 265) and Public Health Act (CAP242)[6]. The former empowers the CCN to establish and maintain solid-waste collection services, while the latter requires the CCN to provide services. Using the Local Government Act, the CCN has enacted by-laws on waste management, although implementation has been weak. The by-laws:

1. Prohibit the illegal deposition of waste;
2. Specify storage and collection responsibilities for waste generators;
3. Reserve the right of the CCN to collect revenues from 'solid waste collection'.

The CCN influences and regulates composting and waste management in Nairobi in a number of ways, including:

1. Refuse/waste management practices that make available waste inputs for composting (collection, transport and disposal);
2. Land use delineation and zoning (development control);
3. Licensing and revenue collection.

To collect, transport and dispose waste from any waste generator, the CCN requires that entities be registered with the CCN.

ECoH Holdings has engaged itself in a pilot public–private partnership in an effort to establish the adequate linkages and relations with the municipal council of Nairobi. The steps followed in order to obtain permission to collect waste from the Wakulima market took a long time, and 2011 will show whether this public-private partnership is effective. One of the remaining challenges is to find a location near the Wakulima market where the composting can take place.

2.6 Advantages and disadvantages

Table 2.2 Advantages and disadvantages

Advantages	Disadvantages
Regarding competition: not easily replicable business model due to the relatively high investment and technical expertise required.	High capital and operational costs
Can be profitable if planned correctly	Highly dependent on public institutions
Business expansion to other countries is possible	Difficulty in assessing waste sources
The physical characteristics of the product (pellets) make it more convincing than normal compost	Lack of academic research in the field can slow down operations

2.7 Conclusion

The modest success of ECoH Holdings as a private company is based on the company having a good product and marketing it professionally. This is a demand-driven business model, with a product that is identifiable. The form is essentially a private-to-private model, based on pure commodity value. Technical, performance, sociocultural, environmental and health aspects are in order. The institutional situation with the current relationship with waste generators and sources appears to be working, but may require some additional work to cover an expansion to a profitable economy of scale.

Challenges lie in the financial-economic and governance and policy areas. In financial terms, break-even in three years is a significant success. However, the fact that profits are elusive suggests that there is an economy of scale problem. The company's challenges to secure external financial means, mirrors the experience of valorisation entrepreneurs in other countries: neither the activity nor the product is seen as 'bankable.' Further success could be facilitated by working with the banking sector, and this might be a reason for the company to look for a project relationship with a facilitating organisation.

In terms of governance and its relationship with the local authorities, the company needs to work hard to create and maintain a relationship that will allow it to expand by increasing its access to sources and its ability to get permits. The fact that this remains a challenge suggests that the City Council of Nairobi is not sufficiently focused on the environmental benefits (positive externalities) that the company's operations create for the city and its citizens. This could be an indication that more PR or public education would be a useful addition to the directly focused marketing strategy.

Chapter 3

Composting by a community-based organisation: a case study of the Women's Group Lilongwe, Lilongwe, Malawi

Nathalie Agathos, WASTE
Contributions and participation from Tabbie Mnolo, CCODE, Lilongwe, Malawi

3.1 Context

Table 3.1 Basic benchmarks

City	Lilongwe, Malawi
Area	Mtandire and Chinsapo
Population	≈ 36, 786 and 60,017, respectively[7]
Amount of solid waste generated	104 tonnes per day[8]
Amount of organic waste generated	62.4 tonnes per day (60% of total)[9]
Types of organic waste	Sugar-cane, mangoes and nsima from hospitals and colleges, kitchen waste, animal manures
Amount of compost produced by private companies	0
Amount of compost produced by NGOs	n/a
Amount of compost produced by CBOs and SHG	≈ 200 tonnes per year
Established municipal waste collection system	Existing but ineffective, under equipped, poorly maintained, inadequately funded and poorly staffed

3.2 Introduction

The conception and creation of a CBO to treat communal organic waste and process it into compost for the Mtandire area evolved within a two-level public-private partnership (PPP) between Lilongwe City Council and several community groups and private entrepreneurs. The purpose of the PPP was to enable the city council to deliver a waste management service in the low-income community of Mtandire. The city council partners with private entrepreneurs or women's groups for the collection, sorting and transport of solid waste, and with Four Seasons Nursery (a large private horticultural company) to buy and use composted organic manure. Two local NGOs – Center for Community Organization and Development (CCODE) and Society for Women against Aids in Malawi (SWAM) – were responsible for mobilising the community and building the capacity of both sides of the partnership. Those were the enabling conditions for the Women's Composting CBO to be created.

The group originally started with three women, all of whom were members of Malawi's Homeless Federation. The group shrank over time because of a lack of significant support and knowledge about the technical aspects of composting, resulting in there being only one woman in the organisation. There were many challenges but once the venture proved feasible and was in operation, the other women rejoined the group. The CBO now consists of 37 women, who work together to operate open air composting on a common plot. The operation produces about

500 kg per day, enough to offer significant income for all its working members. The main business model is quite simple: women collect organic waste from their community and other neighbouring communities, and bring it to a common site. Then they process it in an open air facility. The women combine the material that they have collected in larger piles. The finished compost is sold to Four Seasons Nursery.

3.3 The stakeholders

A stakeholder is a person or organisation that has an interest in a specific system[10]. Based on this definition, the groups that have a stake or interest in the Women's Composting CBO in Lilongwe include the community itself (households, community leaders, farmers), the city council, the Ministry of Local Government and the Four Seasons Nursery. The main stakeholders identified are presented below.

The initiators-owners

As mentioned in the introduction, the initiator of the idea was a group of women from Mtandire, guided by the Center for Community Organization and Development (CCODE) and the city council. The women saw the underlying financial and environmental benefits of composting the organic waste produced nearby. As a result of their uncertainty while waiting for the compost to mature, the majority of the original initiators abandoned the effort, since there was no significant benefit for themselves at that particular moment. However, the current chairwoman of the CBO believed in the process and managed to turn a dubious initiative into a profitable CBO. She also combined some other types of solid waste recovery (i.e. metals and plastics) in order to support the venture financially.

The current structure of the CBO is based on four groups, each of which is responsible for the collection of organic waste from a specific area or zone. Each group consists of four or more women.

Local communities

The Women's Composting CBO is related to and highly dependent on the surrounding local communities, whose role is to supply the organic waste produced within their area to the CBO. The group primarily collects community organic waste. It has developed collaboration networks with local city markets in order to access some fractions of the organic waste generated at these locations.

The city council

The primary role of the city council with regards to solid waste management is to formulate and implement solid waste policies and to provide services for the collection, transport, treatment and disposal of solid waste with the city of Lilongwe. The city council is also responsible for monitoring private companies that are engaged in solid waste activities.

The decision of the city council to develop a PPP model for the area of Mtandire was the cornerstone of the creation of the Women's Composting CBO. Consequently, even though on a day-to-day basis the city council is not monitoring or interacting with the CBO, it benefits from its

operations by having a cleaner living environment. Due to the lack of financial and technical resources, the council has a large stake in maintaining and supporting the group. The council is also highly interested in registering the Women's CBO, in order for it to have a legal standing and be able to access more sources of organic waste.

The Ministry of Local Government

The operations of the composting CBO are also related, in theory at least, to the activities of the Ministry of Local Government, since it is the designated institution for granting permits and licenses to solid waste operators, as well as for monitoring their activities. However, the CBO is not yet registered.

The Four Seasons Nursery

This large private horticultural company has a considerable stake and interest in the CBO's operations, since it is the only client. The nursery has agreed to buy the majority of compost produced by the women, provided it meets some specific specifications.

3.4 The system elements

The Women's Composting CBO has a business model that includes the following elements of a typical waste management system: generation, collection/transport and treatment.

Generation and sourcing

The main supplying sources of organic waste for the CBO include city fruits and vegetables markets and households. In the case of the Women's CBO, the supply locations are spread around the community and the flow of materials is not consistent in time, volume or quality. Nevertheless, all organic waste accumulated for the organisation's use comes from the community.

To respond to the challenge of an inconsistent supply, the women have started investigating collection from areas that are more distant than their usual collection locations. The women are currently facing an additional challenge with regards to the scarcity of organic waste in the area. Since they have proven that the composting of organic waste is a profitable operation, the number of women interested in participating is increasing, resulting in higher collection rates and less organic waste in the streets.

Collection/transport

The collection approach used by the Women's Composting CBO is basic: the women themselves collect directly from markets or other sources. They are divided into four groups, each of which is responsible for collection in one area or zone, in order to avoid overlaps. They collect on average 2 tonnes of organic material each day, and they use push carts for the transport process. They cover on average 5-7 km per day. However, due to the scarcity of materials, the women collect it from as far away as 10 km.

Treatment

Once the organic waste has been collected by the four groups, they transport it to the main processing facility, where the composting process takes place. The facility consists of an open-air site covering approximately two acres. The process is open-air, static-pile composting. It involves basic biological and manual activities like piling, mixing, turning and maturing. The overall composting process takes one month. The equipment used during the individual stages of the process is quite basic, and includes shovels, gloves, plastic nylon covers for the piles and a few small carts.

Part of the treatment operations includes mixing, during which the group adds maize husk (the outer part of maize) or cow dung, in order to enrich the mixture and produce a compost that has more nutrients. The technical characteristics of the compost are currently being researched by the University of Malawi.

The final product is packaged in wooden boxes provided by the Four Seasons Nursery, which also collects the product from the women free of charge.

3.5 The sustainability aspects

Technical

The technical characteristics of the Women's Composting CBO operations refer more to the indicators that represent the technical performance of the group. These indicators are:

- Product types: the only product is compost;
- Production volumes: 0.5 tonnes per day of compost (≈14 tonnes per month);
- Production time: 1 month.

The main technical challenge the CBO is facing is related to the facility currently used for composting. The facility is an open-air field with no protection from varying weather conditions. The CBO with the support of CCODE is currently planning to build a shaded facility, which will also be equipped with windrows, in order to protect the composting process.

Financial

The financial aspects refer to the financial performance of the Women's Composting group as a CBO. The start-up capital needed was not very high as it had to cover only basic equipment for mixing, turning and covering the compost piles. During the start-up phase, the Women's CBO was supported by CCODE, which provided a loan to the group from its own revolving fund (which is locally called the Mchengapi Fund). The women were able to repay the loan within two years of starting production.

Annual turnover: 40,000 Malawi kwachas
Product price: 100-160 Malawi kwachas
External source of finance: loan from a revolving fund
Salary per member: 2,000-3,000 Malawi kwachas per month

Sociocultural

The activity of these women has increased both environmental and social awareness. Women in Malawi are usually marginalised compared to men. Women have less access to education, credit, land and property, but have less access to employment opportunities in the public and private sectors, technology and other key market information to support their business activities. Due to their lack of experience, very few employers are willing to recruit and train them on the job. Thus, the Women's Composting CBO has demonstrated the ability of women to be involved in income-generating activities that benefit not only themselves but also the community as a whole.

The relation developed with local communities is bilateral since the communities benefit from the activities of the Women's CBO. Composting the communal organic waste is a sound environmental management activity that results in larger amounts being diverted from dumps or local landfills. The operations of those women also provide an indirect way of raising awareness of environmental issues within the community. The community has seen the positive effect of the women's activities and the level of involvement is constantly increasing. A type of waste that used to be dumped or burned, is now being recovered and considered a resource within the community. Furthermore, the CBO is offering employment opportunities for the women, who make their own living and are demonstrating women's ability to become entrepreneurs. There is also a small, though not negligible number of farmers who occasionally require quantities of compost to apply to their crops.

The model appears to be replicable as long as the demand holds. A specific challenge is the fact that more and more women would like to get involved in the CBO. However, this is neither possible nor desired by the women in the group, since they would have to collect waste from even more distant locations.

Institutional

The CBO receives significant support from both the city council and the country's academic institutions. The group's activities are perceived as positive for the overall community and every possible access to support is provided. The city council is making efforts to register the CBO. It also created the enabling environment for the cooperation with the Four Seasons Nursery, in order for the CBO to have at least one client to buy the compost. Academic institutions, such as the University of Malawi, are conducting waste management baseline and market research in order to identify the framework in which the CBO is and should be operating.

Environmental

The environmental benefits of the women's activities are viewed as positive for the community. The activities contribute to a healthier living environment by dealing with the organic wastes and by liberating community members from burning or burying their waste. The net environmental impact of the CBO's operations is positive due to the small-scale of operations and the absence of electrical equipment from the production process.

Governance, policy and legal

Land is a basic factor of production as well as an important source of livelihood for most Malawians. There are three legally recognised types of land tenure in Malawi: customary, private and public. Customary tenure is the most widespread category. However, other sub-tenures that are commonly practised by customary landholders (e.g. renting and borrowing) are not legally recognised. Registered private land (freehold and leasehold) accounts for less than 8% of the total land area. Inadequate access to land is one of the critical factors contributing to poverty in the country. Additionally, discrimination in access to land based on social status, economic status and gender is a major constraint.

The CBO has resolved this challenge with the support of CCODE. The land used for hosting the CBO belongs to CCODE, and the women have the right to use it without any charge, as part of the cooperation of CCODE with Malawi's Homeless Federation.

3.6 Advantages and disadvantages

The following table provides more information about the advantages and disadvantages of the approach adopted by the Women's Group Lilongwe CBO.

Table 3.2 Advantages and disadvantages

Advantages	Disadvantages
No significant operational costs	Lack of stability/continuity of the workforce
Easy start-up phase	Not profitable without a public–private partnership or external support
No need to pay taxes	Impossible to access finance from financial institutions.
The benefits stay within the community.	Bound to fail without technical support Easily replicable business model that might create unfavourable competition.

3.7 Conclusion

This initiative can be seen as quite a significant success, especially since there is more demand both for the product and for the participation than is currently possible. The essence of the success is that the operations are demand-driven, and in that sense the involvement of Four Seasons Nursery drives the success. It is this demand – in the context of Malawi's more general scarcity of phosphorus and commercial fertiliser – that promises the most success in the future. The economic and financial aspect is healthy.

The governance aspect is also functioning: the project has the most positive relationship with the local authority (Ligongewe City Council) of all of the case examples. Still, it is quite clear that this is a relationship at a distance, mediated by the NGO CCODE, which facilitated the formation of the women's groups and organised the composting site. The attitude and behaviour of the LCC represents a positively inclined version of 'getting out of the way' and supporting the project passively, based on understanding to some extent that it generates positive environmental and social externalities.

This example is institutionally interesting because it combines the collectively mediated approach of an NGO with the private-to-private business model of ECoH Holdings. But although ECoH has the model of a single company collecting from multiple sources, going to a single company's operation, it depends on conventional marketing to multiple buyers. The Lilongwe Women's Composting project reverses this, with a single buyer (Four Seasons) that purchases compost from a lightly collectivised processing system. The beneficiaries are single women, who work in small groups but remain separate income earners. The case suggests that this organisational form is somehow more stable, but of course the whole enterprise stands or falls on the continuing interest of Four Seasons. For additional robustness, an alternative buyer would be advisable.

Chapter 4

Commercial organic waste recovery by a cooperative society: a case study of NAWAKOM, Nakuru, Kenya

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4.1 Context

Nakuru is Kenya's fourth largest town. It is situated 160 km north-west of Nairobi at an altitude of 1859 m above sea level. In the Maasai dialect, Nakuru means 'the place of dust': in the dry season, the town is engulfed in volcanic soil brought to it by whirlwinds. Centred in a rich agricultural hinterland between the Menengai Crater and Lake Nakuru (home to the famous pink flamingos), Nakuru was once dubbed 'the cleanest town in East Africa'[11] .

Solid waste management is increasingly becoming a focal point among policy makers and development practitioners in north-west Kenya, due to ever increasing volumes of waste. Rapid urban growth, estimated at 3.4% per annum[12], and increased industrial activity are the main contributors to this policy crisis. Incomplete waste collection systems and inadequate, uncontrolled waste disposal lead to accumulating heaps of waste in the town. These are a daily reminder of the need to implement an effective waste management in the area.

4.2 Introduction

In 2002, a group of CBOs faced with waste management problems in Nakuru town took up the challenge to do something positive. Practical Action Kenya joined them in the initiative to found NAWACOM, a cooperative association of Nakuru Waste Collectors and Recyclers Management, a local CBO operating in the industrial area of Nakuru town. NAWACOM currently has 336 members (165 women and 171 men).

While the initiative and technical support come from Practical Action Kenya, financial support for the start-up came from the German Technical Cooperation (GTZ, name recently changed to GIZ) from their Kenya project on solid waste management. Additional funding came from the UK charity Comic Relief. Since the exit of Comic Relief as a donor partner in 2008, NAWACOM has been raising funds domestically from the following channels:

1. Membership subscription, which is currently 5,000 Ksh per member per annum;
2. Sale of their compost at 1,500 Ksh per bag;
3. Access to micro-credit facilities – the cooperative has been a beneficiary of a micro credit loan facility[13] from Family Bank, which was used as working capital to pay the waste collectors who deliver waste to the warehouse before the production season commences.

NAWACOM has 15 members of staff running the day-to-day operations. The roles of the staff are as follows:

1. Nine of the staff are in the management department, which oversees the coordination of operations at the cooperative;
2. Three of the staff are permanent labourers;
3. Three are casual workers.

4.3 The system elements

The cooperative operates by contractual agreements with private waste collectors, who collect organic waste from residences in Nakuru town. The pre-existing claims to organic waste in Nakuru town lie largely with the farmers, for either individual composting on their own farms or as animal feed for pigs. The unprocessed food waste is less expensive and more readily available than compost, and thus reduces the potential market for compost. This is typical of the composting market in both East and West Africa. In fact, NAWACOM has tried to incorporate the farmers, who would use the organic waste to produce compost, into their business model, in order to reduce the competition for the organic waste.

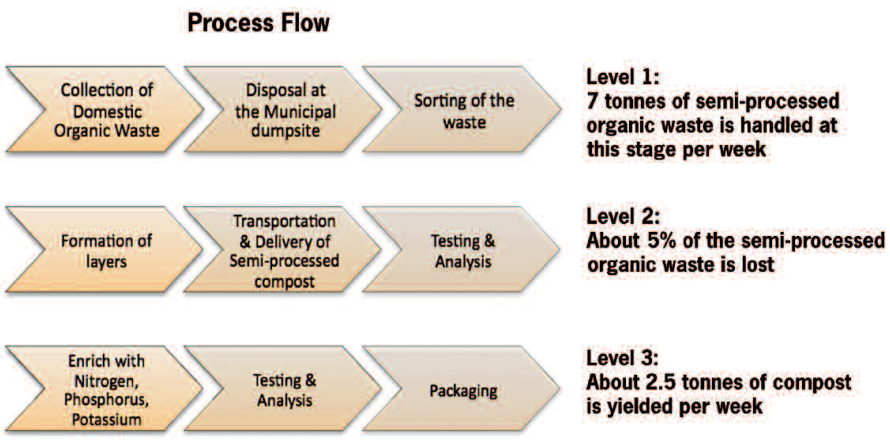

Figure 4.1 Process flow for NAWACOM organic waste recovery

Sourcing and collection

The cooperative hires lorries for 3,500 Ksh per day to collect waste from households. Households do not pay for this service, nor do they receive payments for their supply of waste to the cooperative. The waste is then transported to the municipal dump site, where it is sorted and composted for a period of six weeks. The semi-processed compost is then delivered to the processing site in the industrial area of Nakuru town.

When the semi-processed waste arrives at NAWACOM's warehouse in the business district, it is weighed and collected in a larger area for further decomposition (and curing). After two months, the compost is sampled and taken for analysis at an approved laboratory, after which it is blended and enriched with nitrogen, phosphorus and potassium before being packaged.

The estimated output per week is about 2.5 tonnes, as shown in Figure 4.1.

Equipment and infrastructure

The equipment on site includes:

1. Shifter (conveyor oscillator) – The shifter was locally fabricated. It is equipped with a sieve to separate the fine component from the larger ones through its vibratory motion. The finer components are collected at the bottom in sacks, while the larger ones remain on top of the sieve and are reprocessed;
2. Miscellaneous tools: shovels, goggles, gloves, overalls.

Processing

The plant, though not fully operational at the time of the study due to the low season demand for compost, had accumulated 2000 bags of compost, awaiting the February to April planting season. Some of the challenges faced by the cooperative are:

1. There is an attitude problem among farmers, emanating from the fact that they view organic fertilisers as secondary inputs;
2. The cooperative mentions a lack of government support in terms of knowledge dissemination, promotion and tax relief in order to reduce the cost of the compost. However it is not clear whether the local authorities understand what their interest would be in financially supporting NAWACOM;
3. They are working on the more systematic marketing of the product. They currently rely on word of mouth;
4. The compost produced by the cooperative is in powder form, while most farmers prefer the pelletised form.

Marketing

The compost is sold to farmers under the brand name Mazingira. The buyers are in the larger Nakuru area, as well regions that are further out (such as Kitale, Eldoret, Kisii, Webuye and Nanyuki, which are agricultural areas).

The cooperative tries to adhere to strict production standards to prevent contamination of the compost, and thus take samples from every batch produced and have them tested by approved government laboratories and universities, such as Egerton University – Njoro Campus.

Mazingira compost is enriched with NPK, in order to achieve the ratio of 2-1.5-1.8. The materials used to enrich the compost are natural[14]. The compost is packaged in 10 kg, 25 kg and 50 kg synthetic sacks, similar to those used to package chemical fertilisers. The markets have responded well, as the cooperative is distributing its product through agricultural input stores in Nakuru. This strategy, though not well entrenched and limited to only two stores, has increased the visibility of Mazingira. The cooperative operates on an order by order basis. It currently produces about 50-60 bags of compost per day, which is equivalent to 2,500-3,000 kg per day.

4.4 The sustainability aspects

Financial

The company has been operating profitably since the exit of Comic Relief's funding in 2008, as a result of internal revenue from membership subscription and sales of its compost. The management, though declining to reveal their financial statements, indicated that their profit margin is usually 20-30% of their operating costs, with estimated revenues in 2009 from the sale of compost as shown in Table 1 below.

Table 4.1: Revenue base from compost sales in 2009

Quantity of compost	Price (Ksh) per bag	Sales in 2009	Total sales (Ksh)
Mazingira 10 kg	300	200	60,000
Mazingira 20 kg	750	440	330,000
Mazingira 50 kg	1,500	1,360	2,040,000

The current marketing strategy is word of mouth from farmer to farmer. While this is an inexpensive and friendly strategy, it is limiting in scope and volume. As in the Kenyan context word of mouth may be concentrated within tribal communities, the company might be missing opportunities. Until now, this strategy has prevented the cooperative from maintaining consistent sales volumes, as well as most likely limiting its client base.

NAWACOM, however, allows brokers and agents to sell its product on a commission basis, agreed upon between the cooperative's management and each individual broker. The distribution channels and their estimated percentage consumption shares are estimated to be direct selling (95%), wholesalers and brokers (5%).

Sociocultural

The cooperative has had several kinds of social impacts and has generally positively affected the lives of several people in Nakuru town in various ways. With respect to livelihoods, the individuals who deliver the semi-processed compost have benefited by way of generating income to cater for their livelihoods. Some of the waste processors, who were informal waste pickers, are now formalised and working as full-time employees of waste collection companies.

Organic waste generators in the area are now able to earn some income if they can compost their organic waste and deliver the semi-processed compost to the NAWACOM processing site.

Governance, policy and legal

Compost is largely unregulated in Kenya, as there is no existing legal framework; however, a draft policy on the use of organic inputs in agriculture in Kenya is to be tabled in parliament by the Ministry of Agriculture. Despite numerous research efforts undertaken by both private and public stakeholders, a way forward is still lacking.

Further, there are no set standards and/or guidelines on compost production in Kenya. Fertilisers are regulated under the Fertilizers and Animal Foodstuffs Act; however, compost is not regulated under this act. Although the act defines fertiliser as any substance or mixture of substances that is intended to or offered in order to improve or maintain the growth of plants or the productivity of the soil, it does not include manure, compost, wood ash, gypsum or refuse when sold in its original condition and under the same name, nor does it include organic fertilisers, other than lime. In 2008, the Kenya Bureau of Standards (KEBS) and the Kenya Agricultural Research Institute (KARI) formed a technical team to formulate guidelines for composting in the country. However, the team has not yet developed anything tangible.

The required permits for all composting activities in Kenya are:

1. Waste management permit from Nakuru Municipal Council: costs 17,000 Ksh per year;
2. Waste recycler's permit from NEMA: costs 40,000 Ksh per year.

4.5 Advantages and disadvantages

The NAWACOM case is unique in that it is a cooperative that has brought together various players in the organic waste recovery arena in Nakuru. This has improved the livelihoods of its members and provided a diversion for organic waste. While cooperatives are often the organisational form chosen by CBOs or micro and small enterprise (MSE) waste organisations in West Africa, they are much less common in East Africa. This case demonstrates that a cooperative can achieve success in terms of meeting the needs of a community and improving the quality of the environment.

The current management at NAWACOM believes that the success factor for the cooperative has been the commitment of its members to ensuring that the cooperative continues to produce hygienically produced compost. However, it feels that the cooperative has failed to adequately market its compost, and consequently sales are poor.

The replicability of this case lies in the context of the cooperative model. Despite NAWACOM appearing not to be able to generate sufficient sales due to its weak marketing strategy, its structure allows for all members to be equal beneficiaries, with sufficient transparency in its management structure to curb mismanagement.

4.6 Conclusion

NAWACOM is a partially successful initiative that came about via a project and with strong support of the international NGO Practical Action. The members of the cooperative are also likely to be partially dependent on donor funds, as many of them are NGOs or CBOs. While the cooperative's success in replacing the financial support of Comic Relief is reassuring, its longer term survival will depend on it sharpening its business model and business practices, and on building markets.

The case suggests that there is some institutional strength, and considerable positive environmental benefits, but that there are weaknesses in the financial, organisational, performance, technical and governance aspects. More specifically, there is a kind of expectation that there should be support from the municipal authorities, but the likelihood of receiving such support is questionable as long as there is no clear way to measure the positive environmental impact. Claiming the right to government support will probably not help the cooperative to break even; making their product in the more standard and recognisable pellet form that seems to be a better accepted compost product in Kenya, would be a much faster way to achieve success.

Chapter 5

Biogas from urban organic waste: a case study about the technical and economic potential of the ARTI technology, Nairobi, Kenya

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5.1 Context

Given the large quantities of organic waste generated in Nairobi, the LEI composting project has sought all kinds of opportunities in segregating and using the organic waste stream as a renewable resource for compost/fertiliser and/or energy generation.

At present there are approximately a dozen biogas companies and NGOs in Kenya. Of these, only a small number are operating successfully on a commercial basis. Most of the biogas initiatives receive technical support or subsidies from donors and have not yet succeeded in expanding the biogas market sufficiently.

While a combination of fixed-dome, floating-drum and plastic tubular technologies are being promoted, the large majority of these target domestic and institutional users in rural areas. Livestock dung is the primary feedstock, though examples using other agricultural residues and human manure do exist. Approximately 2,000 biogas units of all types have been installed in Kenya since 2007[15]. The Africa Biogas Partnership Programme – which is implemented by SNV, Hivos and local partners, and funded by the Netherlands Ministry of Foreign Affairs (DGIS) – promotes biogas digesters throughout Africa. In the 2009/2010 period, the programme built 840 digesters in rural areas in Kenya. Plans for 2011 are to build 2200 more digesters in Kenya. In this programme, the end users themselves bear the construction costs of the biodigesters, partly in cash and partly through credit.

Biogas from urban organic waste in Nairobi; a pilot project

In 2010, Carbon Africa and its partners investigated the technical performance and economic potential of energy generation from urban organic waste in Nairobi. The investigation took the form of a pilot project, which consisted of testing the ARTI compact biogas system, a small-scale anaerobic digestion technology. The Appropriate Rural Technology Institute (ARTI) of India – an NGO based in Pune, Maharashtra State – developed this system in 2003. The ARTI[16] plastic, floating drum technology was chosen as it is modular, mobile, easy to install, relatively low cost and can use municipal organic and market green waste as feedstock. It can also be made from local materials.

5.2 Goals and objectives

The pilot project objectives were to:

1. Evaluate whether compact biogas systems are appropriate as part of an urban waste management strategy in Nairobi;
2. Provide a preliminary economic assessment of a new business model for the roll-out of biogas digesters at the household and the institutional level in Kenya.

The implementing partners were two Kenyan firms (Carbon Africa and GreenTech International) and one Tanzanian-based company (Joint Environmental Techniques). Basic system monitoring began in May 2010. The results presented here are based on data up to September 2010.

The pilot project tested the technical performance of two household size (2.5 m^3) and one institutional size (9.5 m^3) urban ARTI biogas digesters for cooking purposes. In this case study, some light financial analysis was done (and is presented here), but the other ISWM aspects were not included in the case analysis. We therefore know little about the institutional, organisational, cultural, governance, environmental or health aspects of biogas in this case.

5.3 Technical and performance aspects of the urban ARTI biogas digester

Unit locations were selected based on access to sunlight (to maintain digester temperatures), ease of gas piping installation and proximity to kitchens where cooking would take place. Starter slurry from an existing biogas system was used to speed up the initial digestion process, resulting in the systems producing gas within a week.

Biogas digester feeding with diluted organic waste feedstock was done daily by the responsible persons at each site. Input parameters and system performance were likewise monitored every day with the use of simple methods and equipment.

Data collected included feedstock type, quantity and structure as well as cooking time and gasholder height. The results of this monitoring are presented in tabel 5.1:

Table 5.1 Set-up and technical performance of the three ARTI biogas digesters

Unit location	**Household 1 (Westlands)**	**Household 2 (Kileleshwa)**	**Institutional (Westlands)**
Unit size	2.5 m^3	2.5 m^3	9.5 m^3
Gas cooker burn rate	2.5-4 l/min.	2.5-4 l/min.	18 l/min.
Daily feedstock quantity	2-4 kg kitchen waste	3-4 kg kitchen waste	60 l potato starch & varying other food waste
Feedstock type	Vegetable and fruit peelings and some lentil/ potato starch	Vegetable peelings and fruit and vegetable residues	Potato starch, vegetable peelings & cooked food residues from events
Feedstock structure	Hand chopped to small pieces	Blended into fine porridge consistency	Liquid state, diluted with water
Average daily cooking time from biogas 2010 (June, July = cold season in Nairobi)	• May, Aug., Sept.: 60 mins • June, July: 180 mins/week	• May, Aug., Sept.: 90 mins • June, July: 180 mins/week	• May: 170 mins • June: 140 mins • July: 120 mins • Aug.: 180 mins • Sept.: 205 mins

When comparing the two household units, it is noticeable that the Kileleshwa unit produced slightly more gas even though both receive a similar amount of sunlight. This is likely to be due to the slightly larger quantities and finer structure of the feedstock.

With regard to the effect of temperature on gas generation, it is clear that the colder temperatures in Nairobi, especially during June and July, significantly affected biogas production (see Figure 5.1). This was especially the case for the household size units, when gas use was reduced to twice a week.

This performance reduction due to low temperatures is a serious issue that may require solutions such as insulation of the units or a focus on warmer cities (such as Kisumu and Mombasa in Kenya).
The larger institutional unit was less vulnerable to the drop in temperatures, but its performance was still curtailed, as can be seen in Figure 5.1.

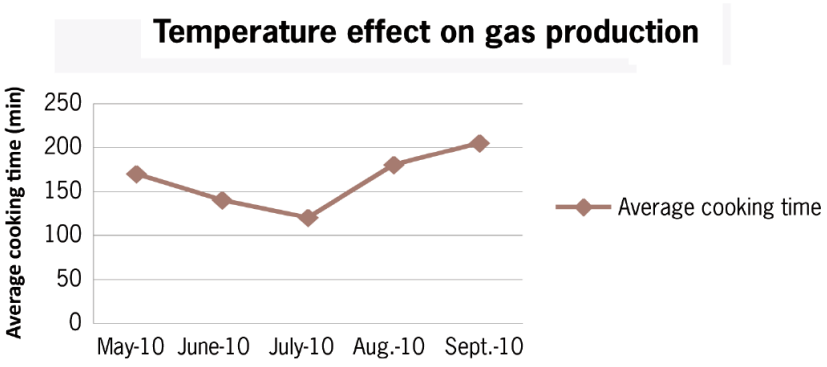

Figure 5.1 Average daily cooking time with the institutional size digester

5.4 Economic and financial aspects of the ARTI system and the 'gas-for-cash' business model

The cost for the pilot systems in Nairobi came to EUR 1,015 for the household size unit and EUR 2,237 for the institutional size unit (see table 5.2).

For the ARTI pilot systems in Nairobi, labour was the most significant cost item due in part for the requirement for the technicians to come from Tanzania. It is expected that these costs could be reduced significantly once local trained technicians are available.

Table 5.2 Costs of ARTI digesters compared with costs of fixed-dome digesters

	Household ARTI digester (2.5 m^3) EUR	**Institutional ARTI digester (9.5 m^3) EUR**
Parts	110	183
Stove	54	99
Foundation	73	141
Tanks	171	600
Labour	607	1214
Total	**1015**	**2237**

We can compare the total costs of the ARTI digesters with figures from 2007 and 2009 Kenyan studies[17], which focused more on the fixed dome technology in rural areas. The figures in these studies range between 435 Euro for a 8m^3 digester and 1372 Euro for a 16m^3 digester. The numbers may however not be directly comparable as it is not clear to what extent the studies include donor subsidies, transport, piping and appliance costs.

Box 1. The gas-for-cash business model

One of the biggest barriers to the uptake of biogas digesters – even with subsidies, sponsors and micro-finance loans – is usually the capital investment costs. One potential way to break this barrier is for a private entity, NGO or consortium to develop an energy service delivery (or 'gas-for-cash' business model) wherein the entity pays for and maintains ownership of the biogas units once installed and the client (household, institution) pays only for the gas delivered. A lease-to-own/instalment payment structure could also be considered, with a small (token) advance deposit by the client. If the monthly cost of the biogas delivered is significantly less than the cost of LPG, fuelwood or charcoal, and if the digesters perform reliably, it is anticipated that such a model would be attractive to a certain market segment. It is also important to note that under this model the operational risk for the digester remains with the entity and not the customer.

Average annual cooking fuel expenditure

In mid 2010, focus group discussions with biogas and non-biogas users were held with 96 individuals in the peri-urban areas of Nairobi and semi-rural areas of northern Mt. Kenya to help gauge the willingness to participate in the gas-for-cash concept. Similarly, a number of existing local biogas companies were interviewed to assess their interest in such a model. While the results are not necessarily representative, the findings are summarised in Table 5.3.

Table 5.3 Average annual cooking fuel expenditure

	Peri-urban Nairobi (in euros)	**Semi-rural Mt. Kenya (in euros)**
Annual average expenditure on cooking fuel (charcoal, wood, LPG)	215 (range of 36 to 780)	137 (range of 0 to 600)
Annual average cooking fuel expenditure of existing biogas users prior to their adoption of biogas *(gives an indication of the cost level at which users adopt biogas)*	580 (range of 360 to 800)	580 (range of 40 to 600)
Annual average income	>4,300 (existing biogas users)	<1,715 (non-biogas users)

Cost savings by using the ARTI biogas system

The figures on average annual cooking fuel expenditure (Table 5.3) coincide well with those of a separate 2009 study in Kenya[18]. The data is useful for a basic understanding of domestic willingness-to-pay for biogas and to help anticipate the market potential of biogas energy from organic waste in urban and semi-urban areas of Kenya's large cities. In the particular case of the Westlands institution that hosted the 9.5 m^3 ARTI biogas digester during the pilot, namely the Jai Jalaram Satsang Mandal Temple, monthly LPG costs for cooking far exceed 1,000 euros (see Table 5.4).

Table 5.4 Monthly LPG costs and LPG savings of the institution testing the ARTI biogas digester

Month	**Year**	**LPG consumption (l)**	**LPG cost (average of 0.70 euros /l)**	**Number of functions held**	**LPG savings (L) with biogas**
May	2009	1924	1347	5	-755
	2010	2679	1875	8	
June	2009	2249	1574	10	117
	2010	2132	1492	10	
July	2009	2314	1620	12	403
	2010	1911	1338	9	
August	2009	2288	1602	10	-292
	2010	2580	1756	13	

As can be seen in Table 5.4, only the month of June can be used for tentative direct comparison as the same number of functions (which affect food waste levels) were held in this month in both 2009 and 2010. This is the only month we can compare, although data from the other three months show that the amount of LPG consumed per function is not necessarily uniform. Based on this, in June the biogas digester achieved a cost savings of approximately 80 euros (117 litres saved times 0.70 euros/l).

Given certain assumptions, a simple payback period calculation reveals the following:

Table 5.5 Payback period for the household and institutional ARTI units

	Urban household 2.5 m³ ARTI unit	**Urban household 2.5 m³ ARTI unit**	**Rural school 9.5 m³ ARTI unit**
ARTI system initial capital cost	1,015 euros	1,015 euros	2,237 euros
Annual cooking fuel expenses	580 euros (based on mid-range of peri-urban users who have already adopted biogas)	580 euros (based on mid-range of peri-urban users who have already adopted biogas)	750 euros (using mid-range of RETAP findings)
Monthly cooking fuel expenses	48 euros	48 euros	62 euros
Monthly savings with ARTI biogas	16 euros (assuming one biogas unit replaces 33% of cooking energy needs)	16 euros (assuming one biogas unit replaces 33% of cooking energy needs)	20 euros (assuming one biogas unit replaces 33% of cooking energy needs)
Payback period	5.3 years	5.3 years	9.3 years

The above estimates are considered fairly conservative as (a) as mentioned, labour costs may be reduced and (b) carbon credits have not been included. However, maintenance and replacement parts cost considerations were also excluded.

Under a gas-for-cash business model, the simple payback period is the amount of time required before the entity owning the units would begin to make a profit. Based on the conservative payback scenario above, it is clear that a company would face a substantial risk investing in such at the household or rural school level. An investment at the urban institutional level may, on the other hand, already make economic sense.

Suitability of gas-for-cash idea

According to the focus group discussions, gas-for-cash is a welcome idea and most participants indicated their willingness to participate in such a scheme.
Key feedback received was:

1. The proposed monthly payments for gas were perceived as a type of 'credit', although more flexible and less threatening than that of a loan from a bank.
2. A key condition for participants' interest in the gas-for-cash idea is that ownership of the biogas system should be handed over after a period of time, which should be agreed between the biogas service company and the user (lease-to-own model).
3. Participants were willing to feed the units but expected that there would be a reduction in gas charges due to the fact that they were also contributing to the biogas production.

However, a summary of interviews with existing biogas companies in Kenya reveals a lack of interest in taking up the gas-for-cash business model. This is due to the bigger risk assumed by the company, the need for initial capital that is unavailable to many companies, and an inability to properly plan and execute such a concept.

Thus the preliminary conclusion is that while potential biogas users would welcome the gas-for-cash business model, existing biogas companies in Kenya are either unable or unwilling to take up the challenge.

The technical advantages and disadvantages of the ARTI compact biogas system are as follows:

Table 5.6 Advantages and Disadvantages of biogas from organic waste using the ARTI system

Advantages	Disadvantages
System fabrication and maintenance is relatively easy (materials are locally available; it is a simple design, without mechanical parts)	The above-ground system is sensitive to fluctuations in temperature and performs poorly in cold weather
The system is mobile, modular and does not take up much space	The waste feedstock may not always be available in sufficient quantities to produce the desired level of gas and in some cases requires some processing (chopping, dilution) to help speed up gas production
The digesters are structurally sound (no slurry leaks and issues such as inlet pipe blockage and water condensation can be quickly solved)	There may be aesthetic issues with the adoption of this technology in urban areas
Longevity of the polyethylene tanks is expected to be more than 20 years	A trained technician is required for serious maintenance and repair issues
Odour not perceived as an issue by the households or the institution that tested the units.	Release of gas from the space between the digester and the telescoping gas holder may reduce system efficiency
	If located too close to a kitchen, the flies that are attracted by the system may turn off users

One interesting missing piece in this investigation is what is done with the slurry, and whether composting or value chain use of the slurry improves the economic and technical performance of the biogas system.

5.5 Key findings of the ARTI biogas pilot project

1. Technical performance: is satisfactory. The ARTI compact biogas test units installed in Nairobi operated as designed. Cooking gas was produced from urban organic waste with no major system problems.

2. Air temperature significantly affects ARTI system performance: during the cold season (June, July) in Nairobi, the colder weather seriously curtailed biogas production in the above-ground, uninsulated ARTI digesters, which operate two hours per day versus three to four hours per day for the institutional unit.

3. Institutional size units are more economical than household units: institutional size units appear to offer a shorter payback period of two to four years versus five to nine years. This suggests that they are more immediately commercially viable, especially where LPG cooking fuel is replaced.

4. Consumers are positive about the gas-for-cash biogas business idea: the initial indications are that existing and potential biogas users in peri-urban and semi-rural areas of Kenya would be willing to participate in the gas-for-cash concept.

5. Providers have a lower level of interest and confidence than consumers. That is, the gas-for-cash idea is perceived as too risky (and/or perhaps too commercially threatening) for existing biogas companies. The required capital investment costs and business risks may be too high to entice a company to implement the gas-for-cash idea.

6. For gas-for-cash to be viable, therefore, there is a need for a third party to reduce the risk. This third party could be a local authority that pays a diversion credit for diverting urban waste, or it could be a buyer of carbon credits. Without such a third party, the business aspect seems questionable.

5.6 Conclusions

This case is the only one of the four in which there is no involvement of the local authority at all; in part, this is because it is not only a rural but also an urban business model. It is similar to the Lilongwe case in that the beneficiaries are individual households or institutions, and to ECoH in that there is a kind of presumption that there will be some kind of private company that will organise the financial side of the gas-for-cash model. This assumption cannot be verified yet, in the face of the fact that the potential users are much more confident and interested in the model than potential umbrella providers.

Not much can be said about the sociocultural, environmental, institutional or governance aspects, as these were neither prominently featured in the project nor reported upon in the case study.

Chapter 6

Reflections and conclusions

Anne Scheinberg, WASTE
Yuca Waarts, LEI, part of Wageningen UR

Project point of departure

The Nairobi urban organic waste project differs in its approach from many other development cooperation projects, and these differences are worth highlighting. The set-up of the project and its main way of proceeding are based neither on the idea of managing urban waste nor on the idea of providing nutrients to the agricultural value chain. Rather, the core idea of the project relates to connecting urban waste streams with peri-urban and rural agricultural value chains.

The four case studies include one (the urban biogas pilot) that was partly financed by the project. The ECoH Holdings composting company finances its own operations as a business. In both cases the economic beneficiaries of the activity are individual natural or legal persons: a company in the case of ECoH, and the household or institutional hosts for the digesters in the case of biogas. There are also individual benefits associated with sourcing in the case of ECoH: some of the suppliers are paid.

Two additional case studies report on initiatives financed and organised primarily as livelihood or revenue enhancement projects. In both cases there are economic benefits to groups, and the organisation of the economic relationship and the sharing of benefits has been facilitated by a third party NGO.

Thus at the core of our project is the idea that while the environmental benefits of closing nutrient cycles are important, they will not drive sustainable economic activity. The essence of sustainability in this case is that the private-to-private transactions work and provide sufficient benefits for all parties. The role of government in such a private-to-private system is relegated to some variety of 'getting out of the way'.

Successful models for connecting urban organic wastes with the agricultural value chain

In some way, all of the four case studies represent some level of success. A reason for this is that we wanted to study initiatives that appear to be operational. However, the fact that we found operational initiatives is in itself quite remarkable, as the track record for organic waste processing and valorisation in sub-Saharan Africa is not robust. So it is worthwhile to look at the ingredients that the projects share, as a way of understanding how these small projects have achieved what so many larger, better-funded initiatives have failed to achieve.

Some specific conclusions are listed below, with the caveat that the number of cases is small and the level of analysis is limited.

- Individual benefits enhance the potential of composting initiatives in the African context
  Specific individual benefits work better in the African context than collective benefits or positive environmental externalities. The more individual the benefits in this rather limited sample, the more robust the interest of the individual stakeholders in making the initiative work.

- A positive enabling environment for initiatives can be created by the local authorities
  In terms of governance, the relationship with the local authority appears best when it is asked for, and gives, passive positive attention to the project. Specifically in Lilongwe, the general understanding of the positive impacts of composting is enough to secure goodwill and a positive enabling environment. Since the initiative does not need more than that, it works.

- Active involvement of local authorities is not realistic as long as disposal is not priced
  The active and especially financial involvement of the CCN is not realistic as long as disposal is not priced. Reaching beyond the cases for additional information, we can take the conclusion in the above paragraph a step further: the lack of active support in Nakuru and Nairobi is to be expected, primarily because these municipalities still do not have priced disposal, and therefore do not derive any economic benefit from the positive environmental externalities (they remain externalities). In this context, it is not realistic to expect financial support from the CCN, and both ECoH and NAWACOM would be better advised to focus more on improving their own operations.

- Entrepreneurs can build sustainable organic waste recycling business models
  Where government cannot be expected to become directly involved, there is a need for entrepreneurs to take an active role in business models that build on valorising organic wastes. Financially sustainable valorisation of organic waste seems to have potential, as the cases in this publication show.

- Financial institutions should take an active role in waste recycling business models
  Access to finance is of paramount importance when waste recycling initiatives want to upscale their activities. It would solve ECoH's need to expand and NAWACOM's need to invest. However, for NAWACOM, the ability to repay a loan – and its bankability as a commercial cooperative – will most likely require not only access to finance, but also a more marketable product and a more professional marketing strategy. The involvement of financial institutions could also create a possibility to build the gas-for-cash business model without the necessary involvement of a risk-averse private investor. Gas-for-cash could, in fact, be organised on the same principle as the Lilongwe Women's Composting CBO: creation of a cooperative of gas hosts, with an NGO or a bank anchoring the collectivity and the public utility managing the billing.

Is there a potential for closing nutrient cycles using slurry from biogas digesters?

After we finalised these case studies, we thought of a specific issue that we should like to investigate in the future: can using slurry from biogas digesters, fed with green organic waste, contribute to closing nutrient cycles between the city and peri-urban areas in a financially sustainable way? This is certainly worth investigating, as a considerable increase in the use of biogas digesters in urban areas will lead to a substantial increase in the quantity of slurry produced, which will become either a nuisance or a valuable asset that can be used or possibly even sold.

In conclusion, these case studies suggest that valorising organic waste in Africa might have more potential than expected, as long as the elements of private sector activity and individual benefits remain central.

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Appendices

Appendix 1: Case study template

Title: Biowaste Management Case Study Template

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Version: Case template version

Recipients: Readers and stakeholders in organic waste in Africa

1 Introduction

The purpose of this document is to guide the consistent, useful, and interesting write-up of experiences with composting in Africa. We are seeking to create a document that provides genuine insight into organic waste management, specifically composting and biogas production. The goal is to produce a small publication that gives readers both qualitative and quantitative information on feasible ways to connect urban organic waste streams with the agricultural supply chain.

We are preparing these case studies for readers in three quite different categories:

1. Development professionals, NGOs, city twinnings and city officials who want to understand the potential role of valorising organic waste in their cities.
2. Micro, small and medium-scale entrepreneurs who and community-based enterprises that want to produce compost and create livelihoods, or use it to create agricultural and horticultural products such as blended topsoil, tomatoes or energy.
3. Local experts in waste management or sustainable agriculture who advise the first two groups.

We expect that there will be two kinds of case write-ups, namely full case studies or case examples, depending on whether the biowaste recovery is going on at the present time and can be visited, or whether it occurred some years ago and can only be reported on second hand. There may also be quite different levels of monitoring and information. We refer to them both as ‘cases’.

The write-up will also generally be clear as to whether the case focuses on:

- a project, which has a beginning, a middle and an end, a budget, an implementing agency, etc.;
- a programme, which runs for longer and has larger ambitions, more actors, multiple purposes and, potentially, multiple sites, or
- an ongoing operation, in the sense that it is part of the normal daily work of a municipal department or an agricultural enterprises, but may not be well-monitored or documented.

The idea is to have good qualitative, quantitative and analytic information in each case, also for the group as a whole, so that we synthesise the experience and produce genuine insights.

This document provides a basic structure for the writing up of case studies, demonstrating experiences in organic waste recovery, treatment and selling. The guiding framework for the development of the case studies is the ISWM framework, which consists of a stakeholders analysis, a waste system's elements analysis (generation, collection, transfer, treatment, etc.) and an analysis of a waste system's aspects (social, technical, environmental, legal, etc.).

We use the ISWM approach as it is presented in the Habitat book Solid Waste Management in the World's Cities so as to position the case as to the policy drivers that are active in solid waste management in the host community of the case. This is because it matters whether the city is busy organising the collection of waste in response to the public health driver, or is working on controlling disposal in service to recently enacted drivers for environmental protection, or that the operational drive is to minimise disposal and conserve resources.

2 Structure of the case example and case study

3 Short case description at the beginning (1-2 pages) (also serves as the shorter 'case example')

a) The context or 'shell' that provides the enabling environment for the case: the host city, its solid waste system, the climate
b) Which drivers, whose problem biowaste is, why was something done in the first place
c) The story or description, with photos
d) Some very basic figures
e) The result (did it work or not?)
f) The insights, the good, the bad, the ugly and the special (see below)

4 Detailed case information based on the ISWM framework

4.1 Stakeholders and their roles. Describe those involved and what roles they have, such as:

a) Project initiator
b) Donor or national ministry that finances
c) Private entrepreneurs
d) Investors
e) Operators
f) Beneficiaries in terms of livelihoods
g) Beneficiaries in terms of organic waste generators
h) Beneficiaries/clients in terms of users of compost or biogas
i) Waste generators/sources
j) Users/buyers/brokers
k) Value chain and where the case fits

4.2 The system elements: description of the physical elements in the system as they are in relation to the case (and if possible, how the project or programme changed them). Begin with the process flow of the organic material:

a) Prepare a process flow/materials balance in Excel, or sketched and then transferred to Excel
b) Where is it generated?
c) How is collected?
d) Where is it transferred to?
e) How is it processed?
f) How much goes in and how much comes out, and what is lost? How much residue and where does it go?
g) Which process is used (windrow, static pile, in-vessel, biogas reactor)?
h) What materials and additives are used?
i) What are the steps, and the residence time?
j) Where is it sold or used?
k) What are the responding markets?
l) What are the specifications?

4.3 The sustainability aspects

Physical/technical, and performance:

a) How many tonnes/day are generated, and what percentage is used in the operation?
b) How does it affect the solid waste system?
c) How does it affect the urban/peri-urban/rural agricultural value chain?
d) What changes has it brought about, what would have happened to organic waste without recovery?
e) What is it used for? What product or energy source does it replace?
f) Performance characteristics and operations
g) Is it operating now and did the researcher see it in operation?
h) How many days did it operate in the last half year, in the last month?
i) How much material was sold last year? Last month? How much material is there now in stock?
j) Is it still going on?
k) What are the plans?

Economic & financial:

a) What is the cost of disposal in the host community and who pays the cost of disposal? If possible, divided by collection cost, disposal cost and prices for services to households and businesses
b) Is it a final or intermediate product?
c) Pro-forma financial analysis: what do the financials look like?
d) Is it profitable now, or when is it projected to be?
e) Sources of funds – grants, subsidies, investors, private equity or loans? From where?
f) Revenues? Do they cover the costs? How are the prices set?
g) Prices charged and per what units – same prices to all users, or differentiated?
h) Who pays whom for what? How does the money flow?
i) Are there funds transfers from the solid waste system, based on avoided costs?
j) Does the municipality sponsor it in any other way, for example, by providing land or equipment, or using the compost?

Sociocultural:

a) Is compost a product? Is it known, valued?
b) Are there taboos or restrictions, for example, on handling or using waste in an Islamic society, whether organic waste is women's or men's work, whether human excreta can be used?
c) Who can and who can't handle women's/men's waste?
d) Lack of knowledge about the product.

Environmental & health:

a) What regulatory issues are there for compost/biogas production?
b) For application or use?
c) Is compost regulated under the same standards as fertiliser?
d) Is there lab testing and what are the results
e) Is NPK regulated?

Organisational and institutional:

a) Who owns the organic material? What claims were/are there that compete with the case operations?
b) Who owns the facility/compost.
c) What kind of agreements/contracts?
d) How is the municipality involved? Do operators have to have permits? Do they have them?

Governance, policy, legal:

a) What is the legal framework?
b) Is the city council or other political organ involved explicitly? Is the construction a PPP? Is there a host community agreement?
c) Is the project on public or private land? Is the agreement long term or short term?
d) Is it formal or informal; that is, does the solid waste system 'know' about and/or recognise it?
e) Do operators need to be registered? Have permits? Pay taxes?
f) Are the operators registered? Do they pay fees and taxes?
g) Is the legal framework supportive/lacking?
h) What are the legal implications/restrictions regarding transport of waste, labelling of products, treatment facilities, etc.?

5 The good, the bad, the ugly, and the special

1. What stands out about this case? What is replicable? Why does the operator think it succeeded or failed? Do you as researcher agree with the operator?
2. What kinds of linkages and relationships has the project or programme created between the urban waste system and the agricultural value chain? What can be learned from those linkages or relationships?

Appendix 2: Visit to Kayole Environmental (19 March 2009)

Anne Scheinberg, WASTE

A visit was made to the plastics recycling operation of Mr S.N. Munywe, who represents a private MSE called Kema Re-using LD Plastics and a CBO called Kayole Environmental. The field visit was in the south-east of Nairobi, and included the area called Kayole and a compost site in the area of Ruai, where the new landfill will be located.

Kema Re-using LD Plastics

We went first to a private house in the Kayole area, where the remnants of a plastics processing operation were shown to us, including photographs and a hand press, and sample roofing tiles. The tiles were about 40 cm square, about 2 cm thick, and not completely uniform in thickness, with a mixed colour showing the original plastics used. The process used was to heat plastics, probably mostly LDPE, in a cast iron cauldron of a sort usually used for household cooking. The melted plastic was cast into a mould to make roofing tiles, apparently one at a time. According to Mr Munywe, more than 10,000 tiles were made, and about 3,000 were sold. The price per tile was not mentioned. In answer to the question whether the tiles melted in use, he stated that they were not vulnerable to melting. He did not state whether there were additives or what the recipe was, nor where the remaining 7,000 tiles are stored. However, it was clear that this operation is no longer active, and that there is a desire to start it up again on a different site, with external capital.

Kayole Environmental

Kayole Environmental is portrayed as a classic East African CBO that began in 2000 to collect waste from households in its area of Kayole. The cost for the service was 40 Ksh per household per month in 2000, and in 2008, when operations stopped, it had risen to 120 Ksh. At the peak, it served 12,000 households with a system of washable waste bags. The collection was three times per week per household, and collected about 7 kg per household per week. Each handcart had a route of about 500 households. The handcart operator provided a clean, washed bag in return for a bag of waste in the reusable washable bag. According to Mr Munywe, the group consisted of about 100 persons, of whom 80 were active in the collection, organised in cells, and the rest in the administration.

The group used an unclaimed site for transfer and composting. They separated non-organic waste and composted the organic waste, using the Tithonia plant, which is known for its high N and P content, as an enricher, and produced about 1,000 tonnes. The compost was sold for about 3 Ksh per kg. Tests had shown that it has an NPK content of 6-4-4 (a statement that the experts in the team seriously doubted).

The operation ended in 2007 when the new rules of NEMA required CBOs to be licensed and their site was repossessed. It was unclear why Kayole did not successfully register, but Mr Munywe implied that there was political influence to give the concession to a private company. It was reported that they had sold some compost, but that they lost about 200 tonnes of finished compost when the site was repossessed.

The CBO would like to resume operations but has not attempted to re-register. Mr Munywe reported plans for recovery of compost from markets, on the model of the women's group at the City Park market opposite the Aga Khan market. He showed us a plot of ¾ acre in a new area where some women were waiting for us in a shed, and asked for 14,000 euros investment funds to start composting at that site. He provided a pro-forma budget for composting.

Appendix 3: The Nairobi organic urban waste project partnership (2009-2010)

The Nairobi organic waste recycling project (2009-2010) was implemented by a partnership of Dutch and Kenyan organisations. The following provides information about these organisations, as well as the contact details of the staff involved in the project.

LEI, part of Wageningen UR

LEI, the agricultural economics research institute which is part of University & Research centre, develops economic expertise for government bodies and industry in the field of food, agriculture and the natural environment. By means of independent research, LEI offers its customers a solid basis for socially and strategically justifiable policy choices.

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Alterra, part of Wageningen UR

Alterra is the research institute for our green living environment. Alterra is part of Wageningen University & Research centre and offers a combination of practical and scientific research in a multitude of disciplines related to the green world around us and the sustainable use of our living environment: knowledge of water, nature, biodiversity, climate, landscape, forest, ecology, environment, soil, landscape and spatial planning, geo-information, remote sensing, flora and fauna, urban green, man and society, etc.

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WASTE advisers on urban environment and development

WASTE advisers on urban environment and development works towards sustainable improvement of the urban poor's living conditions and the urban environment in general. Their multi-year, multi-country programmes and projects have a focus on bottom-up development in relation to recycling, solid waste management, ecological sanitation and knowledge sharing. WASTE, located in the Netherlands, teams up with organisations in Africa, Asia, Latin America and Eastern Europe that share its goals and approaches.

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Environmental Cost Management Centre (ECMC)

The ECM Centre is a specialist consultancy firm providing solutions in quality, environmental and strategic management, and organisational development. The Centre offers a unique range of products and services leading to cost reduction, higher quality and improved environmental performance in industry. Its clients include companies from the manufacturing and service sectors and development agencies.

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Carbon Africa

Carbon Africa is a fully-fledged carbon company providing the essential services to take potential carbon projects from the initial design stages up to the final point of selling the carbon credits. In addition, the company can support the development of the underlying business through feasibility studies, business planning, financial modelling and arranging equity and debt finance. Carbon Africa is part of a global network of next-generation environmental entrepreneurs and investors that assists clients and partners to realise profitable and socially responsible green business opportunities.

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ETC East Africa

For ETC, modern international development cooperation means working in innovative ways on our themes in both the South and North. ETC East Africa is part of the ETC International Group. It is a not-for-profit but market-oriented, businesslike private sector organisation that mainly deals with development programmes for the public and civil society sectors. It encourages and supports local initiatives that enhance empowerment and sustainable development and put people's own culture and resources, local knowledge and experience, and full and genuine participation in development programmes so that they can take responsibility for their own future. The main intervention domains of ETC East Africa are research, extension & development; agriculture and natural resources management; drought management and food security; public health, water and sanitation; training and institutional development; and support for local government reforms and decentralisation.

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Project information on the Wageningen UR library website

For more information on this project, contact one of the contact persons (see above) or find documentation in the Wageningen UR library:

To do so, go to: http://library.wur.nl/ and enter the Library Catalog (http://library.wur.nl/desktop/catalog/). Then search for publications, by using the last names of the contact persons, or by searching with the terms 'Nairobi' and 'waste' or 'organic'.

Alternatively, search the Wageningen UR library for the titles of the following publications:

- Converting City Waste into compost pilot Nairobi (LNV-BO-10-006-115): report inception mission March 16 - 21, 2009
- Converting city waste into compost: pilot Nairobi (LNV-BO-10-006-115): report phase one: inventory and assessment (2009)
- Converting city waste into compost pilot Nairobi (LNV-BO-10-006-115): inventory and analysis of users, producers and markets for compost, biogas and livestock feeds in urban and peri-urban areas of Nairobi (2009)
- Nairobi organic city waste recycling project information (2010)
- Challenges in reusing non-domestic organic waste in Nairobi (2010)
- Final report on household and institutional biogas from urban organic waste in Nairobi. Technical performance & economic potential (2010).

This publication is the result of Project BO-10-011-104, 'Converting City Waste into Compost' (Great Lakes Nations: pilot Nairobi). This action research project was funded in 2009 and 2010 by the Netherlands Ministry of Economic Affairs, Agriculture and Innovation.

Ministry of Economic Affairs, Agriculture and Innovation

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BIO INKT

Waste management is a growing challenge in Africa. The increase in solid waste generation has not been accompanied by an equivalent increase in waste management activities by urban authorities or private entrepreneurs. In a dry continent where soils are seriously depleted and countries like Kenya are facing serious fertiliser shortages, the recovery and valorisation of organic urban waste in agricultural systems is astonishingly underutilised.

This publication presents four examples of recent attempts to manage organic urban waste sustainably in the African context. Three case studies focus on compost production, one case study on the potential of a relatively new technique to convert urban organic waste into biogas.

We hope these case studies will give you genuine insights into the feasibility of a variety of ways to successfully and sustainably valorise urban organic waste streams.