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

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LIST OF ABBREVIATIONS AND ACRONYMS

AKEFEMA:	Association of Kenya Feed Manufacturers
CBO:	Community Based Organisation
CCN:	City Council of Nairobi
CCWC:	Converting City Waste into Compost Project
EMCA:	The Environmental Management and Coordination Act No. 8 of 1999, Laws of Kenya
FBO:	Faith Based Organisation
GTZ-PSDA:	GTZ-Promotion of Private Sector Development in Agriculture
IETC:	International Environment Technology Centre
ISWMP:	Integrated Solid Waste Management Project
KEBS:	Kenya Bureau of Standards
KOAN:	Kenya Organic Agriculture Network
KUSCCO:	Kenya Union of Savings and Credit Co-operatives.
LA:	Local Authority
LPG:	Liquefied Petroleum Gas
MoLD:	Ministry of Livestock Development
MoLG:	Ministry of Local Government
Msl:	Metres above sea level
NAWACOM:	Nakuru Waste Recyclers and Management
NEC:	The National Environmental Council
NEMA:	National Environmental Authority (Kenya)
NGO:	Non Governmental Organisation
NPK:	Nitrogen, Phosphorus and Potassium
REECON:	Renewable Energy Engineering Contractors
SACDEP:	Sustainable Agriculture Community Development Programme, Kenya
SCODE:	Sustainable Community Development Services Programme
SHG:	Self Help Group
S-Mark:	Standardisation Mark of Quality
SSA:	sub Saharan Africa
UNEP:	United Nations Environmental Programme
VFA:	Volatise Fatty Acids

SUMMARY

Introduction

1. This report is part of Converting City Waste into Compost Pilot Project that aims at developing viable system of collecting, processing, distributing and marketing organic city waste material for application in urban and peri-urban agriculture; and contributes to addressing problems of waste management and soil nutrient supply and environmental conservation in the urban and peri-urban areas of Nairobi.

2. The objectives of the study were to make an inventory, map and analyse compost, biogas and livestock feed producers, users and markets in Nairobi and peri-urban areas; and to review their experiences on potentials and challenges of converting city waste into useful products.

Methodology

3. The study was carried out in the urban and peri-urban areas of Nairobi. The methodology adopted for the study comprised three main phases: (a) preparation phase including desk reviews, discussion with project partners as well as literature review and preparation of field tools; (b) sampling and field data collection; and (c) data analysis and reporting.

4. The study methods comprised a combination of literature review, desk studies, field visits and discussions with various stakeholders (institutions and organisations, farmers, individuals, and corporate entrepreneurs, input suppliers and sellers, and key informants). During the field visits, focus group discussions and interviews (using checklist and "free chatting") were held with various stakeholders.

Major findings and conclusions

Compost production, users and markets

5. Compost production-marketing chain in the urban and peri-urban areas of Nairobi is underdeveloped and compost production levels are low. However, opportunities exist to expand production and to turn City waste into compost by addressing the production-marketing linkages and making use of the high organic waste fraction found in the City.

6. Composting in the urban and peri-urban areas of Nairobi is done by private companies, NGOs and community groups, some of which have low financial and technical capacity and are vulnerable to challenges in meeting emerging policy regulations on waste management and standards.

7. Compost producers face diverse technical, financial and policy challenges including inadequate knowledge on rapid composting methods, limited access to source-segregated waste materials; inadequate composting supportive policies; and low financial and customer base. These challenges have partly contributed to low compost production levels.

8. The potential demand for compost is high, but compost marketing remains an intractable challenge for most compost producers. Pertinent market challenges include narrow customer base, inadequate branding and public awareness, market seasonality, and undeveloped marketing chain with limited distribution network and value adding activities, and lack of polices on compost quality standards.

9. Increasing the use of city waste to make compost will require addressing technical, policy and market issues simultaneously. This may include and not limited to:

    - Creating public awareness to peri-urban and urban farmers, nursery operators and other potential compost users on the benefits of using compost;
    - Compost branding and value addition to improve quality;

- Creating linkages with agrovets and input companies to expand compost distribution networks and markets and to positively influence supply-demand factors;
- Capacity building of compost groups in technical aspects of rapid compost production methods, and business skills and record keeping;
- Improvement of governance among community groups;
- Increasing access to financial resources, for example, through credit and grants;
- Formulating strategies to enhance private commercial entrepreneurs' participation in composting activities to up-scale composting activities; and
- Lobbying for fiscal and policy incentives to bridge the gaps in compost production-marketing chain.

Biogas production, users and markets

10. Small scale biogas systems exist in the peri-urban districts and areas surrounding Nairobi where dairy cattle are kept under zero-grazing and manure is used as a feedstock rather than within the "nucleus" urban Nairobi. The potential to up-scale the technology is high in such districts and peri-urban areas where manure is available.

11. Use of organic waste such as plant materials, organic market waste and or slaughter house waste to generate biogas has not been widely explored by biogas producers; though limited cases exist in the use of slaughter house waste in the peri-urban districts surrounding Nairobi.

12. The potential of selling the biogas to neighbours or family members has hardly been explored by smallholder biogas producers. This study, however, indicates that there is a possibility to do so for farmers and or large waste generators such as slaughter houses with surplus biogas that can be distributed to the neighbourhood.

13. There is a potential to upscale the generation of biogas from human excreta from biocentres constructed to address water and sanitation, and income generation in the informal settlements of urban Nairobi as evident from observations made during this study.

14. Small scale biogas production faces challenges in the area of management by producers (poor feeding methods); technical issues (poor design and construction); financial challenges (perceived high costs of installation and maintenance); inadequate awareness by potential producers and consumers; and lack of quality standards. Addressing these issues in an integrated manner, while exploring options for commercialisation, is envisaged to increase the adoption of biogas technology in the future.

15. One of the key questions which remain is on the long term economic feasibility of small scale biogas plants. This should be investigated to further provide information to current and potential biogas producers and users on the costs and benefits of biogas systems.

Livestock feed production, users and markets

16. There is a potential to use organic city waste as raw material for feed production, as there are large quantities available. The organic waste is also already in use, as livestock feed, through informal and formal arrangements between waste generators and users.

17 Individuals and farmers use organic city waste as livestock feed, either directly (letting their animals feed on waste piles) or indirectly after collecting the waste (either with or without paying for it).

18. Although the commercial feed milling industry is a vibrant sub-sector in Nairobi, initiatives converting Nairobi city organic waste into commercial livestock feeds are limited. However, it is envisaged that using organic city waste in feed milling can potentially reduce costs and competition for raw materials between animals and humans.

19. Current challenges facing the livestock feed industry in Kenya are the limited availability of high quality raw materials (e.g. supplements) at affordable cost and high costs of transportation, storage and milling.

20. Converting city waste into livestock feed (concentrates) on a commercial basis will require addressing potential contamination (toxic elements in the waste), variability in nutrient level and quality of waste, presence of naturally occurring anti-nutritional factors and seasonal variability in waste generation and bulkiness.

21. Exploring options for the commercialisation of feed-from-waste production will require a multi-stakeholder approach involving private-public actor linkages to ensure that technical, socio-economic and policy issues are taken into account.

Cross-cutting issues

22. The study has shown that most groups and organisations using organic waste for composting and biogas generation collect it for free. However, it is envisaged that as more and more entrepreneurs, groups, companies and organisations get involved in using city organic waste in the future, the situation may change and "cash transactions" will emerge.

23. Based on findings of this study, a sister study on inventory and analysis of waste sources and diverse criteria, it is envisaged that pilot projects on composting and biogas production would be plausible in making a positive impact and creating opportunities for experimentation and learning in waste-production-processing-marketing value chain. Criteria considered include proximity to waste streams, innovativeness, availability of space, proximity to users and markets, replicability, anticipated impact, ease of starting pilot project, willingness of existing actors/entrepreneurs to participate in a pilot project and possibilities for experimentation and learning from the pilot projects.

Limitations of the study

24. The study attempted to assess producers, users and markets for composting, biogas and livestock feed using a one-time interview and discussion session per respondent/actor. While the data generated were valuable in generating insight into the operations of these actors and potential market segments, there is need to conduct such studies over a longer period of time to capture temporal dimensions, dynamics and seasonality associated with waste generation, conversion of waste into useful products and marketing.

25. The study strived to inventorise and shed light on production, financial and market potentials of composting, biogas and livestock feed production and use by assessing their respective production-marketing value chain. However, the informal nature of some of the composting operations and limited availability of financial and transaction records proved a challenge in estimating cost benefit ratios within the timeframe of the study. Further detailed studies on the viability of selected small scale decentralised urban composting operations are required, in the future, to bridge this information gap.

26. The study assessed linkages among compost producers and users in urban and peri-urban agriculture within Nairobi City and areas in close proximity to the City based on a checklist; and limited to the breadth and scope of the study. To fully understand peri-urban agriculture as a potential market for compost, the extent of linkages among various actors and to understand the peri-urban environment (biophysical, socio-economic and policy), a detailed quantitative and qualitative study of this market segment is proposed; with a wider geographical scope that covers the greater Nairobi metropolitan area.

1. INTRODUCTION

1.1 Background

This report presents an inventory and analysis of users, producers and markets for compost, Biogas and livestock feed in Nairobi and its environs. It is one of the outputs of the "Converting City Waste into Compost Pilot Project", which is funded by the Netherlands Ministry of Agriculture, Nature and Food Quality. The project aims at exploring options of developing a viable system of collecting, processing, distributing and marketing organic city waste material for application in urban and peri-urban agriculture for major cities in East Africa in general and for Nairobi in particular. The project is being implemented in three phases (i) inventory and assessment; (ii) preparation and implementation of pilot projects; and (iii) analysis and information sharing phase. This report is part of the Project's inventory and assessment phase.

The Converting City Waste into Compost Project (CCWC) contributes to addressing problems of waste management and nutrient supply (fertilisers) and environmental conservation in the urban and peri-urban areas of Nairobi. Waste produced in Nairobi comprise mainly biomass (wet and partly decomposed) while the rest includes textile, plastic, paper, glass and metal. Some of the constraints associated with waste management in the urban areas of Nairobi include (i) inadequate capacity of the City Council of Nairobi (CCN) to collect, handle and dispose all waste streams-about 12 tonnes of waste are produced daily; (ii) health risks posed by Dandora dumpsite where all Nairobi waste streams are dumped. The dumpsite is a health hazard for people living around the site and or those whose lives depend on the site; (iii) improper methods of material recovery (burning; manual separation) by scavengers; and (iv) lack of waste segregation at source and transfer stations where material recovery can be done.

In addition to challenges of waste management in Nairobi and its environment, other constraints facing the Kenya citizentry include rising costs of fertilisers and even when fertilisers were to be affordable by majority of farmers, but unjudiciosly applied on large scale, a real danger of eutrophication of open water may occur. Food production has also declined in the recent past with most farmers unable to produce sufficient food hence resulting in food insecurity in many parts of the country. Turning city waste into useful products like compost, livestock feed and biogas (and by-products such as sludge/slurry) would partly contribute to addressing city waste problems, increase accessibility to organic fertilisers and livestock feeds and thereby contribute to food security, and generate income for various actors.

Assumptions underlying the activities of this project are that resource recovery from waste through decentralised, small, medium and large-scale compost, biogas and livestock feed production would (i) produce a useful product with monetary value that can partially meet the cost of proper waste management; (ii) provide natural and affordable compost to the agricultural sector rather than the massive introduction of inorganic fertilisers, which when not used properly results in environmental concerns (e.g. eutrophication); (iii) substantially reduce the waste to be dumped at the dump sites and; (iv) provide additional employment for the poor (in waste segregation, handling and storage of waste to be recycled or used as fuel, composting etc.).

This project links up and compliments a recently launched CCN/ UNEP International Environmental Technology Centre (UNEP/IETC) initiative on the development of the Integrated Solid Waste Management Plan (ISWMP) for Nairobi. The ISWM Plan for Nairobi explores options for the development of proper waste collection and disposal and foresees the development of public-private partnerships for elements (collection, separation, recycling and disposal) of the various waste streams. As the outputs of this

project are deemed to be of importance to the development of the Nairobi ISWMP, the partners in these two initiatives are cooperating and sharing information and results.

1.2 Objectives of the Study

The objectives of this study are as follows:

- To make an inventory, map and analyze compost, biogas and livestock feed producers, users and markets in Nairobi and peri-urban areas; and
- To review the experiences of producers and users of compost, biogas and livestock feed on potentials and challenges of converting city waste into useful products.

1.3. Structure of the Report

The report is structured as follows: Chapter One, this Chapter, provides the introduction to the study including a background and the objectives of the study while Chapter Two presents the approach and methodology used in the study. Chapters Three to Five presents the results of the study by the following study areas: Compost (Chapter three), Biogas (Chapter 4) and Livestock feed (Chapter 5). Conclusions and recommendations are presented at the end of each chapter.

2. APPROACH AND METHODOLOGY

2.1. The Study Environment

2.1.1. Biophysical environment

Nairobi is located at 1° 9'S, 1° 28'S and 36° 4'E, 37° 10'E **(CCN, 2007)**. It occupies an area of 696km^2 **(CBS, 2001).** The altitude varies between 1,600 and 1,850 metres above sea level (msl) **(Mitullah, 2003)** with the Western part of Nairobi being on higher ground (1700-1800 msl) than the Eastern side (approximately 1600 msl) **(Saggerson, 1991)**. Key physical features include the Nairobi, Ngong and Mathare rivers and the indigenous Karura forest in northern Nairobi. The Ngong hills stand towards the West, Mount Kenya towards the North and Mount Kilimanjaro towards the South-east. The soils of the Nairobi area are products of weathering of mainly volcanic rocks **(Saggerson, 1991)**.

Nairobi has a temperate tropical climate with two rainy seasons. Highest rainfall is received between March and April and the short rainy season is between November and December. The mean annual rainfall ranges between 850-1050 mm **(Lakin, sa)**. The mean daily temperature ranges between 12 and 26°C. It is usually dry and cold between July and August (temperature can drop to 10°C (50 °F), but hot and dry in January and February **(CBS, 2003)**. As Nairobi is situated close to the equator, the differences between the seasons are minimal. Similarly, the timing of sunrise and sunset varies little throughout the year. The mean monthly relative humidity varies between 36 and 55 per cent. The mean daily sunshine hours varies between 3.4 and 9.5 hours **(CBS 2003)**.

2.1.2. Public governance

Nairobi is the smallest Province in Kenya. It has one local authority, Nairobi City, which is administered by the City Council of Nairobi (CCN). The local authority, as other Local Authorities in Kenya, falls under the Ministry of Local Government. The CCN is responsible for providing services such as health, primary education, refuse collection, water and sanitation and fire protection services among others. The council has several departments, including the Department of Environment which is charged with the responsibility of waste management among other functions.

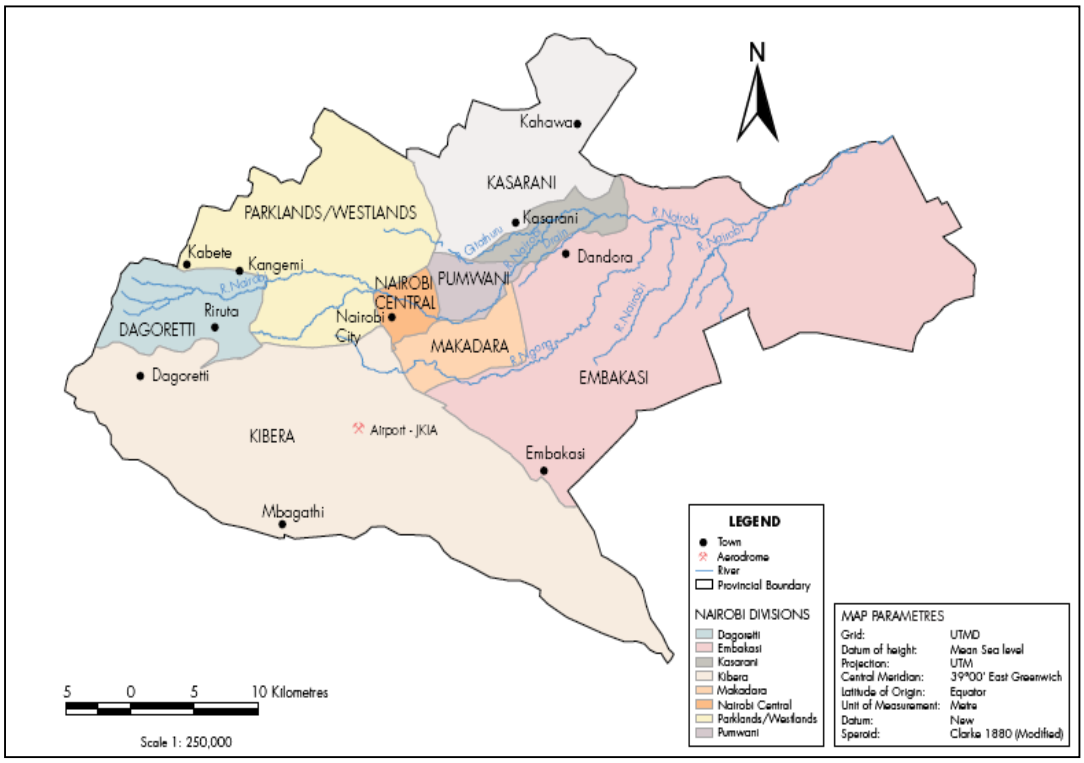
Nairobi City is divided into several administrative Districts and Divisions to improve public service provision **(Figure 1)**. While sub-divisions are still continuing, by June 2009 the administrative Districts were seven: Westlands, Dagoretti and Kibera Districts (part of the former Nairobi West District); Nairobi East District (Embakasi and Makadara Divisions); and Kasarani, Pumwani and Central Districts (part of the former Nairobi North District).

2.1.3. Socio-economic Environment

Nairobi is the most populous city in East Africa with a current estimated population of about 3 million. According to the 1999 Census, 2,143,254 inhabitants lived within 696 km^2 (**CBS, 2001).** The projected population for Nairobi in 2009 is 3 138 295 persons **(http://www.cbs.go.ke/sectoral/population/projections.html)** with a population density of 4,509 persons/km^2. The estimated population growth rate for Nairobi is 6.9%. (http://www.mapsofworld.com/cities/kenya/nairobi/demography.html).

Wealthy Kenyans live mostly in the Western parts of the city, but the majority of Nairobians are poor. About 50% of the Nairobi residents live below the poverty line and are concentrated in peri-urban and slum areas characterized by limited amenities and unhygienic living conditions, especially in the Eastern parts of the city **(Republic of Kenya, 2001)**. Life is precarious for the approximately two million people who live in Nairobi's informal settlements and slums. They make up over half the capital's population yet are crammed into only 5 per cent of the city's residential area and just one per cent of all land in the city.

Figure 1: Map of Nairobi



Source: UNEP *et al*., 2007

They are forced to live in inadequate housing and have little access to clean water, sanitation, healthcare, schools and other essential public services. They also live under the constant threat of forced eviction from the makeshift structures they have made their homes **(Amnesty International, 2009)**.

Most land in Nairobi, including the central business district (CBD), is publicly owned (Government owned) and leased for 99 year periods to private owners **(Rakodi 1997)**. In addition, Government leasehold covers most of the legalized residential areas. However, there is also freehold land, privately owned either by individuals or by groups of individuals to the west and north-west of Nairobi (e.g. Dagoretti, Mwimuto, Runda, Gigiri and part of the Kahawa area in the north). It is estimated that that CCN owns only about 5% of the City's land, mainly in the East of Nairobi **(Rakodi 1997)**. In practice, the public sector has little direct control over land available for development in Nairobi

Although access to land is controlled by legislation, there is corruption and disregard for regulations and planning standards. In the informal settlements, land allocation decisions are partly made through local Chiefs and Village Elders, rather than through recognised municipal authorities. Poverty, the insecurity of housing tenure, and the desire to invest in rural homes limit incentives to improve urban housing conditions in the City **(Peters, 1998)**.

Most of the people who live in the low income areas of Nairobi and in slums depend mainly on the informal sector for their livelihoods **(Bubba and Lamba, 1991)**. They earn their livelihoods as street vendors, maize roasters, shoe shiners, auto-repairers, cart pullers, kiosk owners, street barbers, and water vendors, building contractors, charcoal sellers and furniture makers. Also some of the Nairobi's poor engage in waste picking as a means of income generation **(Peters, 1998)**.

2.1.3. Waste Management

The quantity of solid waste generated and collected by CCN is being quantified in a sister study. However, previous studies have indicated that about 25-40 per cent of the solid waste generated daily in Nairobi gets collected **(JICA 1998; Kibwage and Momanyi, 2003)**. This figure however, is expected to have improved upwards by date of this study. Major problems with solid waste management in Nairobi include low collection ratio (proportion of solid waste generated that is collected), marked inequality in geographical service distribution, widespread indiscriminate dumping in illegal dumpsites, availability of only one official dumpsite (CCN-owned and operated) which is full and located in a densely populated part of the city; and existence of limited transfer facilities[1]. The high income and middle income residential areas in Western part of the city have relatively better waste collection services while the low income areas, especially in slums (informal settlements) where 55-60% of Nairobi residents live have poor services (www.unep.org/PDF/**Kenya_waste**_mngnt.../contents_*et_al*.pdf). The attitudes of poorer city residents toward environmental cleanliness are also a contributing factor to the waste problem in Nairobi **(Kibwage, 1996; Peters, 1998)**. An urgent need exists for new methods of waste handling and raising public awareness on environmental issues.

Previous studies in Nairobi have identified households and institutions as the main waste generators **(JICA, 1998)**. Institutions that generate waste include schools, hospitals, hotels and restaurants, shops and markets.

Prior to the enactment of the Environmental Management and Coordination Act (1999), the CCN had monopolistic control over sanitation and solid waste management as do other Local Authorities in Kenya **(Mulei and Bokea, 1999)**. The Environmental Management and Coordination Act (1999) entitles Kenyan's to a clean and healthy environment and empowers them to sue for improper waste management, prohibits improper discharge and disposal of waste, requires that waste transporters be licensed by National Environmental Management Authority (NEMA) and that waste generators apply measures to reduce waste, among other issues **(see details in Chapter 3.4)**.

Principal actors in waste collection include CCN and private companies (licensed by CCN and NEMA). Others, on a small basis, include Community Based Organisations (environmental groups, youth groups, self help groups etc.), residential (or Neighbourhood) associations, farmers, informal agents and private personal initiatives. Many of the small entities can no longer transport waste over longer distances unless licensed by NEMA. However, CBOs continue to be active, mainly, in the low income areas of the city and informal settlements (slums) which are not effectively covered by CCN services. Despite the increase in players on waste collection, waste management in Nairobi still remains a challenge since the major actors have insufficient financial, technical, and institutional capacities to collect, transport, and safely treat and dispose of municipal waste.

Many approaches to solid waste management exist in Nairobi. These include use of landfills/dump site in Dandora, incineration and recycling, and reuse and reduction of waste. It is also common to find scavengers moving from door to door or sorting through communal bins to pick dry recyclable materials. However, these scavengers are more interested in inorganic recyclable materials such as plastics and glass, but not in organic waste. Organic waste, however, is important to street children who often pick through bins to find their next meal. Some of the larger restaurants and hotels also give farmers their waste as livestock feed. Organic waste is also important to the urban agriculture sector as all sorts of livestock, including goats, chickens and cattle occasionally feed on top of waste heaps in the peri-urban frontiers of the city **(Peters, 1998)**.

[1] Other smaller "non-official dumpsites" exist such as Mathare North dumpiste and K-quarry dumpsite

Organic waste refers to materials directly derived from animal and plant sources, and which can generally be decomposed by micro-organisms **(Davies *et al*., 2004)**. The organic portion of the municipal solid waste generated in Nairobi constitutes over 60% of the total **(Karingi, 1997)** and includes 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 and a fraction that finds its way into dumpsites. If properly treated and utilised, organic waste has the potential of being an important resource for composting, livestock feed and biogas generation. Use of urban organic waste can also reduce the burden of waste disposal for municipalities as well as ameliorate the environmental problems associated with untreated organic waste.

2.2. Study Methodology

The study was carried out in the urban Nairobi and the peri-urban districts surrounding Nairobi. The study methods comprised a combination of literature review, desk studies, field visits and discussions with various stakeholders (institutions and organisations, farmers, individuals and corporate entrepreneurs and key informants). The detailed methodology comprised three main phases: (a) preparation phase including desk reviews, discussion with project partners as well as literature review and preparation of field tools; (b) sampling and field data collection; and (c) data analysis and reporting. Details of the methodology are presented here-after.

Preparation phase

Inception phase comprised discussion with study team members and partners to explore waste problem issues formulate explicit assumptions and identify key thematic study issues and areas of data collection. A preliminary explorative field visit was also carried out (in the urban and peri-urban areas of Nairobi) with study team members to gain knowledge of the study area and to familiarise the study team members with city waste management and major actors.

The preliminary field visit was followed by desk reviews on the location and activities of waste generators and users in the study area. Secondary data on previous studies and lists of organisations involved in composting, animal feeds and biogas production in Nairobi and its environments were consulted and reviewed to make a tentative list of organisations and individual entrepreneurs to be visited. Based on broad areas of data to be collected three separate checklists were made for (i) composting; (ii) biogas studies; and (iii) animal feeds.

Sampling and field data collection

Snowball sampling, a non-probability method, was used to select information-rich key respondents in each of the Nairobi's major geographical and administrative areas and in the peri-urban districts. The respondents were in turn asked to help identify other respondents carrying out similar activities. Snowball sampling relies on referrals from initial respondents to generate additional respondents **(Patton, 1990)**. The initial respondents in the study were identified from secondary data and existing local expert knowledge on various organisations and their activities. To ensure that major stakeholders and actors were represented in the study, respondents identified through snowball sampling were visited and interviewed in addition to those identified through secondary data and local expert knowledge in the various designated administrative districts/geographical areas of Nairobi. Public and private institutions and organisations, farmers and individual entrepreneurs were interviewed.

Primary data collection was done in June-July 2009 staggered over a period of four weeks. Various methods of data collection were used, such as interviews (using a checklist), group discussions, free chatting and dialogue, direct observation and

measurements. A prepared checklist was used to guide the interview process and to collect data **(Appendix 1)**. Data were collected from the following chain actors:

- Producers of compost, biogas, and animal feed: Since there is a close linkage between producers and users of compost, biogas and animal feed (for own use or sell), these category of chain actors were visited to identify those who purchase compost, animal feed, biogas and or sludge/slurry from them and how the chain relationship is like (perceptions of buyers on quality prices, availability, exact use etc).
- Entrepreneurs of biogas reactors and associated: These chain actors were visited to identify those who purchase/seek for construction of biogas plants and how the chain relationship is like.
- Formal business entities: Some business entities, defined in a general sense, are hypothesized to be compost users, biogas, slurry/sludge and or animal feed users; for example those dealing in landscaping; interior decoration, agro-vets and animal feeds etc. Inventory of these business entities was made and selected entities visited.
- Urban and peri-urban gardening sites: visits were made to nursery operators and urban and peri-urban gardening sites to inventorise on their locality, activities and prices of manure.

The details of respondents in this study, drawn from public and private sector, are in **Appendix 2** while information obtained from literature is integrated in relevant sections of the report.

Data Processing, Analysis and Reporting

Data collected was triangulated and analysed and forms the basis of this report. The data were analysed to capture the production, use and marketing of compost, biogas and livestock feed as well as the challenges and potentials of converting Nairobi city waste into these products.

3. COMPOST PRODUCTION, USERS AND MARKETS

3.1. Background

Reuse of organic waste is considered desirable, in general, for resource management and also as a way for urban authorities to substantially reduce the amount of waste requiring disposal and treatment **(Furedy, 2002)**. It is undeniable that composting is the preferred method of processing urban organic waste for reuse. Composting has been defined as any practical system of mixing, layering and breaking down organic materials under a suitable environment to give humus end product (controlled decomposition of organics) **(FAO, 1987)**. In response to challenges of waste management in Cities, small undertakings and private enterprises on composting have been promoted. Composting city waste provides a win-win strategy by reducing waste flows, enhancing soil properties, recycling valuable soil nutrients and creating livelihoods **(Cofie and Bradford, 2006)**.

Aerobic composting and fermentation

Aerobic composting and fermentation are two different biological methods to decompose organic waste. The major difference between the two is that oxygen is required for aerobic composting while fermentation is an anaerobic process. This difference has large consequences for both process conditions and for the end products. During aerobic composting heat is produced and the temperature increases. Heat production during fermentation is much lower and sometimes additional heat is even needed for fermentation. The main products of aerobic composting are compost, carbon dioxide and water. The main products of fermentation are biogas, a mixture of methane and carbon dioxide, and digestate, an organic residue. Aerobic composting is an energy demanding process, whereas fermentation yields energy in the form of biogas.

Both composting and fermentation can be used in the removal of organic waste and in both cases the end products may serve to close the rural-urban nutrient cycle

In the 1990s, international agencies and urban organizations began experimenting with small-scale, little-mechanized, neighbourhood-based composting and vermi-composting practices (producing from 0.5- 6 tons per day) **(Furedy, 2002)**. This period also saw the emergence of some local NGOs (e.g. Uvumbuzi Club, Undugu Society of Kenya, Foundation for Sustainable Development in Africa) and Community Based Organisations (CBOs) taking an active part in composting organic refuse in Nairobi and the peri-urban areas with sponsorships, partly, from international bodies such as United Nations Environment Programme (UNEP), several Scandinavian countries and the Dutch Government **(Peters, 1998)**. Past donors also include Wildlife Clubs of Kenya and UN Habitat among others (http://www.safariweb.com/remind/capacity.htm). By 1992, small-scale community-based composting groups emerged in Nairobi's slum areas including Korogocho, Mukuru-Kayaba, Dandora, Kibera, Mathare and Kangemi **(Kibwage and Momanyi, 2003)**. However, there are limited detailed assessments of these initiatives especially in relation to their impacts on city solid waste management and their continuity in the long term. Similarly, limited studies have been carried out to capture emerging initiatives in composting Nairobi city waste, identifying users and compost markets and drawing lessons learnt.

3.2. Compost Production

3.2.1. Mapping and characteristics of compost producers

The study identified six categories of compost and or organic fertiliser producers within the urban and peri-urban areas of Nairobi, excluding manure vendors and government ministries **(Table 1)**. Majority of organic fertiliser producers were community groups and private companies. Groups include Community Based Organisations (CBOs), which are umbrella for various self help groups; and individual self help groups and youth groups. Most of the groups doing composting are located in the low income residential areas and informal settlements (slums) (for example Kibera, Dandora, Maringo, Korogocho, Kawangware etc), partly in the middle-high income residential areas (e.g. Parklands) and in the peri-urban areas of Nairobi **(Figure 2)**. Examples of community groups doing composting are listed in **Appendix 2**. The community groups met during this study are registered with the Department of Social Development in the Ministry of Gender, Children and Social Development giving them legal identity. The self help groups (SHG) and youth groups have group sizes ranging between 10-30 members with elective committee members and a group constitution. Such small group sizes limit labour available for composting.

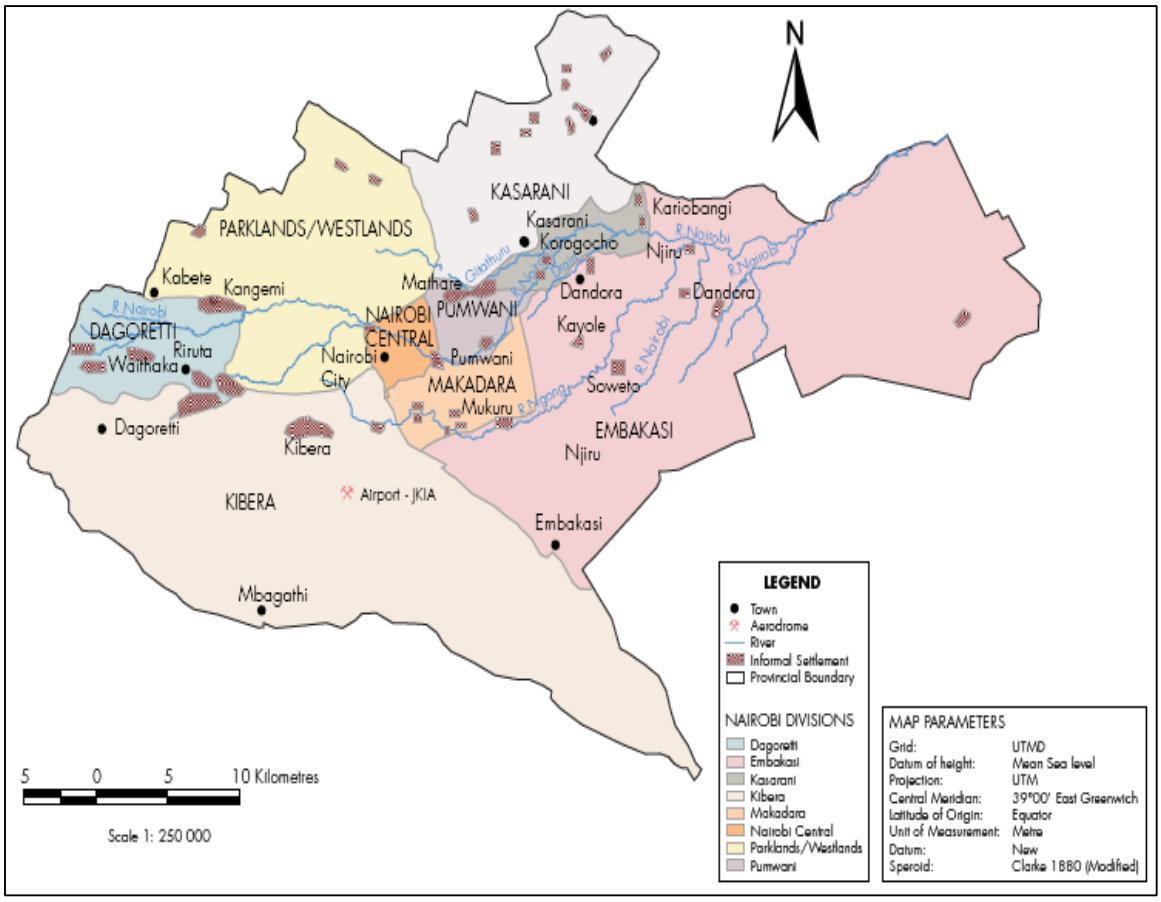
Table 1: Overview of compost and other organic fertiliser producers and sellers interviewed during the study

	Category	Number interviewed	Activity	Raise own funding	Initially donor funded	Currently Donor funded	Public funding
1	Private Companies	7 (3 producers + 4 sellers)	P, S,O*	7	1	0	0
2	NGOs	3	P, S,O	1	0	2	0
3	CBOs	2	P, S,O	1	1	0	0
4	Self Help Group (SHG + Youth groups)	4	P, S, T,O	4	3	0	0
5	Ministries-Agriculture	2	T	0	0	0	3
6	Public schools	1	P,O	0	0	0	1
7	Private educational institutions (colleges)	1	P, S,O	1	1		
8	Faith-Based Organisations	1	P,O	1	1	0	0
9	Individual entrepreneurs (manure sellers along roadside)	16	S	16	0	0	0
	Total interviews	37		31	7	2	4
	% of total			84	19	5	11

Key: P = producer; S = Seller; T = Training and facilitating environment; O = Own use or using part of compost produced

The CBOs are multi-layered in leadership structure and are able to access more labour for composting than SHGs due to their large membership size. An example is the New Nairobi Dam Community Group with 150 members and a structured leadership comprising a Council (Executive committee), Project Coordinator (the CEO) and programme managers in charge of various activities undertaken by the CBO, including composting. The CBOs and self help groups in the urban areas of Nairobi produce compost, mainly, for sale; and partly for use by their members. Similarly, the NGOs and Faith Based Organisations (religious organisations) involved in composting either do it as part of their training programme, for sale and or for their own use.

Figure 2: Map of Nairobi showing location of informal settlements, composting and biocentre sites



Source: Extract from UNEP *et al*., 2007

Location of composting sites

- Kibera*
- Dagoreti
- Parklands*
- Kangemi*
- Kawangware
- Pumwani
- Dandora*
- Korogocho/Kariobangi*

Location of biocentres

- Kibera*
- Mukuru*
- Korogocho*

*Visited during the study

The private companies involved in composting are entrepreneurs with a commercial interest; either producing compost for sale, buying and selling packaged compost (e.g. Phymyx®; ECOH Holdings Ltd.) and or producing compost from company waste (flowers etc) to minimise input cost and to comply with environmental management regulations. The companies have salaried employees carrying out composting.

Land allocation and acquisition for group development activities in the City remains a thorny issue and has an influence on the sustainability of composting activities. Most of the community groups have acquired composting sites from land allocated to them through the provincial administration (e.g. in slum areas), premises given by the CCN or

through lobbying by Councillors, own-arranged plots of land (e.g. Kuku Women group in Dandora; Kayole Environmental Management Association), and road or railway reserves with permission from relevant authorities (e.g. Kenya Railways for Youth Reform Self Help Group in Kibera). Although the "informal" acquisition of composting sites pre-disposes community groups to "harassment" by local and central government authorities, most of the groups felt that their "composting sites" are secure so long as they continue collaborating with relevant authorities. A number of roadside users (nursery operators, flower vendors, manure sellers etc), however, reported paying regular tax or getting a licence from the CCN to operate along the road sites; though this could not be independently confirmed.

Access to financial resources for the groups involved in composting remains a challenge. Only about 19% of the groups interviewed during this study had a previous financial start up support through donor funding and by the time of this interview the donor funding had been phased off. Two donor funded local NGOs (Uvumbuzi Club and Undugu Society of Kenya) and one non-donor funded NGO, Foundation for Sustainable Development in Africa (FSDA) provided support and training to CBOs on composting in several of Nairobi's low-income areas in the early 1990s, but have since phased off their support **(Peters, 1998), Table 2**. Some of the initial groups supported by these NGOs, however, could not be traced during this study. Besides these NGOs, other donors and actors have also supported composting in Nairobi and the peri-urban areas **(see Section 3.1)**.

Table 2: Composting groups in the early 1990s in the urban and peri-urban areas of Nairobi

Support NGO	Community Group	Location of Group
Uvumbuzi Club	Grogan "A" waste recycling group	Korogocho
	Kuku Women Group	Dandora**
	Block making women Group	Kariobangi
	Korogocho Mbolea Group	Korogocho
	Nyayo Market Group	Nyayo market
Foundation for Sustainable Development (FSDA)	City Park Hawkers Market	Parklands, City** Hawkers market
	Wekhonye Women's Group	Dagoreti Corner
	Mwangaza Women's Group	Mukuru-Kayaba
	Kawangware Group	Kawangware
	Mathare Valley Group	Mathare Valley
Undugu Society	Kinyago Bidii Group	Kitui Pumwani
	Ushirikisho Women's Group	Kibera

** Interviewed during this study; Source: Adapted from Peters (1998).

Community groups (CBOs and SHGs) interviewed face financial constraints. Although some of the groups are trying to address this situation through raising their own funds (membership fees, monthly contributions, merry-go-round, proceeds from compost and manure sales, donations from well-wishers and NGOs etc), the funds raised are limited, unreliable and can neither expand composting activities substantially nor a sufficient source of income for long-term capital investments. Despite the financial constraints, none of the respondents in this study indicated having borrowed a loan to carry out composting. Though not answered in the affirmative during the survey, the potential to have a loan for composting, however, exist among the private companies interviewed (19% of the respondents) and with some CBOs. Constraints cited to accessing loans from commercial banks are lack of collateral and "fear of property auctioning". The study further established that some of the community groups have limited knowledge on recent financial products available in the market (such as Women Development Enterprise Fund, Youth Fund, micro-finance products etc) and are faced with compost marketing constraints thus "perceive themselves" to have low capacity to service loans.

Community based composting succeeds when people are able to make an income out of it. Most community groups interviewed expressed the view that they were "making profit"; though no sales records were availed to independently corroborate these perceptions. Observations made in this study further indicate that most community group members involved in composting also engage in small-scale businesses, urban farming and or are partly employed elsewhere to supplement their income. Nevertheless, the activities of composting groups have contributed to the generation of employment opportunities for the urban poor and the composting groups represent beneficial step in terms of social organization and environmental awareness **(Peters, 1998; Kibwage and Momanyi, 2003)**.

Besides the above socio-economic characteristics of compost producers observed in this survey, previous studies have also indicated that most of the community groups involved in composting in the urban and peri-urban areas of Nairobi have low education levels (except among youth groups, CBOs and some SHGs) and attract high level of participation of women **(Kibwage and Momanyi, 2003)**. The low educational levels among some of the composting group members are believed to be contributing to their low productivity- lack of basic technical skills and limited ability to learn new composting techniques.

3.2.2. Input sourcing for composting

Input sourcing

The key question in the waste supply context is: *Where* is *which* amount of waste, of *what* kind of quality and *when* is it available for composting? Documentation of sources of waste in Nairobi and their quantities have been presented in a separate project report. The volume and composition of waste for composting is subject to seasonal variations. The waste stream in Nairobi is not a homogenous mass but a collection of different materials (organic material, plastics, metal, textiles etc.) that can be handled in different ways to maximise recovery and the organic waste fraction preferred for composting remains the largest proportion to be recovered.

Waste used for composting in the urban areas of Nairobi are obtained from diverse sources, including domestic sources, markets (open markets; super markets etc) and kiosks and to a limited extent from the dumpsite or "temporary dumping sites", **Table 3**. Some companies interviewed during this study, for example EM technologies, are pioneering the recycling of water hyacinth (in Nairobi dam) through composting in partnership with Kenya Prison Service (demonstrations) (*personal communication, Mr. John Nchebere EM Technologies Ltd)*.

Table 3: Sources of waste for composting in Nairobi

	Category	Source of waste
1	Private Companies	Market waste; domestic; Flower waste; Farm waste
2	NGOs	Farm waste (livestock and crop wastes);
3	CBOs	Market waste; domestic waste; kiosks;
4	Self Help Group (SHG + Youth groups)	Market waste; domestic; farm waste (livestock and crop waste); Kiosks
5	Public schools	Farm waste; kitchen waste
6	Private educational institutions (colleges)	Farm waste (livestock; crop waste)
7	Faith-Based Organisations	Farm waste (livestock; crop waste); sweepings; hedges etc

Within the urban areas of Nairobi, various arrangements exist for sourcing compost materials. The CBOs and Self Help Groups have their own arrangements where members collect waste (domestic, kiosks etc) using washable plastic waste bags and transport the same, on their backs, handcarts or wheelbarrows to compost site (e.g. New Nairobi Dam Community Group in Kibera, Youth Reform Self Help Group, Kuku Women Group etc). The group members collecting waste provide a clean, washed bag in return for a bag of waste in the reusable washable bag. This method of waste collection appears limited in terms of quantities that can be collected for composting at any given time, but has been instrumental in sustaining the composting operations of many community groups in Nairobi. Some of the CBOs such as Kayole Environmental Management Association, however, had in the past (2008) employed scavengers and recruited members to help in waste collection and transportation using a hand cart at a fee (KES 120 per household). Waste used in composting in many parts of Nairobi, are however, obtained free of charge especially in the low-income estates and in the informal settlements; however commercialised garbage collection is the norm in the up-market estates. In some of the low-to-middle income estates, waste collection costs about KES 100-200 per household per month; this fee is however, expected to be high for the up-market estates and commercial entities such as hotels.

Although waste collection has been commercialised with private companies licensed to collect and transport waste (by CCN and NEMA) in Nairobi, this study observed limited interaction between these companies and actors making compost in Nairobi. Linkages with garbage collectors from the residential areas and markets could offer opportunity for increasing the amount of waste for composting, especially when the compost producers could be willing to give incentives to garbage collectors or identified households for source segregated waste. For example, one company interviewed in this study, ECOH, is willing to pay garbage collectors 100-200% more money for them to segregate waste at source and deliver organic waste to them so that they can directly use it for composting.

In the peri-urban areas/districts of Nairobi, compost is prepared from a mix of biodegradable materials. Sources of organic materials used for composting include: crop residues from past/previous cropping seasons, weeds within the farm, hedge trimmings, kitchen waste, sweepings from the compounds, materials from livestock units (beddings, fodder leftovers, feed rejects, manure), materials grown deliberately within the farm (agro-forestry tree leaves etc), materials collected from public places like along the roads and shrubs such as *Tithonia*, and other local succulent shrubs with a potential to decompose fast etc. These materials are obtained free of charge except for labour required to haul them. In some parts of the peri-urban areas, domestic and market waste are also used.

Quality and types of waste for composting

The study investigated compost producer's preferences for waste and quality of desired waste. Organic domestic and market waste (bio-degradables) are preferred due to "perceived" low levels of contamination and consumers preferences for the resulting compost. The organic waste from dumpsites is perceived "contaminated" and or have a high labour demand for waste segregation. The commercial companies interviewed in this study also preferred non-decomposed, fresh or semi-decomposed materials to control composting process. The quality of vegetation materials preferred for composting are fresh succulent and easy decomposing materials. The quality of materials put in composting heaps determines the eventual quality (NPK contents) of the compost and time taken by the organics to decompose.

3.2.3. Composting systems

Composting can be done at different scales (large, medium, small) by various people (municipalities, NGOs, communities, individuals) and for various purposes (gardening,

landscaping and farming). Small scale decentralized composting systems are found in the urban and peri-urban areas of Nairobi. Composting systems observed during this study include open pile, pit composting, bin (box) composting, composting in bio-reactors or general "in-vessel" composting, trench composting, vermi-composting, basket composting and their adaptations. Open pile composting (aerobic composting) is the most common method employed by the composting community groups in Nairobi **(Box 1)** while trench and basket composting are *in-situ* composting procedures practiced in the peri-urban districts surrounding Nairobi and other parts of rural Kenya. Even within a given composting system, many variations exist in terms of how materials are laid, how the system is managed, additives used and duration taken by the compost to be ready for use **(Appendix 3)**.

Box 1: Open pile composting (a variant)

1. Select a 1.5 m x 1.5 m area under the shade of a tree or polythene sheet. The cover shelters the compost pile from direct sun, strong winds and heavy rains.
2. Clear and dig the area to a depth of 15-30 cm. Digging deeper permits excess water and heavy rains to drain, allowing for better aeration.
3. Apply a 7.5 cm layer of coarse dry vegetation such as maize stalks, banana stems and tree branches to allow air to pass through the pile.
4. Add a 10 cm layer of chopped and fine dry vegetation
5. Add a 5 cm layer of green waste and cover it with a 2.5 cm layer of soil to reduce the odor and keep away flies and other pests.
6. Add more layers of dry vegetation, green waste and soil until the pile is 1.2-1.5 m high. Each layer of materials should be watered.
7. In the dry season, make the top of the pile flat and rounded during the rainy season. Cover the pile with a sheet of polythene paper to protect it further from winds and to conserve moisture. During dry seasons, the pile is watered every morning and evening to promote the activities of decomposing organisms.
8. Drive a long, sharpened stick diagonally into the middle of the compost pile. The stick is used to monitor the composting process. The pile is turned once every week. The compost is ready for use when it turns dark-brown, and has no unpleasant odour. The composting process requires approximately 4 to 6 weeks.
9. When the compost is ready, large and non-decomposed objects are removed by passing the compost through a wire mesh. The large objects are either added in the next compost pile or disposed. A mesh size of 5 mm results in finer-textured and more uniform compost, but 10 mm mesh allows for more rapid sieving and greater recovery of finished product.
10. After the screening process, the compost is packaged and sold.

Source: Adapted from Aboli and Scully (1993); Kibwage and Momanyi (2003)

Composting systems observed in this study takes 4-12 weeks to be ready except on one incidence where composting took 6 months for the product to be ready. The duration taken by compost to be ready depends on a number of inter-related factors: Carbon to nitrogen ratio, moisture content, oxygen supply (aeration), particle size, pH, temperature, turning frequency, micro-organisms and invertebrates, control of pathogens, degree of decomposition and nitrogen conservation **(Cofie and Bradford, 2006)**. Composting systems in use in Nairobi are illustrated in **Figure 3** of this report.

Traditional methods of composting (anaerobic and or aerobic decomposition based on passive aeration through measures like little and infrequent turnings or static aeration provisions like perforated poles/pipes) take about 6-12 months to obtain good finished compost while "*Rapid Methods* that make use of treatments or additives to expedite the aerobic decomposition process can bring down the composting period to four to five weeks **(Misra and Roy, Sa)**. In this study, composting groups making use of Effective Micro-organisms (EM) as an activator reported that their piles took shorter time to be ready, 4-6 weeks. Effective Micro-organisms (EM1®) is a liquid containing many co-existing microorganisms: lactic acid bacteria, yeast and phototrophic bacteria. When these organisms are placed in contact with organic matter, they secrete substances such as vitamins, organic acids, minerals and antioxidants that beneficially affect plants and

other micro-organisms **(Chandi, 2003)**. Although EM1 and EM Composta®), a derivative, is available in many agro-vet stores and some supermarkets in Nairobi, this study revealed that the groups which have heard about the product and are actually using it are limited.

The groups interviewed currently do not intentionally use additives to improve the nutrient contents of compost. The use of additives such as bone meals, blood meals to improve phosphorus contents of compost was not reported. However, some groups reported using *Tithonia diversifolia (Hemsl.) A. Gray* and a mix of kitchen waste and wood ash to enhance the quality of compost (N and P contents). Some groups also reported mixing various waste types with the hope of improving the quality of the end product, compost.

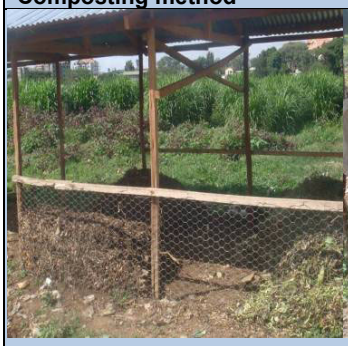
Composting systems observed in this study are manually operated and may or may not involve the harvesting of a bio-product, leachate, in addition to the target "natural/solid compost". Where it is harvested, the leachate bi-product of composting process is used or sold as a foliar spray product for boosting crop growth.

Harvested and packed leachate, ECO Balance ®)…… ECOH Holdings LTD., Nairobi.

The leachate is abio-product of the composting process and is "rich in Ca, Mg, S, Fe, Mn, Cu, Zn, Mo, B and organic acids that act a plant regulators….*Personal communication Collins Mwenda*

Photo by Davies Onduru

Figure 3: Composting systems in the urban and peri-urban areas of Nairobi*-I

Composting method	Description
  New Nairobi Dam Community Group composting site	*Open pile composting (variations exist)* Compost materials are laid above the ground. The heap is turned 1-2 times before being ready. Some of the groups carry out composting using Effective Micro-organisms e.g. City Garbage Recyclers located on Nile Road Nairobi; and New Nairobi Dam Community Group in Kibera, Nairobi. In some of the groups, FBOs and NGOs, the base of the compost is a shallow pit (0.3-1 metre deep) and the compost pile is built up to a height of 1.2 to 1.5 metres high above the ground.
 City Garbage Recyclers  Composting-Kuku Women Group	
  Shallow pit composting-Good Shepherd Sisters; materials are laid in the pit and above it to about 1.2 to 1.5 metre high	
  Compost bins-New Nairobi Dam Community Group	*Bin (container) composting (variations exist)* Container (bin) composting is a small scale composting system, using any of a wide variety of plastic, wood, or wire screen containers. Bin systems are contained by a constructed structure on three or all four sides of the pile. Compost bin provides the ideal controlled environment for aerobic decomposition to occur rapidly, while providing the home garden a tidy, sanitary spot for on-site disposal of any yard or kitchen waste

* Peri-urban areas includes peri-urban districts

Figure 3 ctd: Composting systems in the urban and peri-urban areas of Nairobi*-II

Composting method	Description
 Basket composting with crops planted along the outlines of the basket with a layer of dry grass as mulch for moisture conservation-KIOF	*Basket composting (done in-situ)* Compost is made *in-situ* in circular holes (0.6 m x 0.6 m x 0.6 m). Materials are laid inside the hole and crops planted around the hole.
 Trench compost-Kenya Institute of Organic Farming (2009; 2000)	*Trench composting (done in-situ)* Compost is made in-situ in a shallow trench (0.6 m wide x 0.6 m deep x any length). Materials are laid inside the trench and crops planted along the edge of the trench
 Composting *in-situ* holes-Kenya Organic Agriculture and Environmental Technologies Institute (2009)	*5-9 plants/hole composting in-situ* Biodegradable materials are laid inside a hole of 0.6-0.9 metres cube. EM 1 (*Composta*) is added to the different layers to enhance the speed of decomposition and crops are planted along the edges of the hole.

* Peri-urban area includes peri-urban districts

Fig 3 ctd: Composting systems in the urban and peri-urban areas of Nairobi*- III

Composting method	Description
 Maize growing in 5-9 plants/hole in-situ composting technique Kenya Organic Agriculture and Environmental Technologies Institute (2009	*5-9 plants/hole composting in-situ*
  Shredder used to chop compost materials; shredded materials     Vermi-composting in PENTA Flowers, Thika	*Vermi-composting (V-composting)* Vermi-composting or *Vermiculture* is the use of earth worms to digest organic waste into rich humus, similar to compost. Local species of both surface and burrowing earthworms can be used, although the latter are particularly suited as they not only digest organic matter but also modify the soil structure. Vermicompost contains not only worm castings, but also bedding materials and organic waste at various stages of decomposition. It also contains worms at various stages of development and other microorganisms associated with composting. Vermicast, similarly known as worm castings, worm humus or worm manure, is the end-product of the breakdown of organic matter by some species of earthworms. During the decomposition process, leachates are harvested as a bio-product of the decomposition process.

* Peri-urban areas includes peri-urban districts

3.2.4. Production levels and compost utilisation

Production levels

The study investigated the capacity of various actors in the urban and peri-urban areas of Nairobi to produce compost. Compost produced per unit time was extrapolated to annual basis to enable comparison across various actors **(Appendix 3)**. Compost production is done on small-scale, but with private companies and CBOs noting that they can produce high quantities when market environment is favourable **(Table 4)**.

Table 4: Reported compost production levels by various actors interviewed in the urban and peri-urban areas of Nairobi

	Category	Production tonnes year^{-1}	Comments
1	Private Companies	24-180	Potential is large; production depends on market demand
2	NGOs	60-120	Potential is large; production depends on user requirements
3	CBOs and SHG	5-84	Production depends on market demand; Can produce up to 100 tonnes year^{-1} when market is favourable

Container gardening: Kibera

Container gardening: Kenya Institute of Organic Farming

Photoes by Davies Onduru

The study observed that availability of organic waste is not the major constraint to compost production, but rather the marketing aspects. Actors interviewed in this study expressed the idea that "market is the pull factor" and when favourable can stimulate large scale production of compost.

However, the potential market for compost does not only determine the size of the composting system but also the composting technique and the post treatment of the compost as potential customers have specific needs for their application of compost.

Urban agriculture and potential use of compost

The use of compost in urban gardening especially container gardening is more prominent in the low-income areas of Kibera where Ministry of Agriculture and Faith Based Organisations (FBOs) have been promoting the production of vegetables in "sacks". Container gardening is also promoted by some CBOs and NGOs working within the urban and peri-urban areas of Nairobi. Compost used in these containers are either purchased or made by CBO members themselves, partly, for purposes of urban gardening and for sale. However, some gardeners use manure or top-soil alone without compost to grow vegetables.

The interviews with composting group members suggest that composting can have a positive impact on food security in the urban informal settlements and in the peri-urban areas of Nairobi in terms of vegetable gardening. This view has been corroborated by

previous studies on food security and urban agriculture in the urban and peri-urban areas of Nairobi **(Wambui Njogu, 2008; Kettel *et al*., 1995)**. In 1991, it was estimated that a third of Nairobi population were engaged in some form of urban agriculture (crop and livestock) in both private and public land **(Freeman, 1991)**. A study on urban agriculture by the **Mazingira Institute (1987)** estimated that three quarters of urban farmers in Nairobi consume all that they produce thus saves on food expenditure.

This study explored the linkages between compost production and urban agriculture by interviewing gardeners in Nairobi and the peri-urban areas: Eastlands (Kasarani, Kayole, Ruai), Westlands (Dagoreti, westlands, Karen), Athi River, Northern parts of Nairobi (Kahawa, Ruiri, Kiambaa) and surrounding districts (Kiambu, Kajiado, Thika and Machakos) etc **(Figure 4)**. Observations indicate that there are weak linkages between compost production and urban agriculture; rather many of the urban gardeners raise plants using manure and or without any form of soil amendments/fertilisation. Those that use compost are few.

Roadside Nursery-Ring Road Parklands

Roadside Nursery-Ngong Road, Nairobi

Roadside manure sales-Getathuru Road, Nairobi

Photoes by Davies Onduru

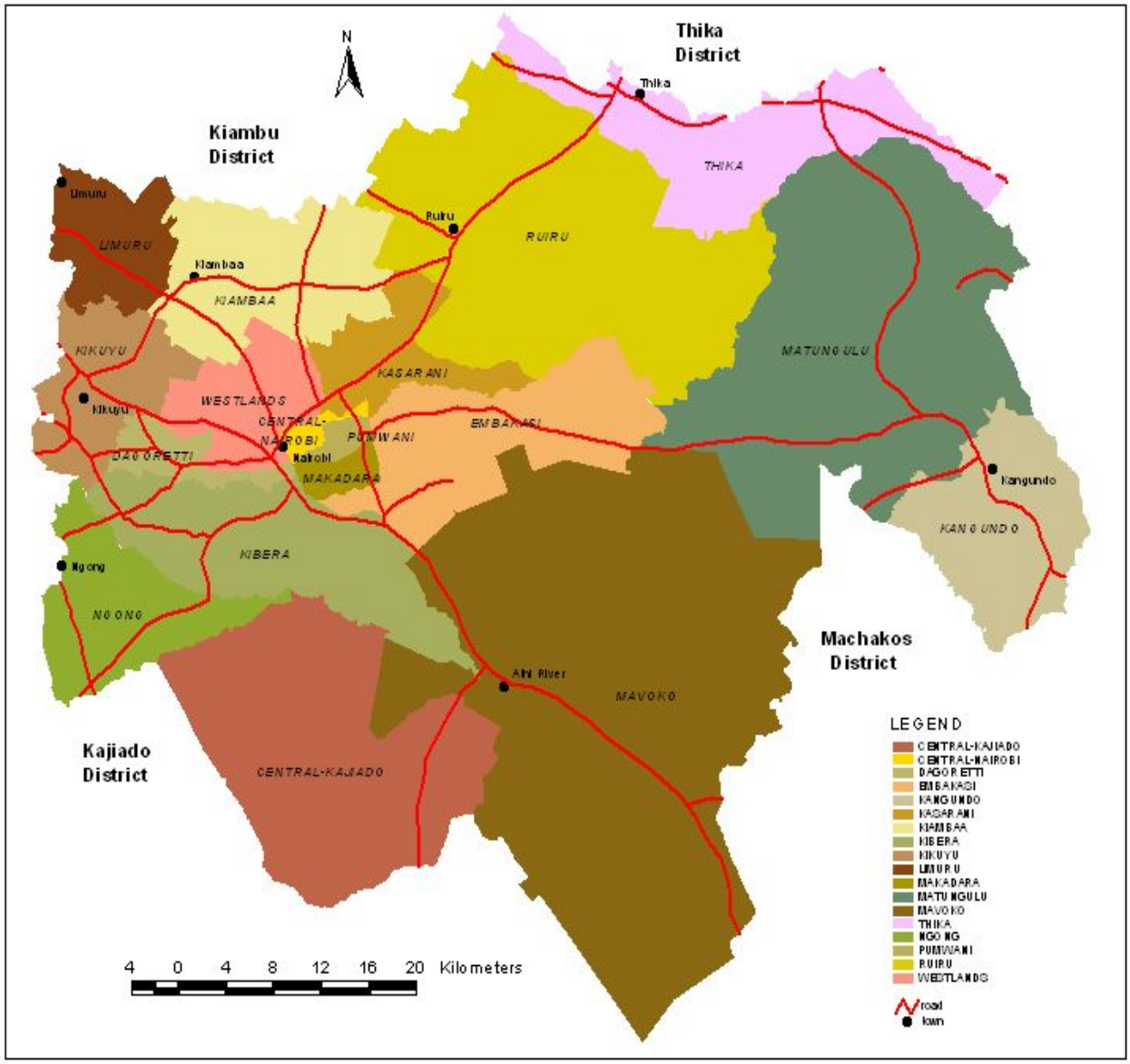
However previous studies do indicate that buyers of compost from CBOs in Nairobi include plant nurseries, ornamental gardeners, landscapers, estate developers from the urban areas of Nairobi, organizations and institutions in urban and peri-urban areas of Nairobi within a distance of 0.01 to 50 km and horticultural farms (flower farms), **Njega *et al*., (2007)**. However, the findings of this study do indicate that even among these actors manure is increasingly being used while some landscapers/golf courses compost their own waste. Among the nursery operators and ornamental gardeners manure use was the norm.

Responses on the willingness to purchase or use compost were difficult to interpret as the knowledge on compost and its benefits received mixed feelings. Some of the urban farmers responded that they would be willing to use compost in amounts and costs equivalent to their current use of manure or amounts that give “same value” as the use of fertilizers. Others required quality assurance criteria that the compost is not contaminated before they can use it. However, in general, one can deduce that there are no “extensive” negative attitudes or cultural barriers towards compost use.

Perceptions on compost use by potential user segments such as street side nurseries, landscapers and municipal and parks were also solicited. The study observed that this market segment mainly rely on manure; but some landscapers and golf courses composting their own refuse for use. Livestock manure is preferred because it is readily available, it is “light and powdery” and easy to use. Some of the actors in this segment expressed a willingness to use compost if available at prices comparable to that of

manure while others reserved their opinions due to “perceived lack of past experience in using compost and or information on the potential benefits of compost”.

Figure 4: Map of Nairobi metropolitan showing location of actual and potential urban and peri-urban farmers



Compost application rates

Some of the compost producers have specific recommendations for compost use depending on the type of crop and compost product (granulated, natural/solid compost or leachate) **(See Appendix 3).** Some of the natural/solid compost products are branded for application at the rate of 20-25 tonnes ha^{-1} at time of planting. This implies that there is a potential for two-times application annually in rain-fed urban agricultural practices where there is a bi-modal rainfall pattern. However, the residual effects of organic materials such as compost and manure can last in the soil for up to three seasons **(Ikombo, 1984; Kihanda and Warren, 1998)**.

Compost and competing products

The use of manure was dominant among nursery operators and landscapers and some vegetable growers. Manure is the greatest "competitor" to compost use in Nairobi and its environs, though compost market exists, but small **(see Section 3.3)**.

Factors influencing marketability of compost:

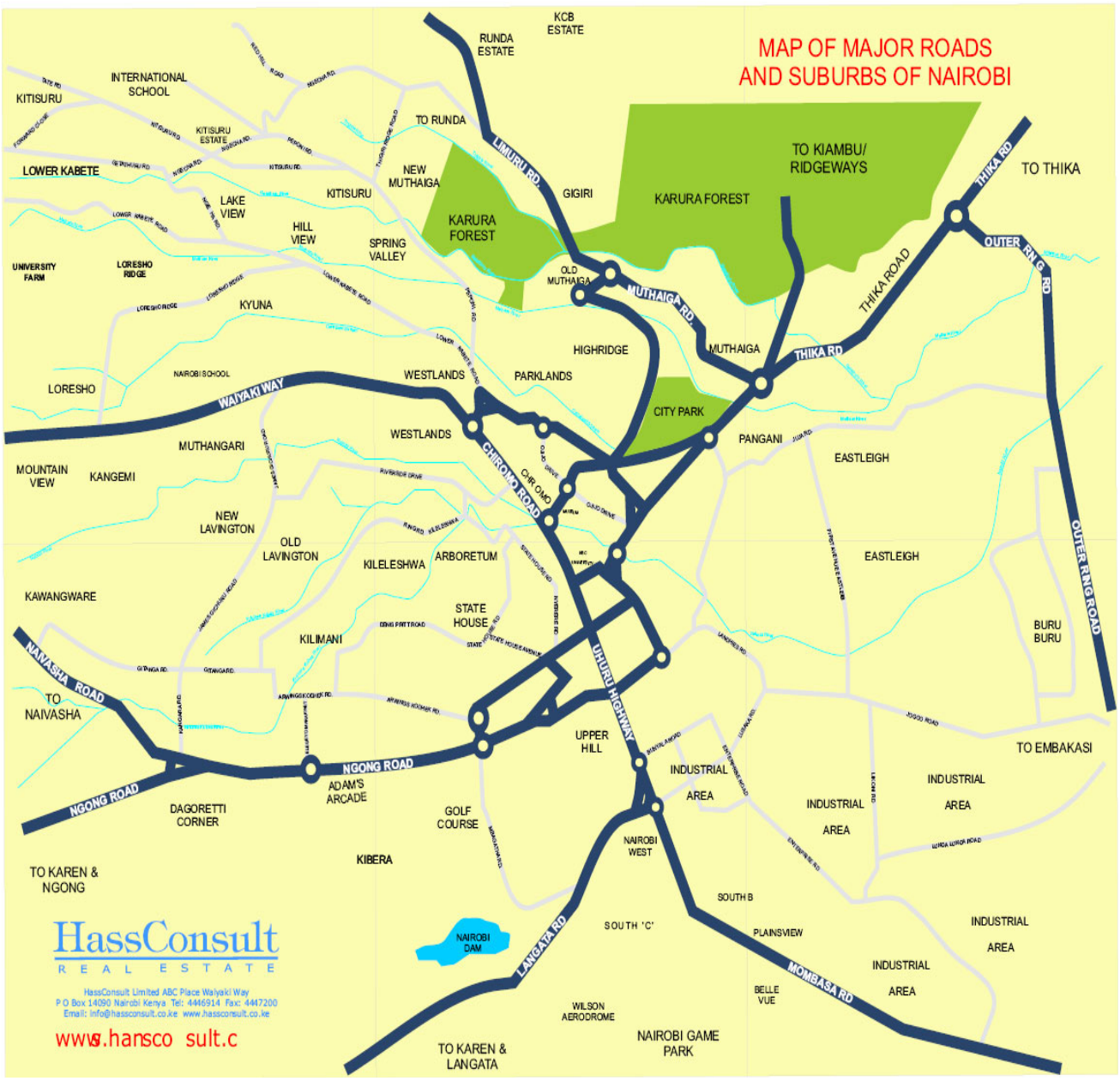
- Lack of awareness and knowledge on how, how much and when to use compost;
- Misunderstanding about what compost is (e. g. expecting it to behave in the same way as a chemical fertiliser);
- Concerns about the quality of compost made from organic urban waste-sometimes based on negative associations or past experience;
- Inclination of many farmers to focus on optimising their yield within a short time;
- Competition with chemical fertilisers, similar low-cost products like manure or products perceived to be the same (e.g. raw waste);
- High transport costs relative to product value, as compost is often produced far from its market;
- Unfavourable regulations and policies hindering the composting approach.

Source: Rouse et al. (2008)

The study mapped roadside nurseries (some selling manure), manure vendors and manure sources in Nairobi **(Figure 5 and Appendix 4)**. The manure used in Nairobi is obtained from the pastoralist areas (*manyattas*) surrounding Nairobi (Arid and Semi-Arid Lands-livestock areas). This includes Kajiado, Narok, Mai Mahiu, Ngong and the surrounding areas, distances between 60 and 100 km away from Nairobi. Some authors have reported that manures sold in Nairobi are sourced as far as 300 km away **(Njega *et al*., 2007)**. The manure is obtained from livestock kraals (boma) at low prices and trucked to Nairobi where they are sold to flower vendors, nursery operators, landscapers and other users. Some of the manure passes through Nairobi and ends up in the high potential areas within 150 km radius of Nairobi where demand is high. A portion of manure reaching Nairobi is also from surrounding slaughterhouses and over-night cattle kraals constructed by some Masai community members within the peri-urban areas of Nairobi. Although cattle manure is the dominant type used in Nairobi, the study observed that manure from mixed livestock types (poultry, goats etc) appeared to be fetching high prices.

Besides manure, the study observed that some old garbage heaps are mined and the degraded organic matter used for growing vegetables in the urban areas and or in raising vegetable and tree nurseries. An example of the use of mining old garbage heap and using the same to grow vegetables was observed in Vision Brothers Self Help Group, Kibera. In other parts of Nairobi, top-soil, "red-soil" and or soil scooped under trees were being used among nursery operators combined with livestock manure and in some cases used alone to raise tree seedlings.

Figure 5: Map of major roads in Nairobi (nursery operators and manure vendors are located on major roads)[1]



[1]See Appendix 4 for specific road names where nursery operators and manure vendors are located

3.3. Compost Marketing

3.3.1. Compost market demand

This study identified several factors, which *inter-alia* influences compost demand and marketing in the urban and peri-urban areas of Nairobi. The availability of competitive products such as livestock manure and inorganic fertilizers partly influences the demand for compost. The same holds true for alternative uses of city waste as livestock feed. Also the perceptions on compost and knowledge of its use are important factors influencing compost demand. Awareness on the various benefits of using compost was limited among some of the urban gardeners who preferred using dry manure for its "lightness" and ease of application and or were not aware where the compost could be sourced from. Information on the origin of compost has been limited and hence the fear of potential risks associated with urban waste such as heavy metal and pathogen contamination. In a study conducted in 2003, it was reported that compost samples made from materials from the Dandora dumpsite had high zinc (Zn) levels and lead (Pb), 366-383 mg Pb kg^{-1} against critical levels of 150mg Pb kg^{-1} **(Njega *et al*., 2007)**. Similarly Zn levels were higher than recommended levels of 300 mg kg^{-1} **(World Bank, 1997)**. This indicates the need to ascertain quality of compost made from municipal dumpsite before it can be used as a fertilizer. It also appeared that some of the urban gardeners and policy makers were unaware of the soil fertility and environmental management benefits of compost making.

Another factor affecting the demand and marketability of compost is "market quality-policy and institutional environment" relationships. The institutional and policy framework with respect to compost marketing is discussed in **Section 3.4**. The state and nature of compost also affects its marketability and demand. Groups selling granulated compost (e.g. ECOH Holdings) have been able to find some market (though limited) among the flower companies and are of the opinion that "granulated compost" is readily acceptable to users than the ordinary natutal/solid compost; it is also easy to transport. The Flower companies, ornamental and flower venders, nursery operators, container-vegetable growing and general urban agriculture are potential markets for compost.

The potential demand for nursery operators (nurseries raising trees and flower seedlings) is year-round: particularly during the dry season so that the trees and flower seedlings are ready for sale during the rainy season. Among growers of vegetables and potted ornamental plants, the demand is expected to be high during the rainy season. The potential demand for compost among flower gardens and urban crop farming is also expected to be high during the rainy season. Thus seasonal fluctuations in compost demand are expected from time to time.

Currently, urban agriculture does not feature in the comprehensive urban development plan for Nairobi. However, in 1994, about 13.9 per cent of land, (≈ 96.8 km^2), in Nairobi metropolitan area was estimated to be under urban agriculture. Out of the total area under urban agriculture about 66.5 km^2 (6650 hectares) were estimated to be under subsistence and plantation crops **(DRSRS, 1994; UNEP *et al*., 2007)**. Assuming that compost is applied in the cropping area at a rate of 20 tonnes per hectare $season^{-1}$, then compost demand would be 133,000 tonnes $season^{-1}$; out of which 61, 600 tones would be the compost demand for subsistence cropping. Thus, theoretically, there is a potentially large market for compost in the urban and peri-urban area as compost can be applied to any soil. However, the lack of knowledge on the benefits of compost and hands on experience, the cost of the product, transportation and application constraints and competing products pose challenges in compost demand.

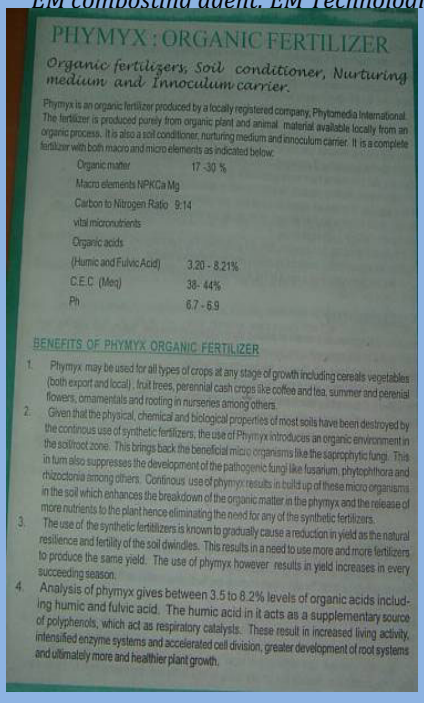
3.3.2. Perceptions on market quality of compost

Although compost is a highly effective soil conditioner, which can reduce the need for chemical fertilisers, it does not enjoy a ready-made market. Customers expect the compost they buy to be of high quality, modestly priced, effective and safe to use. The quality of compost is determined by a number of factors that include input raw materials used and their sources (not contaminated with heavy metals) and production management **(Dalzell *et al*., 2007; Rouse *et al*., 2008)**.

The study investigated whether compost producers and sellers have an idea of compost quality and what market demands exist in terms of compost quality. Responses from this study indicate that most customers buying compost use visual criteria to assess compost quality. These include colour, smell, visible foreign matter, perceived degree of maturity (should be earth/soil like), origin of compost materials and consistency and physical appearance of the compost (natural/powder, pelletised). Also presentation of compost as granules/pellets or of uniform consistency has enabled some of the compost producers to penetrate the market. Good compost is perceived to be of uniform colour, odourless or having "earth smell" and void of foreign matter. It is believed that

EM1 for reconstitution and preparation of compost: EM Technologies Ltd

EM compostina aaent: EM Technologies


PHYMYX : ORGANIC FERTILIZER

Organic fertilizers, Soil conditioner, Nurturing medium and Innoculum carrier.

Phymyx is an organic fertilizer produced by a locally registered company, Phytomedia International. The fertilizer is produced purely from organic plant and animal material available locally from an organic process. It is also a soil conditioner, nurturing medium and innoculum carrier. It is a complete fertilizer with both macro and micro elements as indicated below:

Organic matter	17 -30 %
Macro elements NPKCa Mg	
Carbon to Nitrogen Ratio	9:14
vital micronutrients	
Organic acids	
(Humic and Fulvic Acid)	3.20 - 8.21%
C.E.C. (Meq)	38 - 44%
Ph	6.7 - 6.9

BENEFITS OF PHYMYX ORGANIC FERTILIZER

1. Phymyx may be used for all types of crops at any stage of growth including cereals vegetables (both export and local) , fruit trees, perennial cash crops like coffee and tea, summer and perenial flowers, ornamentals and rooting in nurseries among others.
2. Given that the physical, chemical and biological properties of most soils have been destroyed by the continous use of synthetic fertilizers, the use of Phymyx introduces an organic environment in the soil/root zone. This brings back the beneficial micro organisms like the saprophytic fungi. This in turn also suppresses the development of the pathogenic fungi like fusarium, phytophthora and rhizoctonia among others. Continous use of phymyx results in build up of these micro organisms in the soil which enhances the breakdown of the organic matter in the phymyx and the release of more nutrients to the plant hence eliminating the need for any of the synthetic fertilizers.
3. The use of the synthetic fertilizers is known to gradually cause a reduction in yield as the natural resilience and fertility of the soil dwindles. This results in a need to use more and more fertilizers to produce the same yield. The use of phymyx however results in yield increases in every succeeding season.
4. Analysis of phymyx gives between 3.5 to 8.2% levels of organic acids including humic and fulvic acid. The humic acid in it acts as a supplementary source of polyphenols, which act as respiratory catalysts. These result in increased living activity, intensified enzyme systems and accelerated cell division, greater development of root systems and ultimately more and healthier plant growth.

Branded compost label, Phymyx®: Phytomedia International

Photographs: Davies Onduru

producing consistently high-quality compost is the key to better prices and marketing success.

Although visible quality criteria are dominantly used, some customers were reportedly requiring additional non-visible criteria as quality assurance: nutrient contents, suitability of compost for use (pH, salt content), absence of pathogens and heavy metals, and explanations on the potentials and effectiveness of compost.

3.3.3. Compost branding and marketing strategies

Experience shows that many previous composting projects have either focused on technological aspects of composting or social aspects of composting schemes. Much less attention has been given to assessment of the market for compost and the importance of the interaction of product quality, price and customer has often been underestimated leading to unviable composting systems **(Zurbrügg, 2002; Kibwage and Momanyi, 2003)**. Marketing is about identifying and targeting customers and succeeding to sell products that satisfy customers at a price and in sufficient quantity to ensure the success of a business. Among other criteria, customers judge products by appearance and presentation. Branding is therefore imperative.

The study investigated whether compost producers and sellers in the urban and peri-urban areas of Nairobi brand their products and what marketing strategies they have in place to increase their customer base. The results show that a majority of community-based composting groups:

- do not currently brand their compost products and label them (compost features, benefits and quality, packaging, presentation, and image and production principles);
- have poor market research and weak advertisements and awareness creation strategies (promotion to inform customers about the benefits of using compost, pricing of compost, building awareness and overcoming negative attitudes or perceptions to ensure the sale of compost product); and
- are not well known (location of composting sites and where customers can buy their products if different from the composting site).

A compost quality label can generate customer confidence and contribute to marketing of compost products, especially when awarded by independent national organisation such as Kenya Bureau of Standard (KEBS) which is legally mandated to control quality of market products **(see Section 3.4)**. Meeting the standards for approval by KEBS and National Environmental Management Authority (NEMA Kenya) was cited as one of the constraints facing some of the compost groups. Some of the community groups, however, are in different stages of applying for KEBS mark of quality and or planning for laboratory analysis of compost samples to help in branding and marketing their products.

Companies in compost production, as a business, are much a head of the community compost groups in terms of establishing quality criteria and or branding and marketing their products. This is probably due to their “relative high financial base” to cater for costs involved in labeling and branding. Most of them have done laboratory analysis and or field research on the potentials of their products to facilitate branding and labeling (e.g. EM Technologies, Phytomedia International and ECOH Holdings). Some have also obtained KEBS S-mark of quality as well as NEMA approval for environmental impact assessment of their composting sites (e.g. EM Technologies) and or have registered trademarks for their compost products (see branded or semi-branded compost products, **Figure 6)**. Compost producers sieve their compost (using wire mesh) before packaging the products for sale. The compost is packaged in different packing materials including nylon bags, gunny sacks and polythene bags.

An appropriate marketing and distribution strategy is needed to increase access to outlets for the finished product and is fundamental to sustainability of any composting

activity. Four main marketing strategies used by compost producers and sellers in Nairobi and the peri-urban areas were identified during this study: direct marketing to end users (direct distribution), marketing through a bulk supplier (indirect distribution), marketing through sales agents (retailers-indirect marketing) and a combination of direct marketing and indirect marketing strategies.

Direct marketing to end users involve compost groups marketing their products *in-situ* i.e. from the composting site. It is the dominant method used by the community groups involve in composting in Nairobi and peri-urban areas. These groups do not have a distribution network in place or do not have appropriate means of transport to run a distribution network (costs for transportation of the product add to the price thus restricting the distance of distribution). Though having a wide distribution network in the future is the ultimate aim of most of these community groups, many factors have contributed to locating their composting site and business, which invariably calls for a compromise. These factors include the need to be closer to the source of raw materials to reduce transportation costs; labour supply; rents of land and business premises; location of competitors; transport distances and costs; and location of customers. Also some of the compost producers claim that selling direct is important because contact with customers provides important feedback for their business and product development.

Companies such as Phytomedia International (producing Phymyx® brand) and EM Technologies Ltd. (producing Mazao Bora®) have a network of distribution system. They sell their products directly and indirectly through bulk suppliers and sales agents (retailers). For example, Phytomedia International sells their products in bulk through Simlaw seeds, East African Seeds, Kenya Farmers Association and Kiambu Fertilisers Ltd. among others. EM Technologies also have a distribution network among bulk buyers and retailers (agro-vet shops, agricultural input suppliers and selected shop keepers and or agents).

3.3.4. Compost pricing and fertilizer value

Product pricing is a function of multiple factors including production costs, product development, distribution and promotion. Covering costs is essential for a self- sustained business, so product price is partly dependent on production costs in addition to envisaged profit margins. This study did not investigate the costs of production in details. However, previous studies on the economics of compost production in the urban and peri-urban areas of Nairobi have indicated high variability in compost pricing, which has also been corroborated by this study **(Table 5)**. While CBOs sell their compost at 10-20 KES per kg, branded compost were sold by companies at a higher price, KES 36-50 per kg (average KES 42), reflecting the potential that partly exist in branding, packaging, adoption of sound marketing strategies and quality control. These prices were between 8-18 times higher than the sale price of the competing product, cattle manure with an average price of KES 2.40 per kg **(Table 6)**.

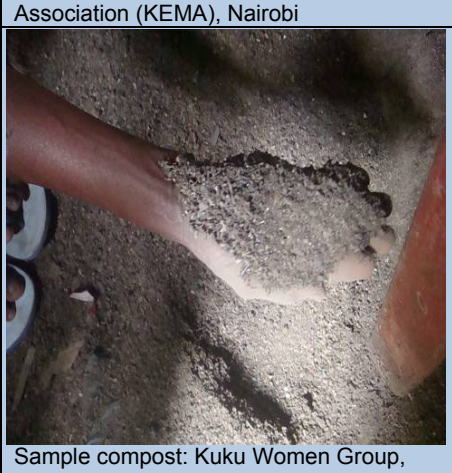
Although compost pricing depends on a number of influencing factors, previous studies have questioned whether the compost products in Nairobi are not being overpriced. For example, **Kibwage and Momanyi (2003)** reported that if the CBOs in Nairobi were to sell their compost at a third-to-quarter of their current prices, they might still be able to breakeven and or make profit. Similarly, a study by **Njega *et al*., (2007)** questioned the current compost prices given that farmers still have “cheaper alternatives” and most CBOs have not been able to brand their compost products adequately.

Figure 6: Examples of branded and semi-branded compost products in Nairobi

Sample of granulated/palletised compost: ECOH Holdings Ltd, Nairobi

Sample of compost product from Kayole Environmental Management Association (KEMA), Nairobi

Branded compost: City Garbage Recyclers, Nairobi



Sample compost: Kuku Women Group, Nairobi

Sample of compost before sieving: New Nairobi Dam Community Group, Nairobi

EM Mazao Bora Compost: EM Technologies Ltd.

EM Mazao Bora Branded: EM Technologies LTD

The retail market price for fertiliser was collected **(see Appendix 5)** and used to calculate the cost of NPK nutrients, comparing it with compost and manure while a list of input suppliers, including inorganic fertilizers, are presented in **Appendix 6**. Nutrient contents of compost and manure were not analysed during this study, but are known to be variable depending on materials used for composting and how composting process is managed. However, previous reviews mention nutrient contents of compost in the range 0.34 to 1.5%N; Phosphate of 0.2 to 0.9% and potash contents of 0.4 to 1.2% **(Muller-Samann and Kotschi, 1994; Onduru *et al*., 2002)**.

Table 5: Compost pricing in urban and peri-urban areas of Nairobi

Source	Source category	Sample location	Producing 1 tonne compost (KES tone^{-1})	Sales price (KES kg^{-1})	Price in 2009 (KES kg^{-1})	Packaging
Kibwage and Momanyi (2003)	CBOs	Compost groups in Nairobi (n =??)	488	10	11	N/R
Onduru *et al*., 2002	CBOs	Eastern Kenya	838	N/R		
	CBOs	Central Kenya	1614	N/R		
Njenga *et al* 2007 [study in 2003/ 2004]	CBOs	Urban Nairobi	N/R	4.8 to 9.6* (≈ 7.2)	5.2 to 10.4 (extrapolated)	
YARRD + 1 bottle ECOH Balance	Company	Nairobi			36	50kg bag 1 litre ECOH Balance
City Hawkers Compost group	SHG	Natural solid compost Nairobi			10-20	
KIOF-compost	NGO	Peri-urban			3 (range 5- 10)	Flexible packing
East African Seeds Ltd-	Company	Nairobi Phymyx®			40	50kg-pack
Kayole Environmental Management Association	CBO	Natural solid compost			20 (3-20)	5kg-bag; 10kg-bag; 50kg-bag
City Garbage Recyclers	Self Help Group				20	25kg-bag; 50kg-bag
Simlaw Seeds Ltd	Company	Nairobi Phymyx®			36	10kg-pack; 20kg-pack; and 50kg-pack
New Nairobi Community Group	CBO				20	Flexible packing to suit customer
Kuku Women group	SHG	Natural solid compost			20	Flexible packing
Kenya Farmers Association Ltd	Company/ Association	Nairobi Phymyx®			50	50kg pack
EM Technologies LTD	Company	Embu/Nairobi Mazao Bora®			50	5kg-pack

*Conversion based on 1 US$ = KES 72 (in 2006); 1US$ = KES 77 (Aug 2009) N/R: Not reported; Inflation rate in 2003 = 9.8%; In 2006 = 14.5%; In July 2009 = 17.8%

Njega *et al.* (2007) conducted analyses of compost in the period 2003 in the urban and peri-urban areas of Nairobi from 11 CBOs and reported compost nutrient contents of 1.3 to 1.33%N, 0.43 to 0.63%P and 1.3 to 2.9%K. A previous review of cattle manure quality in the peri-urban areas of Nairobi have indicated nutrient contents of 1.1 to 1.4%N, 0.2 to 0.6%P and 1.3 to 2.4%K **(Lekasi and Kimani, 2003; Onduru *et al*., 2008)**. Cattle manure from zero-grazing units can have ≥ 2%N depending on type of feeding system used **(Njega *et al*., 2007)**. However, manures sold in Nairobi are expected to have low nutrient contents and high carbon: nitrogen ratio, a reflection of manures derived from the semi-arid areas of Kenya. Previous analysis of manure derived from semi-arid districts in close proximity to Nairobi has reported nutrient contents of 0.17 to 1.28%N, 0.08 to 0.45%P and 0.26 to 2.65%K **(Probert *et al*., 1992; Onduru *et al*., 1999)**.

Table 6: Prices of livestock manure on sale in Nairobi

Major Road side nursery/point of sale	Unit of sale (on-site)	On-site price per unit (KES)	Price (KES/kg)
Thika Road	One 90kg-bag (Cattle manure)	140	1.6
	One 90kg-bag (Cattle manure)	100	1.1
Outer Ring Road	One 90kg-bag (Poultry manure)	600	6.7
Ngong Road	7-tone lorry (cattle manure)	8000	1.1
	One 90kg-poultry manure	200	2.2
	One pick-up (1 tonne) cattle manure	1200	1.2
Lower Kabete Road	One pick-up (cattle manure)	1200	1.2
Ngecha Road	One 90-kg sack (cattle manure)	300	3.3
Getathuru Road	One-pick up (mixed cattle, goat and poultry)	1600	1.6
	One-90 kg manure (mixed cattle, goats and sheep)	300	3.3
Ringroad (Parklands)	One pick-up (cattle manure)	1800	1.8
	One 90-kg sack (cattle manure)	400	4.4
Limuru Road	One pick-up (cattle manure)	2000	2.0
James Gichuru Road	One pick-up (cattle manure)	2000	2.0
Namanga Road	One pick-up (cattle manure)	3000	3.0

Using retail fertiliser prices **(see Appendix 5),** prices of branded compost **(Table 5)** and assuming compost quality of 1.3%N, 0.53%P and 2.1%K to represent compost made by CBOs in Nairobi; a price of KES 20 per kg of compost made by CBOs in Nairobi; and cattle manure quality of 0.7%N, 0.3%P and 1.5%K; and cattle manure cost of KES 2.4 per kg, an estimation nutrient costs was made **(Table 7)**. Compost made by Nakuru Waste Recyclers and Management (NAWACOM), Mazingira®, was also included in the comparison. It has an average moisture content of 35% and nutrient contents of 2%N, 1.8%P and 1.5%K and sells at KES 20 per kg **(Daily Nation: Wednesday, June 3, 2009)**. The branded compost, Mazao Bora® (by EM Technologies Ltd) has average nutrient contents of 2%N, 4.5%P and 2.4%K and sells at KES 50 per kg. The calculations made in **Table 7** further assumes dry matter of 35% for manure, 55% for compost and 100% for inorganic fertilisers **(Brunt *et al*., 1985; Onduru *et al*., 1999; Onduru *et al*., 2008)**. The calculations also assume that compost and manure have only three elements (NPK).

Table 7: Comparative analysis of fertiliser value of compost and inorganic fertilisers based on market prices and nutrient contents, July 2009

Nutrient source	Supplying 60 kgNha-1		Supplying 60 kg P_2O_5 ha-1 [≈ 26 kg P ha^{-1})	
	Quantity of materials required (kg)	Cost (KES)/ha	Quantity of materials required (kg)	Cost (KES)/ha
Compost-CBOs	8,392	16,783	20,583	411,664
Cattle manure	24,490	58,776	57,143	137,143
Mazingira® compost	5,455	109,091	6,061	121,212
Mazao Bora® Compost	5,455	272,727	2,424	121,212
23-23-0	261	15,652	261	15,652
17-17-17	353	22,941	353	22,941
20-20-0	300	18,000	300	18,000
DAP (18-46-0)	333	19,333	130	7,565
TSP (0-46-0)	-	-	130	9,130
Mijingu Rock Phosphate (0-30-0)	-	-	200	10,000
CAN (26-0-0)	231	9,923	-	-
Urea (46-0-0)	130	7,826	-	-

The cost of supplying nitrogen from branded compost products (Mazingira® and Mazao Bora®) and cattle manure was higher than sourcing the same from inorganic fertilisers. Similar trends were observed for the supply of phosphorus. Compost and manure has low nutrient contents and are required in large doses to provide same level of nutrients as inorganic fertilizers thus making it "more expensive" to use. However, comparing compost and inorganic fertilizers on nutrient basis alone has its own shortfalls for compost provides both macro-and-micro-nutrients while many inorganic fertilizer formulations provide a narrow range of specified nutrients.

To market compost, the product needs to have a competitive edge: reputation, source of organic matter, and or promoting the product as 'environmentally friendly' and source of employment for the poor among other promotional messages. To compete with similar products in the market and to meet customer requirements, compost can be enriched with additives (e. g. urea, potash, blood meal, bone meal, inorganic fertilizers, rock phosphates and poultry manure etc.) to obtain a balanced NPK ratio. The compost can also be grinded and pelletised to resemble inorganic fertilizers that farmers know.

Comparing compost and inorganic fertilizers

When comparing compost and inorganic fertilizers on a nutrient basis several points must be kept in mind:

- **Compost quality vary widely depending on materials used in their preparation**
- **Compost provides macro and micro nutrients while one inorganic fertilizer type provides only a narrow range of nutrients specified in its formulation.**
- **Nutrients are released slowly from compost (with residual effects of 2-3 seasons)**
- **Compost application reduces nutrient leaching**
- **Compost is a source of organic matter and provides fulvic and humic acids resulting in increased beneficial soil life activities and fast development of root systems**

3.4. Composting Institutional and Policy Environment

3.4.1. Principal policy setting and regulatory actors

Principal policy setting and regulatory bodies that directly or indirectly influence the operations of composting activities in Nairobi include Nairobi City Council, a Local Authority in the Ministry of Local Government; Kenya Bureau of Standards (KEBS) in the Ministry of Industrialisation; and National Environmental Management Authority in the Ministry of Environment and Mineral Resources.

Ministry of Local Government: All Local Authorities (LA) including the City Council of Nairobi (CCN) are under the Ministry of Local Government (MoLG). The MoLG is charged with the role of policy formulation, providing technical assistance to LAs, and supervisory oversight and guidance. Local Authorities are established under the Local Government Act Cap. 265 of the Laws of Kenya and are mandated to provide basic services including water and sanitation, health, education, general infrastructure, security, and employment and other economic activities to residents under their areas of jurisdiction. The same Act empowers the LAs to make and enforce by-laws pertaining to various areas of service provision; for example raising funds through rates, fees and other user charges.

Apart from the main legislation that governs all Local Authorities (The Local Government Act Cap 265 of the Laws of Kenya of 1997), there are other pieces of legislations that affect and influence the management of Local Governments. These include: Local Government Loans Authority Act (Cap. 270); Land Planning Act (Cap. 330); Trade Licensing Act (Cap. 497); Rating Act (Cap 267); Valuation for Rating Act (Cap 255); and Agriculture Act (Cap 318).

Although LAs are supposed to be autonomous and independent, the Local Government Act empowers the Minister for Local Government to establish, abolish and control (oversight role) all LAs including the CCN. It also empowers the Minister to remove Councilors, dissolve the Council and appoint a Commission in their place. The Councilors in the LAs are responsible for policy formulation, but ministerial approval is required before the policies can be implemented. Policies formulated by the Council through their various committees are implemented by Chief Officers headed by the City Clerk (CEO and Secretary to the Council) who are accountable to the Ministry of Local Government. Previous studies have underscored the past challenges in the MoLG to offer supervisory oversight, guidance and capacity building of LAs including the CCN, resulting in various wrangles and sometimes uncoordinated implementation of policies relating to solid waste management **(Ikiara *et al.*, 2004)**. The unclear boundaries, in terms of operations and implementation, between the roles of the MoLG and CCN have also partly resulted in poor coordination and implementation of relevant policies on waste management in the CCN.

City Council of Nairobi: The City Council of Nairobi (CCN) has two operational structures: decision making (political or policy) structure, run on a committee-based system and headed by the mayor; and administrative or management structure, run on a department-based system and headed by City Clerk. The management team (in the management structure) consolidates departmental recommendations to be presented to the relevant sectoral committees (political structure) for consideration. The highest decision making organ is the Full Council (made of only Councilors), below which are the standing sectoral committees that make decisions on service delivery and by-laws based on the Council's plans, financial resources availability and technical advice from the management staff.

The CCN has 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), Ikiara *et al.* (2004). 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:

- prohibit illegal deposition of waste;
- specify storage and collection responsibilities for waste generators; and
- reserve the right of the CCN to collect revenues from "solid waste collection".

The CCN affects composting and waste management in Nairobi in a number of ways including (i) refuse/waste management practices that avail waste inputs for composting (collection, transportation and disposal); (ii) land use delineation and zoning (development control); and (iii) licensing and revenue collection. To collect, transport and dispose waste from any waste generator, the CCN requires that such entities be registered with the CCN. The waste so collected is supposed to be taken to the designated dumpsite. The CCN Councillors formulate solid waste collection policies through the Environmental Committee, which are in turn implemented by the Department of the Environment of the CCN.

The Local Government Act, Cap. 265 (revised 1986), allows CCN to alienate, own and sell land within their jurisdiction in accordance with the Trust Lands Act Cap.288 of 1962 (Revised 1970) or to purchase land within the jurisdiction of other local authorities. This mandate affects composting in terms of the site where such operations can be located as the Council reserves the right to collect rent on land leases. Similarly, land zoning and Town Planning by the CCN may dictate where particular development activities are to be located. Compost producers and roadside manure vendors are required to pay levies to the council (rent or business licenses and seek approval for location of the business sites).

Nairobi has one official waste disposal site (City Council-owned and operated) situated in Dandora, Eastlands, about 7.5 km from the city centre, where waste (excluding hospital waste) collected is supposed to be taken[2] **(AfDB 2002)**. The City Council of Nairobi installed a weighbridge at Dandora disposal site in January 2006 to estimate amounts of disposed waste ending in the site. A new landfill, about 40 hectares has also been identified in Ruai, Eastlands.

Despite the by-laws being in place, the implementation of the by-laws has not been to expectations. The frequent interference with the Central Government and Provincial Administration has often led to clashing and or duplication of roles. Also polices on waste recycling and reuse, and urban agriculture and community involvement in solid waste management has remained unclear to the general public **(Ikiara *et al*., 2004)**. The situation, however, is changing with the establishment of NEMA providing regulatory framework nationally on solid waste management.

Ministry of Environment and Mineral Resources: The ministry is responsible for promoting, monitoring, conserving, protecting and sustainably managing the environment and mineral resources for national development. The Ministry is charged with overall environmental management, which includes pollution and waste management and carries out policy formulation, development and advice on environmental matters. The Environmental Management and Coordination Act (EMCA) No. 8 of 1999, spearheaded by the Ministry, established the National Environmental Council (NEC) for policy formulation, setting of national environmental goals and objectives and promotion of external cooperation; and also The National Environment Management Authority (NEMA)

[2] Other smaller "non-official dumpsites" exist such as Mathare North dumpiste and K-quarry dumpsite

for policy implementation. NEMA is a state corporation under the Ministry of Environment and Mineral Resources and is the principal instrument of government in the implementation of all policies relating to the environment.

National Environmental Management Authority: The Authority under the Ministry of Environment and Mineral Resources is charged with environmental policy implementation including waste management and treatment. NEMA has a standards committee and Enforcement Review Committee for various environmental aspects including waste management. The Authority conducts environmental licensing, auditing, incidence management and reporting and registration of experts.

NEMA has spearheaded the formulation of Waste Management Regulations, 2006 (Legal Notice No. 121), which has been gazetted by the Minister of Environment and Mineral Resources. The Waste Management Regulations (2006) has the following highlights:

- Waste Management Regulations are meant to streamline the handling, transportation and disposal of various types of waste. The regulations place emphasis on waste minimization, cleaner production and segregation of waste at source.
- The regulations have classified various types of waste and recommended appropriate disposal methods for each waste type.
- Under the Waste Management Regulations, NEMA licenses transporters, incinerators, landfills, composers, recyclers and transfer stations. The licensing employs a risk-based approach by concentrating on facilities considered to pose a high risk to the environment.
- The Waste Management Regulations also provide an opportunity for investment in various aspects of waste management

Kenya Bureau of Standards: Kenya Bureau of Standards (KEBS), a parastatal in the Ministry of Industrialisation, is charged with development of Standards and Standards based solutions (Standards Act Cap 496, Laws of Kenya) and works through established committee structures. The Kenya Bureau of Standards (KEBS) operates a Product Certification Scheme in line with its functions of developing quality standards, ascertaining compliance with such standards, and controlling the application and use of the standardisation / Quality Mark and other distinctive Marks. Operational standards include Diamond Mark of Quality, Import Standardisation Mark and Standardisation Mark.

Standardisation Mark (S-Mark) is mandatory and covers locally manufactured and imported products in accordance to section 10 of the Standards Act Cap 496, Laws of Kenya. Fees are paid annually for getting the S-Mark according to turnover for Micro-and small enterprises. A permit issued for using S-Mark of quality is valid for one year. All goods offered on sale are supposed to have S-Mark. It is the mark that is expected to influence the sale of products like compost. KEBS carries out regular inspections to ensure compliance with S-Mark.

KEBS is in the process of developing standards, in collaboration with other stakeholders such as Kenya Organic Agriculture Network, for use and marketing of compost and other organic inputs (*personal communication Eustace Kiarii of Kenya Organic Agriculture Network, KOAN*). The standard being developed recognises three categories of compost: liquid compost (e.g. leachates from vermicomposting), pelletised/granulated compost and natural/solid compost. KOAN is the custodian of the East African Organic Products Standards and has negotiated with KEBS to exempt certified organic products from the S-Mark of quality requirement. KOAN is also lobbying the Director of Food Security and Early Warning System, Ministry of Agriculture, which has set up an organic agriculture desk at the headquarters office, *Kilimo* House. The lobbying is envisaged to contribute to the recognition of organic products.

3.4.2. Other actors: CBOs, NGOs, farmers and Contractors

Since 1992, there has been an emergence of community-based initiatives in waste collection, transport, storage, trading and recycling. These groups include charitable organistions, welfare societies, self help groups and residential associations. The majority of the CBOs engage in waste composting although the main activity is neighbourhood cleaning and waste picking **(Ikiara *et al*., 2004)**. The CBOs had been sponsored by national and international bodies, including NGOs **(see Section 3.1)** and or have had private initiatives. Residential associations also emerged in the middle and high-income residential areas to address cleanliness, security and roads (e.g. Karen and Langata District Association, Nairobi Central Business District Association etc.). The role played by these groups in transportation of waste over long distances and or to the dumpsite has been affected by the coming into force of NEMA and the requirements for licensing, which most of the groups are not able to meet. However, localised performances especially in the informal settlements are on-going.

Other Waste Recycling Methods

Making briquettes from recycled paper Mukuru Cycling Centre, Dandora

Made briquettes stacked for drying

Photoes by Davies Onduru

Many informal agents (waste pickers, traders and dealers, itinerant buyers, informal dump service providers and informal recycling enterprises) are also involved in Nairobi's solid waste management sector. They carry out activities such as waste collection, separation, storage, reuse, recovery, recycling, trading, transport and disposal especially in non-serviced areas inhabited by the urban poor. However, their contribution to the larger picture on waste management has been influenced by the policies of CCN and NEMA requiring registration and licensing. To some extent, however, the CCN has some informal relationships with CBOs, aimed at helping people living in slums and promotion of environmental clean ups.

Urban and peri-urban farmers are also important actors in Nairobi solid waste management sector according to previous studies **(Ikiara *et al*., 2004)**. They collect poultry waste, green vegetable waste, and cowdung as well as food waste from hotels, markets and other institutions, and transport it for use either as animal feed or an as organic fertiliser. The volume of this activity is not known due to the dominant "informal nature of the business".

3.5. Challenges in Compost Production and Marketing

3.5.1. Knowledge base and technical capacity

The study revealed that compost production as a business venture is a challenge for the producer due to limited production knowledge partly contributing to poor compost quality. While knowledge on rapid composting methods and the use of additives to improve compost quality is high among the companies and NGOs involved in composting, the same is not so among CBOs where there is wide disparity in knowledge gaps. Knowledge of the CBOs on the use of phosphorus-based additives and nitrogen activators and or the use of effective micro-organisms, pelletising and vermicomposting techniques are inadequate despite the existence of such technologies among other producers. However, efforts by community groups to use compost fortifying agents such as *Mijingu* rock phosphate is limited by the perceived high cost and the current large and perceived costly packs of 50kg-bags. Knowledge on techniques for sound management of composting process for improved compost quality is also inadequate. Most CBOs and Self Help Group members have low educational levels and skills affecting their ability to produce high quality compost **(see Section 3.2.1)**.

Sourcing waste
Capacity of actors to produce and up-scale composting activities are also challenged by lack of source separation of waste and inadequate public awareness on the same. Segregation of waste at composting site is a labour intensive activity constraining the up-scaling of compost process **(Table 8)**. Similarly, labour required for preparing compost is an issue among compost producers. Although some of the community groups have instructed their members to segregate waste at source, most waste received at composting sites are not source-segregated.

Transportation of waste from source to composting site is also an up-hill task and some CBOs supplement their voluntary efforts by hiring labour to haul domestic and market waste, especially in the slum areas. Most compost producers, especially the CBOs do not have their own trucks for transportation e.g. for organic market waste considered good for composting. Among some CBOs in the informal settlements, wheelbarrows or handcarts are used to access narrow streets and pathways.

Domestic and market waste is obtained for free in most parts of the informal settlements, but labour is required to collect and transport them to the composting site. In some households domestic waste are dumped directly on backyards instead of being composted. Observations in this study indicate that availability of organic waste is not the limiting factor for compost production, although, not every form of waste is always available as there are often alternative uses (fodder, fuel, livestock feed etc) and seasonal variations.

In some arrangements, the waste generators have to pay agreed fees for the waste to be collected by the CBO doing composting. Among the Youth Reform Self help Group, each participating household has to pay KES 20 per for day of waste collection. Actors in these arrangements periodically experience challenges in households who do not pay up in good time even when waste has been collected. There are also challenges in purchasing the washable polythene bags required for collection of domestic and market waste, which needs replacement from time to time.

Table 8: Identified gaps and possible areas of support for compost producers

Compost produce	Identified gaps	Proposed areas of intervention
Community groups (CBOs, SHGs etc)	Low skills in production of high quality compost	On-the-job training strategy to ensure production of consistent and high quality compost; training on how to monitor compost piles
Community groups NGOs; Companies (e.g. ECHO Holdings)	Lack of segregation of waste at source	Raising awareness to waste generators on the importance of waste segregation at source
Community groups NGOs; Companies (e.g. ECO Holdings)	Lack of means of transport to collect waste from source	Support the provision of transport for compost producers to access and transport organic waste e.g. market waste
Community groups; NGOs; Companies	Inadequate branding strategies	Support for labelling and branding; and packaging
		Support for analysis of compost quality
Community groups NGOs; Companies	Limited market outlets	Create linkages with agrovets and input sellers; and compost users in different market segments; advertisements; exhibitions etc
		Support awareness creation strategies on the benefits of using compost and counteract negative attitude on products made from waste recycling
Community groups; companies such as ECO Holdings	Low financial base	Support linkages to sources of funds or credit
Community groups NGOs; Companies	Inadequate policies (pro-compost policies)	Lobbying and creating linkages with relevant government authorities so that compost can readily be accepted and favourable policies formulated.

3.5.2. Organisational capacity

Although the community groups are organized with a leadership structure, sometimes they face challenges in terms of group administration. In the past, some of the composting groups had collapsed when a motivated member of the management, or a few competent individuals withdraw from the group operations and or when the mode of sharing benefits accruing from composting activity is not well spelt out in the group by-laws.

3.5.3. Marketing and financial base

The community groups have weak marketing strategies in terms of branding and advertisements to enable them penetrate the market; and finding a market for compost is a major challenge. This also holds true for some companies such as ECOH Holdings Ltd. However, some of the community groups are located in inaccessible areas and do not have distribution networks or partnerships with retailers to expand customer base. The current market outlets are perceived to be limited and customer base narrow and some potential market segments are not fully aware of the benefits of using compost over competing products like manure. Also some potential users look at compost as taking long to give results compared to inorganic fertilisers. Seasonal variations in the demand for compost, causing fluctuation in income, were also reported. The expense of transportation and rent payments also prevent the groups from bringing compost to an accessible point of sale as compost is perceived by some actors to be a low value product limiting recovery of transport expenses. These challenges have made some studies to indicate that most CBOs have low financial base and may not be able to sustain their composting activities based on income from compost sales alone unless sound marketing strategies are put in place **(Kibwage and Momanyi, 2003)**.

3.5.4. Policy and regulations

Lack of a policy on source separation of solid waste and a general sense of irresponsibility on the part of residents adversely affect composting because sorting is crucial for up-scaling and improving the safety of waste recycling. Source separation also reduces the weight and moisture content of solid waste, easing its handling and transportation.

Most compost groups do not have a permanent title to land for their operations and thus low motivation for long-term capital investment. Some of the composting locations have inadequate boundaries that would otherwise reduce offensive smells emanating from sorting areas and young compost piles. Composting sites usually are not well planned and environmental impact assessment is seldom considered when selecting locations for recycling operations. These policy-related factors put the composting groups at the mercy of relevant government authorities; in the past sites allocated to some CBOs for composting were re-possessed by the CCN and or Provincial Administration.

Although most government agencies recognise the environmental benefits of composting few policy incentives exist to promote composting. Due to policy gaps, anyone can currently sell a "product" in the market calling it compost as there are no standards. Also, a part from the few allocations of small plots to the composting groups, the CCN has not, in practical terms, integrated composting activities within its solid waste management system and thus technical, financial or other types of assistance have not been forthcoming from CCN. Some of the composting groups interviewed in this study, also expressed a concern that when CCN is approached for "a permit" granting waste collection for composting, there is a 50-50 chance that they might accept and even when they do so, there needs to be infrastructure and a licence for waste collection and transportation, requirements that most groups do not meet.

Urban and peri-urban farmers are envisaged to be major compost users. However, urban cultivators face occasional harassment by CCN officials as the legal status of urban agriculture is unclear. Although most people assume that urban agriculture is illegal, a closer look at the Local Government Act, Cap. 265 (revised 1986) and Public Health Act, CAP 242 and the CCN by laws indicate that urban farming may be practiced under certain restrictions **(Ayaga *et al.* 2004)**. While urban agriculture presents opportunities for supporting alternative livelihoods, its risks include upsurge of zoonotic diseases, chemical poisoning, and environmental damage. Also some of the low-income farmers partly get their irrigation water from polluted sources such as Nairobi River. This then requires that urban agriculture needs regulation in the interest of public safety and health.

Kenya is a signatory to the Harare Declaration of 2003 on urban and peri-urban agriculture in eastern and southern Africa, which recommends the development of policies to create an enabling environment for integrating urban agriculture into the urban economies. Against that background, there are calls for the development of an appropriate policy framework for urban agriculture in Kenya **(Ayaga *et al.* 2004).** The Government of Kenya has included clauses on urban agriculture and forestry in the draft National Land Policy, still under discussion. The Policy defines urban agriculture as the production of food and non-food items through cultivation of plants, tree crop, aquaculture, and animal husbandry, within urban and peri-urban areas; and provides for the promotion of multi-functional urban land use and the creation of an appropriate legal framework to regulate and govern urban agriculture.

In another attempt to address urban agriculture and food security, the Ministries of Agriculture and Livestock have stationed agricultural extension officers in every district/Division in Nairobi to stimulate urban and peri-urban agriculture and livestock farming. This is expected to lift up the status of urban and peri-urban agriculture, and

food security in the near future, especially when supportive policies on urban agriculture would have been formulated and come into force.

3.6. Conclusions and Recommendations

Inventory of compost production, users and markets in the urban and peri-urban areas of Nairobi reveals that the compost production-marketing chain is underdeveloped compared to the informal sector of recycling other waste streams such as paper and scrap metal. However, opportunities exist in turning City waste into compost by addressing the production-marketing linkages and making use of the high organic waste fraction found in the City.

Composting in the urban and peri-urban areas of Nairobi is done by private companies, NGOs and community groups, some of which have low financial and technical capacity and are vulnerable to challenges in the emerging policy environment related to urban solid waste management.

Compost production levels are low, about 5-180 tonnes per producer per year, a fact partly dictated by methods and skills of production and available markets. Majority of compost producers in Nairobi use aerobic open pile composting that takes about 4-12 weeks with few using rapid composting methods with or without effective micro-organisms or other methods of enhancing decomposition.

The potential demand for compost is high, but compost marketing remains an intractable challenge for most compost producers. Pertinent market challenges include narrow customer base, inadequate branding and public awareness, market seasonality, and undeveloped marketing chain with limited distribution network and value adding activities and lack of polices on compost quality standards.

The community groups that currently dominate composting activities from city waste face diverse challenges including inadequate knowledge and technical capacity on emerging composting methods; limited access to source-segregated compost materials; inadequate composting supportive policies; and low financial and customer base and challenges in meeting policy regulations on solid waste management regarding waste collection and transportation. These challenges have partly contributed to low compost production levels.

Increasing the use of city waste to make compost will require addressing technical, policy and market issues simultaneously. This may include and not limited to:

- Creating public awareness on the benefits of using compost through different media;
- Compost branding and value addition to improve quality;
- Creating linkages with agrovets and input companies to expand compost distribution networks and markets and to positively influence supply-demand factors;
- Capacity building of compost groups in technical aspects of rapid compost production methods, and business skills and record keeping;
- Improvement of governance among community groups;
- Increasing access to financial resources, for example, through credit and grants;
- Formulating strategies to enhance private commercial entrepreneurs' participation in composting activities to up-scale composting activities; and
- Lobbying for fiscal and policy incentives to bridge the gaps in compost production-marketing chain.

4. BIOGAS PRODUCTION, USERS AND MARKETS

4.1. Background

Aerobic composting and anaerobic digestion (fermentation) are increasingly being recognized as options for dealing with organic solid waste. Both treatment options reduce the environmental burden and enable the generation of a nutrient rich fertilizer as an output. Furthermore, anaerobic digestion adds value to organic waste through the production of energy in the form of biogas **(Engler *et al*., Sa)**. Anaerobic digestion destroys pathogens and weeds, reduces odours and homogenises organic waste used in the digestion process making it (digestate) easier to spread. Anaerobic digestion (fermentation) is wide-spread in nature, as in rumens of ruminants and in paddy fields, and is a completely a microbiological process; no higher organisms are involved, in contrast to composting.

Biogas is produced by bacteria that breakdown organic matter in anaerobic digestion to produce methane (biogas) and carbon dioxide. Biogas consists of 45-85 % methane (CH_4) and 15-45 % carbon dioxide (CO_2), with the exact proportions depending on the production conditions and processing techniques. In addition, hydrogen sulphide (H_2S), ammonia (NH_3) and nitrogen gas (N_2) may be present in small amounts. Biogas is normally saturated with water vapour **(Heat and Power Ltd, Sa)**. Natural gas is about 90-95% methane and thus biogas can be considered “a low grade natural gas”. Both methane and carbon dioxide are odourless and if the raw biogas smells, it is usually due to the presence of sulphur compounds.

Four ingredients are needed for biogas production: organic matter, bacteria, anaerobic conditions and heat. When the ingredients are present and conditions met, biogas production will take place in four steps (i) hydrolysis, the conversion of polymers into monomers (sugars, fatty acids and amino acids); (ii) acidogenesis, the conversion of the monomers into volatile fatty acids (VFA), alcohols, hydrogen gas, ammonia and carbon dioxide; (iii) acetogenesis, the conversion of VFA and alcohols by acetogenic bacteria into acetate, hydrogen and carbon dioxide; and (iv) methanogenesis, the conversion of acetate, hydrogen and carbon dioxide into methane by methanogenic bacteria **(Angenent and Wrenn, 2008; Gijzen, 1987, Wilkie, 2008)**:

Biogas is celebrated by environmentalists for its low carbon output. It can be used for heating, cooking, lighting and as a substitute for fossil fuel in generators (Genstat) and or in vehicles. Biogas also provides an alternative to the use of fire wood, charcoal, and Liquefied Petroleum Gas (LPG). In Kenya, biomass (mostly wood fuel) accounts for about 68 percent of the total primary energy consumption, followed by petroleum at 22 percent, electricity at 9 percent and others at about less than 1 percent. In rural areas, the reliance on biomass is over 80 percent **(ETC Group, 2007)**. Only about 15 percent of Kenyans have access to grid electricity. As fire wood is increasingly becoming scarce and space is limited to plant trees for fire wood, using biogas enables households, and especially women, to spend less time on collecting or buying firewood, and potentially decreases the unsustainable harvesting of trees leading to deforestation **(Muchiri, 2008)**. Also the burning of fire wood and charcoal has larger impacts on health than the use of biogas, for instance by causing respiratory diseases **(Muchiri, 2008)**. LPG is also expensive, and not all households have access to the use of LPG.

Large scale biogas generation technology is at infancy phase in Sub Saharan Africa (SSA) although there is a large potential because of the available biomass **(Karekezi, 1994)**. Where available, waste from agro-industries can provide opportunity for large-scale biogas generation as relatively unpolluted material can be supplied in large quantities **(Jungersen *et al*. 1997)**. However, challenges exist in implementing such large scale plants in terms of organizing the collection, processing of manure and urban waste and marketing the biogas **(Karekezi, 1994)**. In Kenya, biogas production dates

back to 1957, when a Mr. Tim Hutchinson built the first biogas digester (floating drum) in Kenya to produce gas and fertiliser in a coffee farm. However, active promotion of biogas systems gained momentum in the 1980s. Over the last two decades, biogas technology has been promoted by national and international organisations (both Government and NGO) and Kenyan technicians. It is estimated that up to 1400 units[3] have been installed in total, though it is impossible to estimate what percent remain in working condition due to the dispersed and sometimes uncontrolled and informal nature of installations. The majority of systems were installed in the 1980s and 1990s. Unfortunately, a high proportion of digesters appear to operate below capacity, are dormant or in disuse after construction because of management, technical (poor design and construction), socio-cultural and economic problems as well as due to lack of standards **(ETC Group, 2007; Muchiri, 2008)**. Biogas plants constructed in Kenya are typically small units of 8-124 m^3 digesters and are dominantly found in the peri-urban districts and rural areas where there are dairy cattle under zero-grazing units.

4.2. Biogas Production and Technologies

4.2.1. Mapping and characteristics of biogas producers

Most producers of biogas in Kenya are also the end users. Observations from this study indicate that biogas producers in the study area are small scale, owning either fixed dome, floating dome and or tubular digesters **(see Section 4.2.2)**. They can further be stratified into the following categories according to type of waste used for biogas generation: (i) Small scale family producers using manure (ii) Small scale producers with comparatively large digesters using slaughter house waste and or livestock manure to produce surplus biogas for own consumption and or with a potential to sell; and (iii) small scale producers using human waste (biocentre/biolatrine operators) **(Table 9)**. The biogas producers are presented in **Appendix 2** while organisations and companies supporting these initiatives are described in **Section 4.4** as well as in **Appendix 2.**

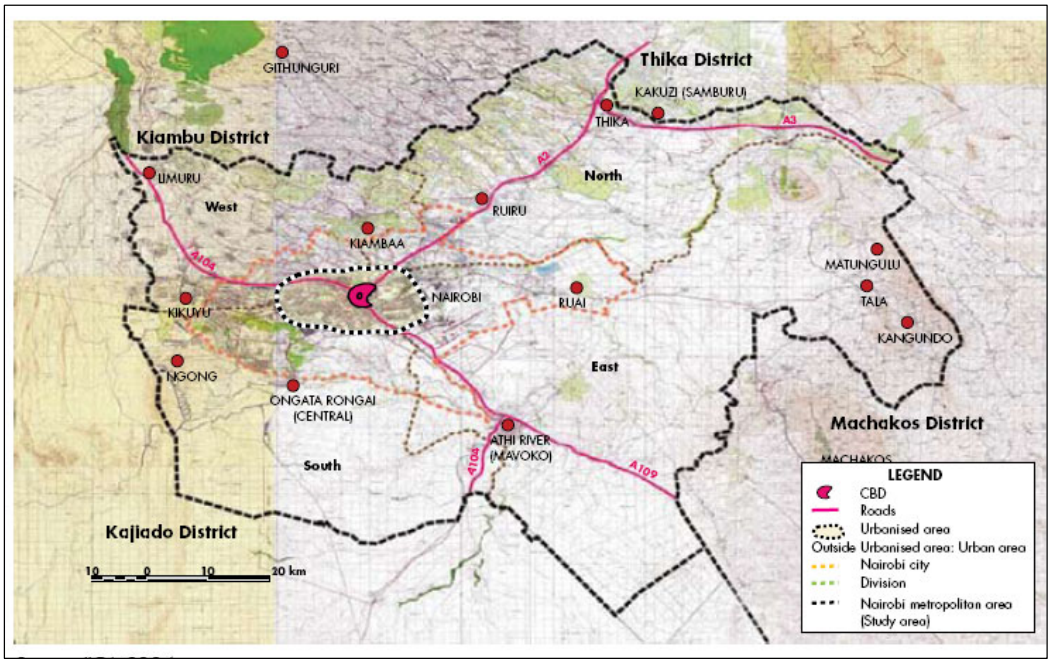
Table 9: Characteristics of biogas producers interviewed during the study

Category	No. interviewed	Location
Small scale family producers	7	Kiambu East and Githunguri District (peri-urban districts)
Small scale producers producing large volumes of biogas or surplus biogas with a potential to sell	2	Kiambu Municipality Division; Kiserian • 1 farmer • Keenyoike Slaughter house
Biocentre operators	7	Nairobi informal settlements • Korogocho • Kibera • Mukuru-Lunga Lunga
Supportive organisations	6	Nairobi, Kajiado and Kiambu • Practical Action Eastern Africa • Ministry of Livestock (Githunguri, Kiambu East Districts and Kasarani Districts) • Kenya High Yield Farmers Foundation (CBO in Githunguri) • Pioneer Technologies Ltd. • Ministry of Agriculture EU-GTZ Biogas Promotion: GTZ-Promotion of Private Sector Development in Agriculture (GTZ-PSDA) • Renewable Energy Engineering Contractors (REECON)

[3] Ministry of Energy, Kenya estimates 1392 family plants having been constructed in Kenya

Small scale biogas producers using waste other than human excreta are dominantly located outside the urban Nairobi. They are found in peri-urban districts surrounding Nairobi (Larger Kiambu, Kajiado and Thika) and other rural districts **(Figure 7)**. This is partly due to the history of biogas promotion in Kenya, which focused on generating biogas from manure among farmers with zero-grazing units outside Nairobi (e.g. efforts of Ministry of Energy-GTZ Special Energy Programme), limited exploration or drive to use alternative waste for biogas generation that could have supported the use of market waste and other agricultural waste; and the fact that access to grid electricity is highest in Nairobi than other parts of Kenya (during normal weather patterns?).

Figure 7: Map of Nairobi with locations of surrounding districts of the larger Kiambu, Thika and Kajiado Districts



Source: Extract from UNEP *et al*., 2007 (cited in JICA, 2004)

The small scale family biogas producers are characterised by use of cattle manure from zero-grazing units or semi-zero grazing units and dominantly produce biogas for their own consumption. Producers of biogas in this category own dairy cattle or improved breeds of livestock (≥ 2 cattle). Previous studies have indicated that the family biogas producers are in the better-off category compared to other community members (have permanent buildings, practice zero-grazing, either are in formal employment or have their own businesses); have family sizes of 4 to 8; have high levels of exposure to alternative energy technologies; have monthly expenditures on energy (excluding electricity) ranging from €10 to €20 per month depending on the type of fuel purchased; have either financed the biogas units on their own or received partial funding from some NGOs; and are partly averse to taking credit finance **(ETC group, 2007)**.

The small scale producers who either use slaughterhouse waste or have access to large quantities of manure with a potential to produce surplus biogas are also located in the peri-urban districts surrounding Nairobi (for example in Kiambu and Kajiado) and other rural districts. Examples include Keekonyoike Slaughter House in Kiserian (now in Kajiado North District); Githunguri Slaughter House, PILCAM Estate) (in Kiambu-now Githunguri District); Egerton University, Njoro (near Nakuru); Moi University, Eldoret; and Farmers Choice Co.?? **(see Section 4.3.3.)**. The Githunguri biogas plant (a fixed dome with 32 m3 digester) constructed at a cost of KES 300,000 has however failed to operate due to technical problems in construction and management problems of feeding the

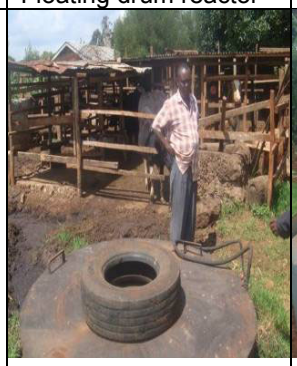
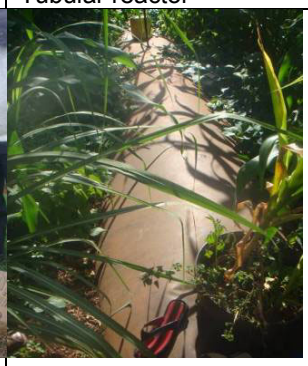
digester **(See Box 2)**. These categories of producers, mainly institutions, are able to mobilize funding for construction of "large digesters" of up to 124 m3 and potentially can supply surplus biogas to neighbours.

Biogas producers from human excreta, biocentre/biolatrine operators, are located in the informal settlements in Nairobi such as Kibera (in Kibera District), Korogocho (in Kasarani District) and in Lunga Lunga, Mukuru of Makadara Constituency in Nairobi East District **(see Figure 2)**. These producers comprise the poor in slums and are donor sponsored to construct biocentres/bio-latrines or Ecosan toilets to address water and sanitation problems in slum areas while at the same time generating income and biogas from such installations.

4.2.2. Biogas production and technologies

Small scale biogas reactors using non-human waste
The biogas systems found in Kenya are small, with a volume of 4-16m^3 and a 'maximum gas capacity of 3 m^3, which is considered sufficient to meet the cooking and lighting needs of a family of 5 persons' **(Kamfor, 2002)** and can be fed by dung from 3 cows **(Kuria and Maringa, 2008)**. A 12 m^3 fixed dome digester can generate enough biogas to let a 4 banner stove burn for 12 hrs a day. The following three types of small scale biogas installations were observed in the peri-urban districts surrounding Nairobi: Floating drum, fixed dome and tubular reactor **(Table 10)**.

Table 10: A comparison of biogas reactors in the peri-urban districts surrounding Nairobi

Technologies	Floating drum reactor	Fixed dome reactor	Tubular reactor
Appearance			
Retail selling price (2009) for 16 m^3	€1188-1403	€750-1400	€350-400 (for 9m^3 within 40 km radius from Nairobi)
Experience	Introduced in 1950s	Introduced in 1990s	Introduced in 1990s; and re-introduced again in 2006
Promoters	Tunnel technologies GTZ-SEP	SCODE PEMAGI REECON GTZ-PSDA Pioneer Technologies Private technicians	Pioneer Technologies
Ease of use/operation	Easy	Very easy	Easy
Perception	A bit dirty, but good	Very good	On trial
Efficiency	Needs time	Needs time	Works faster
Ease of installation	Simple to complex	Very complex	Simple
Durability	At least 30 years (30-50 years)	At least 30 years (30-50 years)	10-15 years (estimated)
Extension/technical support	Limited	Some	A little
Maintenance	Every 3-4 years	Minimal (only feeding digester)	Unknown

Source: Adapted from ETC Group, (2007) and Field data from this study (2009)

A key feature of fixed drum technology is the "drum that floats" depending on the amount of gas in the digester. Floating drum biogas systems were initially promoted in Kenya to generate high quality fertiliser and as an alternative energy source after the energy crises of the late 1970s (through Tim Hutchinson of Tunnel Technologies, and the Special Energy Programme). Several models of the floating drum technology have been made and used in Kenya. Costs of building/installing the floating drum depend upon the size and model. Floating drum digesters need some routine maintenance depending on how well they are managed: cleaning, painting and fixing leaks. The lifespan of digesters vary widely, and is dependent upon the quality of materials used in construction, as well as management and maintenance. The technical and management factors have contributed to the success and or failure of the biogas systems **(Box 2)**.

Fixed dome systems have advantages over floating drums in terms of cost (including maintenance), space and aesthetic appeal. This type of digester is built on or more usually under ground level, with only the plumbing, inlet and outlets visible. There are several models of this digester; dome shaped and flat shaped being the most common. The digester comes in several sizes, ranging from 8 m^3 to 124 m^3 **(Table 11)**.

Table 11: Biogas digesters promoted by GTZ-PSDA

Digester size	No of cattle required on zero-grazing
8-9 m^3	2-3
12 m^3	3-6
16 m^3	10
24 m^3	16
32 m^3	20
48 m^3	25
91 m^3	47
124 m^3	40-65

Source: Personal communication, Mr. Kimani, GTZ-PSDA farmer mobiliser (2009); Amy of REECON (2009)

Box 2: Why some previous biogas projects failed in Kenya

- **Poor maintenance:** Digesters are built without proper explanation to users on how to care for them. In other cases people simply stop maintaining them, especially the repair of the gasholder.
- **Poor dissemination strategy by promoters:** Biogas demonstrations are carried out with little or no digester research and development to understand quality and end use issues.
- **Poor planning and monitoring by promoters:** It is important to consider *why* one is building a biogas digester. Both gas and fertiliser are by-products of biogas digesters. If there is no use for the fertiliser produced, then much money and work will have been spent to collect a comparatively small amount of gas. Before building, one must be sure there is enough *organic material* and *water* to "feed" the digester. Biogas digesters often fail because of shortages of water or feedstock and or improper feeding methods. Biogas digesters produce methane gas and fertiliser for plants as well as being a sanitation aid. Many bags of charcoal can be bought for the money it takes to build one biogas digester.
- **Poor construction or design leading to gas pressure problems:** Many people have seen working biogas digesters and attempted to build their own. However, biogas digesters are not as simple as they look. They must be properly designed and constructed. If an unqualified person attempts to build a digester, he will probably run into problems. People have been trained to build biogas digesters in Kenya and interested farmers should enlist the help of the qualified biogas constructors. Farmers should also be educated on proper utilization of biogas and pros and cons of incorrect application of equipment.
- **Acceptance problem:** The re-charging of the digester may be seen as a dirty job and hence leads to poor ownership responsibility by users.

Source: Adapted from Hankins, M., 1987 cited in ETC Group, 2007

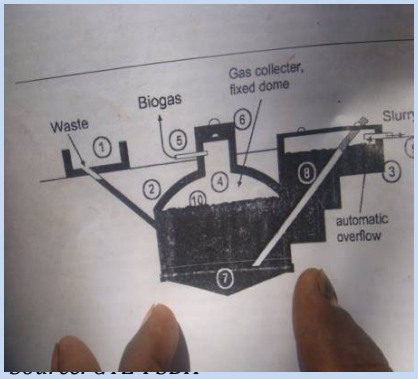
A fixed dome reactor has three elements (i) mixing chamber or inlet where animal excrement is mixed with water before it is poured into digester chamber; (ii) digester chamber where excrement and water are fermented. Methane and other gases will be produced in the chamber and these gases will push manure and slurry at bottom of the floor into expansion chamber; (iii) expansion chamber that collects excess manure and slurry. When gas is being used, manure and slurry will flow back into digester chamber to push gas up for usage. When the excess manure exceeds the volume of the chamber, the manure drains out (see schematic drawings next page).

Plastic tubular digesters (by Pioneer Technologies Ltd.) have capacity ranging from 9 m^3 to 18 m^3. The technology looks simple to install and use but has complex technical considerations during installation, use and maintenance. The tube is fragile and needs some form of protection, and possibly insulation against cold, which may increase cost of installation.

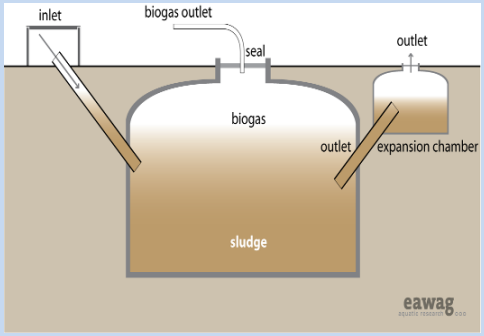
Small scale biogas generation from human excreta

Biogas is generated from a biocentre, which is a biogas generating latrine block, managed by community groups. The biocentre is meant to treat human waste *in-situ* without requiring sewerage infrastructure. A biocentre comprises the following: (i) Digester that mixes water and human waste in anaerobic conditions to make biogas; remaining liquid effluent is 90% pathogen free and is filtered on site (ii) Biogas that is used for cooking; (iii) Toilets and washrooms constructed on the ground floor (iv) Water Kiosk selling affordable clean water; and (v) Upper floors with a hall and ancillary rooms for community and livelihoods activities e.g. cottage industries or restaurant **(see Figure 8)**.

Schematic drawing of a fixed dome reactor-1



Schematic drawing of a fixed dome reactor-2



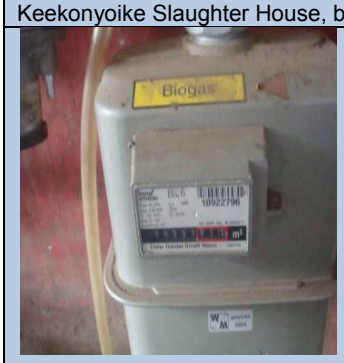
http://www.akvo.org/wiki/index.php/Anaerobic_Biogas_Reactor).

The excreta from the toilets are led into one central fixed dome digester built underground in the biocentre. The sizes of the fixed domes differ from group to group but a standard size has a diameter of 10m and a height of 2.5m (≈ 196m^3??). The design is developed in a participatory way involving discussions between the community group and the Contractor, Umande Trust. The biogas generated is piped into an upper room in the biocentre for use. The sludge (digestate) from the digester is led out into a retention tank for further treatment prior to draining the same into drainage/storm lines. It is currently not used for agriculture. The retention tank has three chambers/compartments: (i) first chamber which receives the solid waste from the digester; (ii) second chamber with sand to filter particles and foster sedimentation; and (iii) third chamber with charcoal dust to smoother odour and colour.

Figure 8: Biocentres and Keekonyoike Slaughter House

Biocentre	Description
  Tegemeo Scout Youth, Korogocho informal settlement	Biocentre with toilets and bathroom on the floor and an upper business hall/room with biogas cooker/stove 
  Lunga Lunga Youth Group Biocentre in Lunga Lunga slums (Mukuru)	Biocentre with similar construction as for Tegemeo Scout Youth; Similar construction holds for all biocentres constructed by the Contractor, Umande Trust
  Keekonyoike Slaughter House, Kiserian	Keekonyoike Slaughter House, Kiserian
 	Keekonyoike Slaughter House, Kiserian

Figure 8: Biocentres and Keekonyoike Slaughter House ctd

  Keekonyoike Slaughter House digester and lid at the top	Keekonyoike Slaughter House, Kiserian
  Keekonyoike Slaughter House Genset using 80% biogas and 20% diesel (20 KVA-3 phase)	Keekonyoike Slaughter House, Kiserian
  Keekonyoike Slaughter House, biogas pipings	Keekonyoike Slaughter House
  Keekonyoike Slaughter House, biogas metres	Keekonyoike Slaughter House

Community groups visited, their characteristics and how they use biogas generated from the biocentres are presented in **Appendix 8.** In some of the biocentres, the biogas

generated is used for cooking in kiosks/hotels, and for lighting, for example Gatwekera Tosha in Kibera, Lunga Lunga Youth Group Bio-power Project (Lunga lunga) and

Ushirika wa Usafi Laini Saba. In some of the groups the biogas generated is yet to be used in economic ventures. About 12 biocentres have been built by Umande Trust while others are on-going. However, some biocentres have only toilet and bathroom facilities without a digester.

Challenges faced in biocentre construction and use includes limited available space for construction, poor accessibility for transporting construction materials and storage of materials. Other challenges include how the biogas can be stored and or piped into neighbouring kioks/hotels as an income generating venture. The digestate (solid waste sludge) is not used but dumped in the sewers, even though it could be a valuable resource for farms. Inhabitants do not see the selling of digestate as a business opportunity. Linking up with farmers to use the digestate and or marketing it is a challenge also because of cultural perceptions. Operations of some of the biocentres have also not been smooth in the past due to management challenges (leadership and execution of tasks in the biocentres).

Use of digestate from biogas digesters

The remaining mixture of solution and solids after fermentation (digestate) from biogas plants are used as a fertilizer in agriculture. The characteristic of the digestate and its fertilizing effect is determined by the source material, the digestion process and by processing following the digestion **(Vogel, 2009)**. The solid fraction is rich in organic matter and still contains a lot of organic N and P. This is because during the anaerobic digestion, part of organic nitrogen is converted to inorganic nitrogen (ammonia nitrogen), increasing the proportion of ammonia nitrogen (NH_4-N), which is readily available for crop uptake. Similarly, part of organic phosphorus is converted to inorganic phosphorus, which is readily available for crop uptake. The properties of the solid fraction, if added to soils are comparable to compost, but are also relatively richer in ligno-cellulose. This means that the solid fraction of digestate is more labile to further decomposition in the soil than compost. The soluble fraction of the digestate is also rich in nutrients (N, P and K). During fermentation all nutrients remain in the reactor, including nitrogen. So, in contrast to composting, no nitrogen is lost during fermentation.

Field observations during this study indicated that zero-grazing farmers were using the digestate to grow crops in the peri-urban districts. Crops grown include Napier, vegetables, bananas, maize and other crops. However, the digestate from the biocentres, where the feedstock is human excreta, is not currently used to grow crops. The reason for this is expected to be the fact that the use of human excrement is a culturally sensitive issue; people do not speak about it, and they are usually not aware of the potential usefulness of using such digestate as a fertilizer.

4.2.3. Input sourcing for biogas

This study found that animal manure and or slaughter waste are the dominant feedstocks used for biogas production in the small scale reactors found in peri-urban district surrounding Nairobi. Manure from cattle and pigs can be used, though currently cattle manure is the main feedstock (sheep and goat pellets are less well digested and non-consistent??). In the informal settlements of urban Nairobi, human excreta are also used. Cases where biogas is produced from plant based material (for instance from organic waste), or where animal manure is mixed with plant based material have received limited attention in Kenya. In literature, almost all plant and animal biomass can be used for biogas production with the exception of biomass rich in lignin (lignin cannot be decomposed in the absence of oxygen). However, in practice, farmers are instructed by promoters of biogas technologies to use pure cattle or pig dung mixed with water (ratio 1:1) and to sieve out all straw and hay in order to properly feed the digester (**Fulford, 1998)**.

4.3. Commercialising Biogas

4.3.1 Potential demand for biogas digesters

According to Ministry of Energy the technical potential for biogas is highest in the high population density areas where zero grazing is practiced. Under current extension strategy, potentially any farmer with two cattle and above, under zero grazing, is a potential candidate for installing biogas systems. In practice, farmers who install biogas systems have both cattle under zero-grazing system and other sources of income to foot the cost of installation. Data for making estimates on potential biogas demand is scarce. Kenya is yet to have reliable livestock census (scheduled for 2009) after several decades and has been relying mainly on estimates and projections with scanty data on number of households owning livestock and or zero-grazing units. Based on livestock population estimates (provided by Ministry of Livestock Development), wage earnings and existence of zero-grazing units in rural areas **ETC Group (2007)** estimated the potential demand for biogas units to be 172, 312 for 35 districts of Kenya, including Kiambu, where zero zero-grazing is practiced and technically possible, but excluding Nairobi where urban residents rely mostly on grid electricity.

The dairy sector is dominated by smallholders who own 2-3 cows (≈2.5) under zero-grazing **(Baltenweck, 2000).** A figure of 2.5 dairy cows per household was used to estimate the number of households owning dairy cattle[4] **(Table 12)**. Assuming a nominal figure that 10% of households who own dairy livestock are potentially able to mobilize funds (from wages, are credit worthy etc) to construct zero-grazing and biogas units (see ETC Group, 2007), the potential for construction of biogas units is still large. For example it is estimated that there are only 42 biogas units in Kiambu (20 fixed dome constructed by GTZ-PSDA; 15 fixed domes constructed through SACDEP; 2 Tubular digesters constructed through Pioneer Technologies LTD supported by Land 'O' Lakes; and 5 Floating drum digesters) *(DLPO Githunguri; Farmer Mobiliser GTZ-PSDA, personal communication)*.

Table 12: Estimated potential demand for small scale biogas units in peri-urban Nairobi and its environs

Characteristic	Larger districts before sub-division				
	Nairobi	Kiambu	Thika	Kajiado	Machakos
Est. population (2009)	3,138,295	862,096	676,328	600,542	1,058,052
Total no. of households	649,426	189,706	171,569	96,621	186, 299
Wage employment (% of population)		63.6	42.7	45.3	11
Cattle owned (2004)[5]	22,800	159,000	122,700	400,400	263600
Dairy cattle owned (2004)	19,500	152,000	84,900	80,300	33100
Estimated households with dairy cattle (number)	7,800	60,800	33,960	32,120	13240
Potential number of households who can own biogas units	780	6,080	3,396	3,212	1324

[4] This figure may vary from district to district-however reliable livestock census data is yet to be available in 2009/2010

[5] Reliable number of livestock not available-estimations drawn from GoK, 2004: Support to NAPAD-CAADP implementation TCP/KEN/2908 (1). Vol. 4. Bankable investment project profile. Disease control and facilitation of livestock commodity marketing. Republic of Kenya

Potential demand for biogas from slaughter house is high *(GTZ-PSDA, personal communication)*. Although there are three major slaughter houses in the peri-urban Nairobi (one in Kiserian and two in Dagoretti), which are "large waste generators" only one has a biogas digester. The Keekonyokie Slaughter House, Kiserian has connected six customers to the biogas, on a pilot basis, and has received additional requests (20??) for similar connections.

Biogas generation from human excreta is dominantly in the slum areas, where it is combined with water and sanitation activities. It is estimated that 2 million people live in the slum and informal settlements in Nairobi with limited access to proper sanitation facilities. These 2 million people are active potential customers of biocentres. One biocentre has a potential of serving 600-650 persons daily. Programmes designed to offer sanitation facilities to even 1% of the population may require about 30 biocentres assuming the rest can be reached through other means (e.g. bio-latrines without biogas digesters). Currently, 12 biocentres have been built or under different stages of construction, way below what would be required to cover 100% of the population. The demand for biocentres is mainly in terms of toilet and bathroom facilities while commercial use of the biogas generated is under experimental basis- is yet to be exploited or being used in heating water in the bathrooms with a potential to pipe it to customers within 100-300m radius or to use it in running a hotel/kiosk within the same biocentre premises. Lunga Lunga Youth group recorded 4 kiosk/users who would like to be connected to the biogas at a cost. Similarly, Gatwekera Tosha have received requests (no records available??), but prefer to use the biogas in their own biocentre and only supply surplus to potential customers

4.3.2 Economics of biogas production

As the initial investment in setting up a biogas system can be quite high, farmers that invest in a biogas system, usually already tend to be relatively well off, with dairy animals under zero-grazing units and having access to other energy sources such as grid electricity, charcoal or LPG.

Table 13 presents comparative costs of constructing three biogas systems based on field information obtained during this study. Because of inflation, these prices cannot always be compared. Furthermore, information on the lifetime of the biogas digesters and related costs, including the potential years of functioning and lifetime maintenance costs is not available which is why the total costs and benefits cannot be calculated. However, indications are given.

As no price for biogas was observed due to non-existence of markets for biogas, the benefits from biogas generation are calculated by taking the opportunity costs of biogas use, namely the monthly costs of using fire wood, charcoal, LPG and electricity. We focus on using biogas for cooking, which was the main form of using biogas in the study area.

As can be seen from **Table 13**, the construction costs are recovered between 1 and 2.5 years, although it must be stated that not all costs have been taken into account (for instance, maintenance costs are not clear), and the costs of alternative fuel use stated by the interviewees appears rather high. In literature pay back periods of up to 20 years have been reported when biogas systems are compared with LPG gas **(Hammad *et al*., 1999)**. Even though assumptions need to be made in the calculations as not all required information is available, return on investment is positive for cases investigated, indicating that it is worthwhile for the studied households to have invested in biogas systems.

Table 13: Types of biogas digesters and their characteristics

	Fixed dome digester 1	Fixed dome digester 2	Floating dome digester	Tubular system 1	Tubular system 2
Construction costs	KES 500,000.	KES 100,000 - 120,000 for $12m^3$ exclusive of piping.	KES 50,000 including a cooker of KES 3000.	KES 42,000 (including piping to 2 houses and banners). Takes one day to construct	KES 32,000 (including everything)
Construction year	2008	2009	2007	2007	2006
Size	13ft depth 18ft diameter	$12m^3$	10 ft depth 10 ft diameter	10 meter 2-3 feet width	Similar as Tubular 1
Feeding	Cow manure, mixed with water (ratio 1:1). 9 drums of feedstock after every 4 days.	Cow manure. Minimum of 3 cows needed to get to 12-$16m^3$ of gas.	Cow manure.	Cow manure, mixed with water (ratio 1:1).The starter is 12 drums of mixed dung and water.	Cow manure. Minimum 3 cows needed for the system.
Biogas use	Feeding 9 drums generates gas for 4 days, which can be used by 6 households. Only for cooking	Only for cooking	Only for cooking (1 household)	2 households (one household and one employee). Only for cooking	One household, only for cooking
Monthly income from biogas	Potentially KES 3000 /household (when sold)	N/R[6]	N/R	N/R	N/R
Maintenance	Clay: 20 Kg: KES 300. But little of the clay used per year. Life expectancy: 35-50 years	Life expectancy: 35-50 years	After 10 years major repairs are needed	Vulnerable to damage. Roofing to protect from the sun, and fences to protect from animals. Shadow from roof decreases gas output.	Vulnerable to damage. Maize planted to protect the tubular from animals, but shadow from maize decreases gas production

Alternative fire wood / charcoal and LPG use and its related costs when biogas would not have been generated	2600 KES + firewood / household per month	Fire wood a month: KES 2000-2500 LPG costs a month: KES 1800-2000 Total: +/- 4000 KES per month	Sometimes when many visitors; use of fuel wood or LPG next to biogas as they do not have enough banners. KES 4000 in total per month	N/R	N/R
Payback period[6]	32 months	30 months	12.5 months	10-14 months[7]	8-10 months[2]
Return on Investment	14.2[8]	14	8.6[9]	N/R	N/R
Number of cows at the farm	7 large cows 4 middle size 9 calves	6 cows 3 calves	10 cows 2 calves (a minimum of 5 cows are needed)	2 cows, one calf	5 cows and one calf
Digestate use	Digestate used for growing vegetables, Napier and maize; no other fertilizer used	Digestate is used in Napier, coffee or shared with neighbours	Use as fertilizer in Napier, bananas, maize; Sometimes gives away digestate to neighbours	Digestate is for farming as fertilizer	Digestate for farming as fertilizer

[6] Calculated by dividing the construction costs with the monthly gain from using biogas.
[7] Calculated assuming that alternative fuel use would cost KES 4000 per month
[8] Calculated by using the formula: (gain over lifetime – construction costs)/construction costs, not taking into account maintenance costs as these are not available, taking the lowest expected life expectancy of 35 years and the highest mentioned construction costs.
[9] Calculated by using the formula: (gain over lifetime – construction costs)/construction costs, not taking into account maintenance costs as these are not available, using a life expectancy of 10 years as after 10 years major repairs are required (probably this Return on Investment will be higher in reality).
[6]N/R: Information not available or not reported

4.3.3 Attempts at "large volume biogas" production and commercialisation

Attempts are being made to construct large reactors/digesters than can produce more biogas either for domestic use and or for commercialisation. These attempts are at infancy stage and in peri-urban and rural districts. Examples are described below:

Individual entrepreneur in Kilifi, coastal Kenya: A sisal estate in Kilifi has made an attempt to produce biogas at industrial scale from 700 m^3 digester (Eng. Romas Radtke of GTZ-PSDA *personal communication*). The biogas produced is used to run two Genset generators (imported from Germany) to produce electricity with a potential to supply to the national grid. However, the entrepreneur does not supply the grid power due to perceived low payments from KENGEN (≈ 7 US cents per unit supplied), which does not cover the cost of production (running costs and cost of personnel). The generated biogas is used to run machinery in the sisal estate.

*Individual farmer in Kiambu Municipality (Mr. Harrison Gicheru Nganga): Harrison c*onstructed a fixed dome reactor at cost of KES 500,000 in the year 2008. The reactor was constructed by a GTZ-PSDA trained technician. The reactor is fed with cattle manure-water mixture from 7 cows, 4 heifers and 9 calves (under zero-grazing unit). The biogas is piped within a radius of about 300 meters to five other households (five sons) in addition to Mr. Gicheru's own house. Although the biogas is not metered and beneficiary households are not currently paying, Harrison estimates that he would be earning KES 3000 per month suppose the beneficiary households were to pay on agreed upon terms. The sludge (digestate) that comes from the biogas plant is also used for growing vegetables, maize, and Napier grass.

Individual entrepreneur in Matuu, Yatta District: One fixed dome plant in Matuu (124 m^3 digester??) has ventured into using a mix of farm residues (vegetable peelings), slaughter house residues and manure in running a biogas plant (GTZ-PSDA, personal communication). The plant gets manure from 8 cows and runs a 12 KVA generator using 20% diesel and 80% biogas. The generator can provide energy 12-14 hours a day and the farmers has the potential to commercialise biogas generated. The farmer saves one jerican (20litres) fuel each day.

Biogas plants in public institutions: Biogas plants of 124 m^3 and 91 m^3 digesters have been constructed in Egerton University (Njoro) and in Moi University respectively. The biogas generated is not sold, but used within the institutions as a cost saving strategy. In Egerton, the biogas is metered to monitor its use **(See Box 3)**.

Box 3: Fixed dome biogas plant in Egerton University

Biogas Plant in Egerton University

- Digester volume: 124 M^3
- Gas storage capacity: 15 m^3
- Daily charge of Digester: 20 wheelbarrows (ca. 1m^3) + 1 M3 water = 2m^3
- Daily Biogas Production: 20-30m^3
- Average biogas consumption: 22 m^3 /day (570 M^3/ month)
- Fuel savings through biogas/month: 3135 kg of firewood OR 228 kg LPG OR 940 kg Charcoal
- Liquid fertilizer production (slurry): 2 m^3 x 30 d = 60 m^3
- Average value of nutrients in slurry: 120 kg Nitrogen; 93 kg Phosphate; and 60 kg potassium
- Investment costs for Biogas plant and 300 metre gas piping: KES 820,000 (EUR 8000)
- Gas use in kitchen since commissioning March 2007 until January 2009 (21 months): 13564 m3 (≈ 5426 kg of LPG)
- Equivalent market price LPG (KES 250 per kg): KES 1,356,400 (KESH 64,590 per month)
- Payback period: KES820000 / KES64590 = 12.7 months

Potential for using generators: Pilot initiatives have been started with GTZ-PSDA to convert diesel and petrol generators (or *Genstat*) to use biogas. This offers opportunity for generating energy for small scale use or for industrial use depending on volume of biogas generated and capacity of the generator. Pilot trials have shown that the use of such generators can cut down fuel costs by 60-70%. The use of biogas to run GENSET/small generators is increasingly being explored. It is estimated that a farmer with 16 m3 digester can generate enough gas to run a generator for chaff-cutter or provide energy for cottage based industry where such exists. A chaff cutter can be run by an electric motor of 1000W (240 Volts A/C) single phase or three phase type. The generators being promoted and their capacity are in **Table 14**.

Table 14: Examples of generators in the market that can be converted to run on biogas

No.	Wattage	Voltage
1	700 Volt-Amps	240 volts AC
2	1.2 KW	240 Volts AC
3	1.8 KW	240 Volts AC
4	2.2 KW	240 Volts AC
5	2.5 KW	240 Volts AC
6	3.0 KW	240 Volts AC (≈ single phase)
7	3.3 KW	240 Volts AC AC(≈ single phase)
8	3.5 KW	240 Volts or 415 Volts AC (≈ three phase)
9	3.2 KW	240 Volts or 415 Volts AC (≈ three phase)
10	4.5 KW	240 Volts or 415 Volts AC (≈ three phase)

The cost of a generator with 700W is estimated at KES 30,000-60,000 depending on type and origin.

Exploring potential for storing and distributing biogas: Commercialisation of biogas will require some form of storage. Storage of biogas is still a challenge for pilot initiatives. However, there are some pilot trials investigating whether balloons can be used to store biogas prior to distribution **(see Box 4)**. Biogas meters costing KES 10000 are also being imported (by GTZ-PSDA) to the country (from China and Germany) to monitor biogas usage to clients. The uses of such meters are still at infancy stages. Similarly different forms of pipes are being explored in some pilot initiatives to distribute gas within a radius of 300-meters: Polyvinyl Chloride (PVC), Galvanised Iron (GI) and Polypropylene Random (PPR) pipes.

Box 4: Keekonyokie Slaughter House, Kiserian

Keekonyoike Slaughter House is in Kiserian Town in the peri-urban Kajiado North District bordering Nairobi. The slaughter House has installed twin digesters of 124 m^3 each (modified fixed domes…50m^3 each??) in 2006. The modified plant has a feeding chamber, digester and expansion chamber. There are also two slurry pumps to mix the slurry/waste (scam) from the slaughter house before being fed into the digester. The slurry pumps are run by a generator using about 80% biogas and 20% diesel. The two digesters are able to cope up with about 9-15 m^3 waste generated from slaughter house daily. The digesters have a metal lid at the top. The gas generated from the digesters is piped into a room where there is a balloon for storing the gas (storing 60-70 m^3 biogas). The gas is also used to run a Genset engine/generator (20KVA) with a three-phase output.

The plant (feeding chambers, digesters, slurry pumps, digestate storage, Genset, pipings etc) was constructed at a cost of KES 8 million with the digester alone and the associated units taking about KES 3 million.

The plant can generate (50 m^3 x 2) 100m^3 of biogas per day. Pipes have been laid to supply six hotels with biogas within a 300 meters radius with support from GTZ-PSDA. The total consumption of these hotels are estimated at 76 m^3 biogas daily. The biogas meters purchased by GTZ-PDA have been fitted in each hotel to measure consumption and to levy appropriate charges. The initiative has prompted about 20 other people and entrepreneurs requesting to be connected to the biogas plant *(Evelyn Kinyanjui, personal communication, GTZ-PSDA)*.

The slaughter House has excess organic materials (slaughter waste e.g. from rumen of animals, blood etc) for feeding the biogas plant. About 80 heads of cattle are slaughtered daily except on Mondays and Saturdays when 150 heads of cattle are slaughtered per day. Also 10 goats are slaughtered daily with the figure increasing to 20 on Mondays and Saturdays. It costs the Slaughter House KES 35000 per month to dispose waste. Waste is disposed by hired 7-ton lorries at a cost of KES 1800 per trip (about 5-7 lorries transport the waste away from the Slaughter every week). The disposal is done after the waste has been treated (sludge from the biogas; or dried) and NEMA requirements complied with. The cost of waste disposal is incurred by slaughter house; the treated wastes are partly deposited in a land purchased by the company. Currently, there are no entrepreneurs and or farmers requesting to take away the treated waste.

A major challenge is how to properly feed the digester (labour and management issues). The slaughter waste are sometimes more watery than required causing the digesters to produce low volumes of biogas. The biogas pressure is also low, 5mb compared to the desired pressure of 140mb. There are also technical problems associated with the design of the plant and the balloon storage, which GTZ is soon rectifying

4.4. Institutional and Policy Environment

4.4.1 Principal policy setting and regulatory actors

Ministry of Energy: The Ministry of Energy (MoE) oversees the development and implementation of energy policies and lays the regulatory framework for the sector. In addition it has an oversight responsibility over the provision of reliable and adequate energy generation and distribution. It has three core departments: Geo-exploration; Electric Power and Renewable Energy. MoE operates 10 Energy Centres that provide basic information and technical advice on energy matters and conducts demonstrations including those on biogas. The ministry works with other actors such as the Ministries of Agriculture, Livestock Development, and Environment and Mineral Resources. However, institutional arrangements have not been very strong.

Biogas promotion and regulatory framework is within the Department of Renewable Energy. The Department of Renewable Energy carries out the following functions:

- Renewable energy policy formulation, analysis and review;
- Promotion and development of appropriate renewable energy technologies;
- Pilot feasibility programmes and schemes on various renewable energy options;
- Extension training and public awareness on renewable energy options;
- Promotion of energy conservation and efficiency in households and institutions;
- Quality control of the technologies and conservation devices;
- Demonstration of on-farm woodfuel species seedling production and management;
- Pre-feasibility studies, evaluation and pre-investment analysis;
- Detailed site investigation and analysis;
- Technical appraisal and packaging of renewable energy information;
- Renewable energy technology transfer;
- Maintenance of standards and code of practice; and
- Renewable Energy Resources.

The challenges facing MoE in relation to promotion of biogas technology are inadequate human resources (technicians), limited financial resources allocated to the Energy Centres and weak linkages with other actors.

Under the Ministry of Energy is a state corporation, **Energy Regulatory Commission** (ERC) established under the Energy Act, 2006. ERC is a single sector regulatory agency, with responsibility for economic and technical regulation of power, renewable energy and downstream petroleum sub-sectors, including tariff setting and review, licensing, enforcement, dispute settlement and approval of power purchase and network service contracts.

Ministry of Agriculture and Ministry of Livestock Development: The Ministry of Agriculture (MoA) and Ministry of Livestock Development (MoLD) are jointly involved in provision of extension services under the auspices of the National Agriculture and Livestock Extension Programme (NALEP). As such they promote biogas technology when they are flagging other technologies. The MoLD specifically is mandated to promote livestock development and hence provision of extension services on zero grazing and biogas technology through awareness creation.

4.4.2 Institutions promoting Biogas

GTZ-PSDA: GTZ-Promotion of Private Sector Development in Agriculture (PSDA) is a bilateral programme jointly implemented by German Technical Cooperation (GTZ) on behalf of the Federal Republic of Germany and the Ministry of Agriculture on behalf of the Government of Kenya (GoK). One component of the PSDA is the promotion of environmentally-friendly technologies, among them biogas and energy saving stoves.

The focus of GTZ-PSDA is the use of agricultural waste to generate biogas. Currently, the emphasis is on the use of cowdung in zero-grazing units and or slaughter waste. However, a feasibility study has been done on other agricultural waste potentials, but implementation is yet to take place. The feasibility study explored the potentials for using pineapple waste (Delmonte) and waste from tea factories, flower farms and airport waste. The GTZ-PSDA focuses its work in agricultural areas and currently does not have operational cluster in urban Nairobi. In Kiambu GTZ-PSDA has partnered with Kenya High Yield Foundation (an NGO) to promote biogas and energy saving Jikos.

Activities of GTZ-PSDA include:

- Implementation of cost saving and environment-friendly technologies for energy production, fertilization and irrigation;
- Promotion of productive utilization of agricultural waste.
- Distribution of resource-saving waste recycling technologies in rural and peri urban areas.
- Establishment and capacity building of biogas plant contracting companies and service providers.
- Training of masons in the sizing, siting and construction of biogas plants.
- Training of engineers in the elaboration of concepts for biogas plants for waste and wastewater treatment.
- User training in handling biogas plants
- Training of local self-help groups in assembling and handling compost plants

GTZ started promoting biogas in the middle-to-late 1980s in Kenya, in collaboration with the Ministry of Energy under the Special Energy Programme. However, the GTZ-PSDA on biogas and composting for small-scale farmers in Kenya (Ecosan projects) started in 2005 **(Hoffmann *et al.*, 2006)**.

GTZ-PSDA focuses on fixed dome technologies and is installing 12m^3, 16 m^3, 24m^3, 32m^3, 48 m^3, 91m^3 and 124 m^3 digesters. Installations of biogas plants are as follows:

- Small scale biogas plants have been installed in the peri-urban districts surrounding Nairobi and in the rural agricultural districts (12m^3, 16 m^3 and 24m^3). Farmers cater for the cost of the installations, while GTZ-PSDA provides the artisans and supervises the construction.
- Digesters have been constructed in Matuu (124 M^3), Egerton University (124 M^3) and Moi University Eldoret (91 M^3).
- The demand for biogas in schools is also beginning to emerge. GTZ-PSDA has constructed biogas in public schools outside Nairobi such as Compuera Mangu Girls High School in Thika and Watoto wa Baraka School.
- GTZ-PSDA is supporting the commercialisation of Biogas plant (124 m^3 x 2 fixed dome digesters) in Keekonyoike Slaughter House in Kiserian (peri-urban Kajiado North District).
- GTZ-PSDA is supporting the piping and metering of biogas for commercial purposes and training on the conversion of diesel and petrol Gensets to run on biogas as well as other generators that can use biogas to generate power e.g. for chaff cutter operations.

Pioneer Technologies Ltd: Is a local Kenyan company. The company pioneered the development of plastic tubular technology in the region, although this technology is borrowed from the East and was introduced initially in Kenya in the 1990s. The Company initiated the promotion of the plastic tubular technology in 2006. The company facilitates the use of biogas by producing tailor made bio-digesters for homes, institutions and industries.

Currently, Pioneer Technologies Ltd receives support from **Land 'O' lakes** (from 2006) and has entered into research collaboration with Jomo Kenyatta University of Agriculture and Technology (JKUAT). Land O'Lakes gives financial support to the company in the

production of biogas digesters. JKUAT is supposed to carry out investigations into issues arising from the use of the technology, with a focus on how the technology can be improved and made more efficient among other issues.

Pioneer Technologies Ltd has installed its bio-digester in various parts of the country including peri-urban districts surrounding Nairobi, for example Kiambu. The company has capacity to install up to 3,000 units a year and has trained artisans, though not sufficient.

The biogas technologies promoted by the company includes Tubular digesters, floating drum and fixed dome with sizes tailor-made to fit clients needs.

Renewable Energy Engineering Contractors (REECON) was established in 1998 and registered in 1999. It is involved in development, fabrication and installation of renewable energy systems and technologies that are environmentally friendly. REECON has highly qualified technicians who have been involved in the biogas sector for over 15 years. They also undertake training in construction and operation of biogas plants.

In the past, REECON from Kenya and AKUT Partner from Germany entered into a contract to offer consultancy services to GTZ-PSDA in capacity building, construction of biogas plants, and training of masons and engineers. AKUT provided technical assistance to GTZ/REECON to support capacity building activities, especially related to advances in the biogas plant for large scale use, engine conversion to run on biogas and elaboration of concepts for other types of waste i.e. slaughterhouses and fruit and vegetable processing factories. In this partnership, REECON was in charge of all activities related to training and capacity building, logistical arrangements including awareness creation, identification, and supervision and monitoring of overall activities.

Recently REECON is working in partnership with IT Power (EA) in the Shell Foundation Breathing Space Project to promote biogas. REECON has also joined Sustainable Community Development Services Programme (SCODE), an NGO based in Nakuru to market and service biogas under the project. Under the auspices of the GTZ/PSDA, REECON recently provided biogas training to Kenya Kenya Union of Savings and Credit Co-operatives (KUSCCO).

REECON has constructed biogas units in the peri-urban areas of Nairobi (Larger Kiambu District, Kitengela, Rongai, Kiserian), Masai Mara etc. REECON's activities with GTZ/PSDA also saw the construction of Keekonyoike Slaughter House Biogas plant.

The costs of biogas plants constructed by REECON at household level depends on need and size of the digester, but the construction of fixed domes range from KES 80000 to 100000. An $8m^3$ digester can provide biogas for cooking while higher capacities such as $16m^3$ can provide biogas for cooking and lighting.

Sustainable Agriculture Community Development Programme (SACDEP) Kenya is a local Kenyan NGO with its offices in Thika. SACDEP promotes integrated rural development projects and focus on sustainable agriculture, community development and renewable energy. The organisation promotes biogas energy as part of its integrated projects targeting the poor in selected project areas such as Kiambu and Thika.

SACDEP has collaborated with SCODE to introduce the fixed dome biogas technology. SCODE helped with training of technical staff from SACDEP in biogas construction and other renewable energy technologies. The first biogas unit was constructed with the supervision of SCODE in 2002/3. Subsequent biogas units were installed with the support of GTZ. All the units are of 16-m^3 capacity with a gas holding chamber of 3.8 m^3. Biogas units are installed after participatory training in which community groups join together to cater for part of the biogas construction cost while the rest of the costs are catered for by SACDEP.

PEMAGI Energy Limited: PEMAGI Energy Limited, launched in 1993, is involved in designing, installing and maintaining solar electric systems, biogas systems, waste water management systems and fuel substitution and energy conservation systems.

The company also carries out energy baseline surveys and energy audits, trains her clients and provides advisory services after completion of projects. It has pioneered the development of anaerobic waste water treatment systems where biogas is generated from waste water and waste water is reclaimed and re-used, for example in North Kinangop Catholic Hospital. The hospital uses $300m^3$ of biogas every month since August 1999, which has led to conservation of 30-40 percent of firewood and reduction of indoor air pollution in the kitchen. The sludge (digestate) is used in the farm to grow fodder.

PEMAGI has continued to play a key role in the biogas sector and is currently marketing, floating drum, fixed dome and plastic tubular technology as well.

Umande Trust: Registered in 2004, Umande is a national trust working in the area of water and sanitation in support of community-managed program, especially in the informal settlements. The Trust has staff members with expertise in the technical design of water and sanitation systems, promotion of hygiene, policy and advocacy, and communication and business development. Umande Trust is supporting community groups in slum areas of Nairobi to address water and sanitation issues and to generate biogas and income from biocentres. The Bio-centre treats human waste in-situ, offers affordable sanitation through its mechanism of subsidizing operational costs, reduces carbon emissions and links to hygiene promotion, health and child protection services. About 12 communal sanitation blocks, based on the bio-centre concept have been built in the slum areas of Nairobi.

The Biocentre is built with locally available technology and local unskilled labor under supervision. GOAL, an international NGO working with Umande, adds value to the Biocentre concept by linking it to community health workers trained to disseminate hygiene and health information e.g. to women queuing for water each day, and to make referrals to local institutions for health, HIV/AIDS and child protection issues.

Over the next 3 years, the project aims to reach a critical mass of 20 Biocentres which will serve 12,000 daily users. Each Biocentre will donate 10% of its profits to a community sanitation fund which will be used to scale up the project through providing leverage to attract Government Decentralized Funding, constructing other biocentres or plot-based latrines.

Practical Action: The Intermediate Technology Development Group (ITDG) changed their name to Practical Action (PA). PA is an international NGO with headquarters in UK and works in five other continents. Practical Action Consulting (PAC) is the consultancy wing of PA: through her non-profit consultancy wing, programme staff provides information or support to organizations, governments or private entities in any geographical locality. The Eastern Africa Region Office of PA is based in Nairobi and has been operating since 1985. The organisation works in four programme areas:

- Reducing vulnerability (focus on pastoralists and farmers in marginal areas);
- Making markets work for the poor (access and value addition, identify sources which could have the potential to become valuable products);
- Improving access to infrastructure services in urban areas focusing on water and sanitation, waste management, shelter, energy, low cost transport, urban planning and governance;
- Improving access to new technologies (policy debates, ICT, GMOs, how policies in PA's programme areas affect people).

Within the water and sanitation and waste management sectors, PA has had programmes in the urban areas of Nairobi, Nakuru and other towns in Kenya. In Nairobi, PA has implemented water and sanitation programmes in Kibera (biocentre that has latrines, showers and produces biogas; built in 2003); and plastic, paper and e-waste recycling in other parts of Nairobi. In Nakuru, the focus is on ecological sanitation (Ecosan toilets) and has linkages with Nakuru Waste Recyclers and Management (NAWACOM) on commercial compost production.

4.4. Challenges in production and marketing of biogas

Technical, managerial, financial, and awareness creation challenges have been found among biogas producers using manure and slaughter house waste as feedstocks. Technical challenges include improper construction, siting and laying of biogas pipes. Poorly trained artisans have constructed some biogas plants which have failed to operate well e.g. in the slaughterhouse in Githunguri. Improper construction of biogas digesters results in low-to-no biogas production giving the technology a bad name; and the sector faces a challenge in terms of quality control.

Organisations promoting biogas and trained artisans are few and have fragmented promotional activities. Capacity to install large volume systems is seldom inadequate among artisans. There is also limited post installation support, especially after the expiry of the guarantee period (usually 12 months in some cases).

Liquefying, standardising and or transporting biogas over long distances for sale is a challenge compared to LPG. The product biogas is not always the same in composition thus making it challenging to standardize for sale and it has low methane content compared to natural gas.

Management challenges include improper feeding of the digester resulting in low gas outputs and or fluctuating gas production. Usually farmers are instructed on how to feed the digester, but this knowledge is diluted when they delegate feeding tasks to an employee, who sometimes may also change jobs. A solution would be to train the employees in feeding and to give them access to the biogas, such that they will notice when the digester is not properly fed. Some farmers spray their animals with acaricides in the zero-grazing units. The acaricides end up in the digester sterilising it resulting in low-to-no biogas production. Also some farmers feed the digester with pre-decomposed materials resulting in low gas yields and or do not follow recommended ratios of mixing manure with water.

Financial challenges include the perceived high cost of installing the biogas systems and access to loans. The market for biogas systems is currently limited to those who have animals, medium-to-wealthy and or those who can afford other alternative sources of energy. Obtaining a loan for investments in biogas systems is challenging at the moment as the units cannot be used as collateral in banks and cash income generation is perceived “intangible” and payback period long.This is changing however; some banks have started initiatives offering loans to invest in biogas systems such as Equity Bank, Githunguri Dairy Rural SACCO, and Kenya Women Finance Trust among others.

Inadequate or lack of technology awareness has contributed to low adoption of the technology. Many potential users of the technology are not aware of the technology, many have not even seen it, or those who have are ignorant about how it operates/works and its benefits and personal relevance to them. There is a need for a sustained awareness creation campaign to educate potential users on the uses and benefits of biogas.

4.5. Conclusions and Recommendations

Small scale biogas systems exist in the peri-urban districts surrounding Nairobi where dairy cattle are kept under zero-grazing. Although policy environment for biogas production is conducive in Kenya, the emphasis on biogas promotion has been on smallholder dairy farmers with zero-grazing units in the rural and peri-urban districts using manure as a feedstock rather than within the urban Nairobi.

There is a potential to upscale the production and use of biogas in peri-urban districts where there are cattle under zero-grazing, and it would be affordable for medium-to-rich farmers with capacity to invest in different biogas systems including the tubular system, a cheapest option with short pay-back period.

Use of organic wastes such as plant materials, organic market waste and or slaughter house waste to generate biogas have not been widely explored by biogas producers; though limited cases exist in the use of slaughter house waste in the peri-urban districts surrounding Nairobi. Although there is a potential to convert organic city waste into biogas, in practice there is a long way to go, especially in the use of organic market waste or waste of plant origin.

The potential of selling the biogas to neighbours or family members has hardly been explored by smallholder biogas producers. However, observations from this study indicate that it is possible for farmers and or large waste generators such as slaughter houses with surplus biogas that can be distributed to the neighbourhood. Such initiatives would require contractual agreements between the supplier and the consumer and also a guarantee of the supply of the biogas.

There is a potential to upscale the generation of biogas from human excreta from biocentres constructed to address water and sanitation, and income generation in the informal settlements of urban Nairobi. As has been shown by this study, from cases in Kibera, Lunga lunga (Mukuru) and Korogocho slums, commercialising services based on biogas production, toilet and bathroom facilities is an opportunity which can be replicated elsewhere, though the digestate is not currently used. However, key public health, environmental, social, financial, economic, legal, and institutional issues in the informal settlements may need to be understood to make such initiative sustainable.

Although biogas technology has been actively promoted in Kenya, some of the digesters operate below capacity, are dormant or in disuse after construction because of management (poor feeding methods); technical (poor design and construction); and financial (perceived high costs of installation and maintenance) challenges as well as due to lack of quality standards. Addressing these issues in an integrated manner, while exploring options for commercialisation, is envisaged to increase the adoption of biogas technology in the future.

One of the key questions which remain is on the long term economic feasibility of small scale biogas plants. This should be investigated to further provide information to current and potential biogas producers and users on the costs and benefits of biogas systems.

5. LIVESTOCK FEED PRODUCERS, USERS AND MARKETS

5.1. Background

Peri-urban and urban livestock keeping is an essential livelihood activity for diverse groups including smallholders and the vulnerables. However, urban livestock production is rarely recognised by Nairobi city planners. Too often, livestock keepers are actually harassed or ignored by city officials. However, recent studies of cities in Kenya, Ethiopia, Tanzania and Uganda indicates that urban livestock production appears to be favoured over crop production as it requires less or no land and provides better returns **(Guendel, 2002).** However, development initiatives have tended to focus on improved production in rural areas to supply expanding urban populations and thus information on urban livestock production has remained limited. Similarly, information on urban Nairobi livestock numbers and the use of city organic waste as livestock feed is scanty.

Previous studies in the 1970s and 1980s have indicated that municipal garbage such as kitchen waste from houses and institutions can be processed and sterilized into a reasonable feedstuff as such waste has nutritional potential and is available in large quantities **(yoshida and Hoshii, 1979, Lipstein, 1985)**. **Peters (1998)** and **Baud *et al*. (2004)** have also reported that organic city waste in Nairobi is already in use as some livestock, including goats, chickens and cattle occasionally feed on top of waste heaps. The use of organic waste as feed in Nairobi has further been corroborated by **Mazingira Institute (1987)** which reported that some of the organic waste from 43% of markets and institutions they surveyed was used as livestock feed, mainly for pigs; and that about 14% and 12% of animal producers in the sample studied fed their livestock on garbage during the wet and dry seasons respectively. Similarly, other studies have also indicated that a proportion of food waste from hotels, markets and other institutions in Nairobi are partly used as livestock feed in private and often informal arrangements between waste generators and livestock feed users, but with some waste being sold to, for example, pig farmers **(Peters, 1998; Ikiara *et al*., 2004)**.

Although information on quantities of waste used as livestock feed is scanty, **Baud *et al*. (2004)** claim that the use of organic waste for livestock feed will continue to gain importance in Nairobi. Organic city waste, as an input in agricultural activities, can be fed to livestock, with or without applying processing techniques to transform the material to the desired quality or form depending on the type of waste and livestock in question; some may be boiled before feeding to livestock such as pigs.

Livestock feeding and nutrition influences livestock productivity and the use of city organic waste as a feed has a potential role to play as “a cheap feed source”. In Kenya, feeding alone accounts for between 60 to 80% of the total livestock production costs **(Githinji *et al*., 2009)**. Although natural pastures constitute the main feed resources for ruminants in Kenya, the increase in dairy enterprises and the decreasing land sizes has seen most farmers resorting to the use of supplementary commercial feeds, an important determinant of dairy enterprise profitability. However, the cost of commercial feeds has been on the rise, partly due to the use of costly imported raw materials in feed formulations. Using local waste-streams (after upgrading their quality), could reduce such imports, and the competition for food between animals and humans **(El Boushy and van der Poel, 2000; Nelleman *et al*., 2009)**. However, the use of Nairobi City waste in commercial feed formulation is limited or non-existent and commercial feeds are formulated mainly from inputs trucked from rural farming areas and or from imported raw materials.

5.2. Livestock Feed Producers

5.2.1. Mapping and characteristics of livestock feed producers

In a study to map commercial feed millers in Kenya, **Githinji *et al* (2009)** found that feed millers are located in major urban centres, but with high density in Nairobi and peri-urban districts surrounding Nairobi, such as Kiambu and Thika **(Appendix 9)**. The closer to Nairobi, the higher the number of livestock feed millers. The commercial feed millers are private registered companies, with some being members of Association of Kenya Feed Manufacturers (AKEFEMA). A dominant characteristic of these livestock feed producers (millers) is that they use agricultural based products and by-products for manufacturing commercial livestock feeds. However, none of them have exploited Nairobi market waste and or other types of city organic waste for feed formulation. A list of livestock feed vendors and agro-vet distributors is presented in **Appendices 10**.

Dairy farmers, in urban and peri-urban areas, feed livestock from own-grown fodder, crop residues, and purchased roughages and commercial products (concentrates, minerals, vitamins and other feed additives etc). The commercial feed products are sourced from Nairobi and agro-vet vendors and retailers in local market centres and towns. The concentrates used originate from cereals (maize, wheat, barley, oats, millet, and sorghum), legumes and oilseeds cakes (soybeans, cotton seed cake and sunflower) and animal by-products (fish meal, meat and bone meal), **(MoLD, 2008)**. However, the inconsistent supply of some of the ingredients, especially the imported ones such as oil-seed cakes and meals, finer mineral elements, fish meal, vitamins and amino-acids, has a major effect on the feed quality and pricing.

Besides using fodder such as Napier, farmers in the peri-urban districts also use other crop residues, for example cereal residues, sugarcane tops, baggase and bean pods. Utilization of crop residues is, however, constrained by inadequate knowledge, limited conservation technologies, low nutritive values, post harvest losses and bulkiness **(MoLD, 2008)**.

4.2.2. Livestock feed production

Livestock feed production comprises local on-farm feed formulations and commercial feed formulations. On-farm feed formulations are local formulations made by farmers themselves based on on-farm grown feed resources. Commercial feed formulations are compounded feedstuffs comprising protein, energy, mineral and vitamin concentrates and are important especially for commercial poultry, dairy and pig production. A nation-wide survey conducted in Kenya has shown that commercial livestock feed companies in Nairobi operate at 31-45% potential capacity **(Table 15)**. While the reasons for this level of production vary from company to company, the livestock feed industry is faced with challenges of high prices of inputs, energy and transportation. There are also concerns about feed and food safety and quality, traceability and the need to meet regional and international standards to facilitate trade **(Githinji *et al*., 2009)**. The challenges faced by livestock feed industry has been described in **Chapter 5.5**.

It is estimated that there are about 100 feed manufacturers in Kenya with an annual turnover of about KES 7 billion. The smallest feed company produces about 1,000 tonnes per year while the biggest feed company produces about 90,000 tonnes per year **(MoLD, 2008)**. There is a high potential for the feed industry to expand. **Githinji *et al* (2009)** have indicated that 33 feed millers in the Nairobi region (out of 94 nationwide respondents) have increased their feed production with 44% since 2003 to produce 181,366 tons of feed in 2008 and there is still potential to grow as they have the capacity to produce 405,068 tons

Table 15: Trends in milling capacities of livestock feed producers (percent of installed capacity)

Region	Installed capacity (tons)	Percentage of installed capacity						
		2008**	2008*	2007	2006	2005	2004	2003
Nairobi	405,068	45	37	48	41	36	33	31
Thika	160,940	45	37	44	38	30	29	28
Kiambu	50,160	42	35	31	24	16	4	
North Rift	37,030	59	49	62	45	42	34	11
Nyanza	19,538	62	45	65	66	57	51	61
Nakuru	69,362	57	47	49	50	48	46	35
Mt. Kenya	25,320	18	15	15	17	16	8	7
Coast	76,150	30	25	25	13	9	9	10
Total	**843,568**	44	37	44	38	32	29	26

Source: Adapted from Githinji *et al*. (2009) * Data for 10-months period; **Projected annual data

5.2.3. Livestock feed input sourcing

The commercial livestock feed manufacturers use diversity of inputs sourced locally in rural farming areas, but also supplements deficits by importing such inputs from Eastern Africa countries and abroad **(Table 16).** The millers require and use energy, protein and mineral supplying raw materials in compounded feeds. Millers demand for energy and protein raw materials outstrips supply from the local market. For example the deficit in energy rich materials is met by importing raw materials from Uganda and Tanzania. Similarly, the high deficit of protein supplying materials (except soybeans, sesame and meat meal and blood cake) is bridged through importation of such raw materials. However, most of minerals and premixes used in the feed milling industry are sourced locally, some from individuals who have imported them into the country. Examples include growth promoters, egg colouring agents, coccidiostat's, and poultry mineral-vitamin premix and dicalcium phosphate.

At local farm level, livestock feeds (uncompounded) especially on-farm roughages are in short supply during dry seasons and dry season feeding is a major concern to many livestock farmers **(Snijders and Wouters, 2003)**. This is partly addressed through purchases of livestock feeds (roughages and concentrates) for zero-grazed animals. Some peri-urban farmers with informal and or formal arrangements with hotel and kiosk owners also partly source their livestock feed from the urban centre of Nairobi. Also there are indications that some of the farmers also source market waste and or fresh produce rejects at the airport and truck the same to peri-urban areas to feed livestock. However, the use of city organic waste in commercial feed milling and formulation is limited and or underexploited.

5.3. Livestock feed marketing

5.3.1. Potential demand for livestock feeds

In the rural areas, pastures/forages are the dominant source of feeds for local animal breeds. However, where dairy animals are kept both roughages and commercial feeds are used to increase animal productivity. The potential demand for livestock feed from city waste is not clear from this study. Even though organic city waste is used as livestock feed in Nairobi, no company was found with a core business of processing city waste into livestock feed during the inventory, except for one observation reported in literature where fish remains from dumpsite were supposedly used in livestock feed formulation **(Kantai, 2000)**.

Table 16: Livestock feed input requirements at national level and their sources

Raw Material	Requirement (Tons)	Used (Tons)	Source		Source of Import
			Local %	Import %	
Maize grain	88861	79,662	98.4	1.6	UG, TZ
Maize bran	42399	40237	92.0	8.0	UG, TZ
Maize germ	62598	61517	90.0	10.0	UG, TZ
Maize germ cake	11570	106037	97.0	3.0	UG, TZ
Wheat grain	4281	2071	99.6	0.4	Not Indicated
Wheat bran	99374	86953	94.5	5.5	UG, Rwanda
Wheat pollard	83748	81636	92.4	7.6	UG,TZ Rwanda
Rice polishing	5937	4555	54.5	45.5	UG, TZ
Rice bran	10593	9042	93.6	6.4	UG, TZ
Rice hulls	0	0	0.0	0.0	-
Broken rice grains	1380	85	93.0	7.0	Pakistan
Millets	3802	2542	82.7	17.3	UG, TZ
Sorghum	5964	3571	99.8	0.2	UG
Cassava	510	368	100.0	0.0	-
Soy bean meal	10608	9167	61.2*	38.8	UG, India, Europe
Full fat soybean	867	366	100.0*	0.0	-
Cotton seed meal	16052	15078	17.0	83.0	UG, TZ
Cotton seed cake	43079	38295	67.2*	32.8	UG, TZ
Sunflower seed cake	35539	33771	65.5*	34.5	UG, TZ
Simsim cake	202	201	100.0	0.0	-
Copra cake	5391	4044	20.0	80.0	UG, TZ
Fish meal	5785	4796	50.9	49.1	UG & TZ
Omena	17545	16386	40.8	59.2	UG & TZ
Meat meal	688	58	100.0	0.0	-
Meat and bone meal	2223	1527	86.9	13.1	Not Indicated
Blood meal	450	428	100.0	0.0	-
Bone meal	14517	13633	99.6	0.4	Not Indicated
Limestone	22940	21141	99.9	0.1	Europe
Dicalcium phosphate	2799	2769	43.1*	56.9	Europe, Israel, Belgium, S. Africa, India, China,
Common salt	4296	4067	99.9	0.1	Russia
Poultry mineral vitamin premix	3043	3039	67.5*	32.5	Europe, Asia, Brazil, S. Africa, Israel
Coccidiostat	440	432	90.5*	9.5	Europe, Asia, Israel
Egg colouring agent (e.g. caraphyll orange)	378	361	99.2*	0.8	S. Africa, Europe, Asia
Growth promoters	1327	1287	95.9[10]	4.1	S. Africa, U.S.A India
Molasses	11943	11807	67.7	32.3	TZ
Oil	842	842	100.0	0.0	_
TOTAL	**621,971**	**566,338**	**-**	**-**	_

Source: Adapted from Githinji *et al*. (2009); Key: UG: Uganda; TZ: Tanzania

The sale of waste for feeding purposes has been indicated to occur in Nairobi informally and to some extent formally, but not fully commercialised **(Peters, 1998)**. Rather, the use of commercially compounded feeds, such as concentrates, among dairy farmers in urban and peri-urban areas is common.

Concentrate feed is a major cost component in dairy production systems and accounts for up to 80% of the total cost of production. Any famer with dairy animals under zero-grazing or other forms of intensive production system, in the urban and peri-urban districts, surrounding Nairobi is a potential buyer of commercial concentrate feeds in addition to using own-grown or purchased roughages or other forms of agricultural waste edible to livestock. The study has estimated the potential roughage requirement based on population of cattle in the peri-urban districts of Nairobi. The roughage demand has been calculated based on assumption of cattle body mass of 400 kg **(Lanyasunya *et al*.,**

[10] Raw materials sourced from dealers who have imported them into the country.

2006), 70-110 kg fresh roughage (Napier) per day (≈ 90kg) for large dairy breeds, **(MoALD&M, Sa)**, lactation period of 305 days and a flat concentrate feeding (dairy meal) of 2 kg per cow lactation day **(Staal *et al*., 1997)**, and milk yields of 15 kg/cow/day **(Table 17)**. To estimate the cash flows for using feeds, roughage (Napier) was valued at on-farm price of KES 2 per kg, dairy meal at market price of KES 20.70 and milk at KES 20 per kg. In reality, the lactation period of most dairy animals in peri-urban districts surrounding Nairobi can be longer, up to 388 days due to poor management and the available cattle breeds **(Staal *et al*., 1997)**, concentrates need to be fed according to milk yields and cows can produce up to 7 kg milk daily on good quality roughage alone **(MoALD&M, Sa)**. Water and labour were assumed to be having no cash cost in the calculations.

Table 17: Estimated potential demand for livestock feeds in urban and peri-urban Nairobi and surrounding areas

Characteristic	Larger districts before sub-division				
	Nairobi	**Kiambu**	**Thika**	**Kajiado**	**Machakos**
General					
Est. population (2009)	3,138,295	862,096	676,328	600,542	1058,052
Total no. of households	649,426	189,706	171,569	96,621	186, 299
Cattle owned (2004)[11]	22,800	159,000	122,700	400,400	263,600
Dairy cattle owned (2004)	19,500	152,000	84,900	80,300	33,100
Estimated roughage required (tones fresh weight year-1)[1]	748,980	5,223,150	4,030,695	13,153,140	8,659,260
Dairy cattle					
Estimated roughage required (tones fresh weight over 305 lactating days)	535,275	4,172,400	2,330,505	2,204,235	908,595
Estimated dairy meal required (tones per 305 lactating days)	11,895	92,720	51,789	48,983	20,191
Estimated milk production (over 305 lactating days, tons)	89,213	695,400	388,418	367,373	151,433
Cash flows for dairy cattle					
Roughage costs	1,070,550	8,344,800	4,661,010	4,408,470	1,817,190
Dairy meal costs (KES x 1000)	246,227	1,919,304	1,072,032	1,013,948	417,954
Cash value of milk (KES x 1000)	1,784,260	13,908,000	7,768,360	7,347,460	3,028,660
Net cash flow (KES x 1000)	467,484	3,643,896	2,035,317	1,925,041	793,516

[1]Roughage/Napier dry matter fraction of 0.15-0.30

[11] Reliable number of livestock not available-estimations drawn from GoK, 2004: Support to NAPAD-CAADP implementation TCP/KEN/2908 (1). Vol. 4. Bankable investment project profile. Disease control and facilitation of livestock commodity marketing. Republic of Kenya

5.3.2. Branding, marketing strategies and perceptions on livestock feed quality

Under "Fertilizers and Animal Foodstuffs Act" [CAP 345, Laws of Kenya], feed manufacturers are required to brand and package feedstuff in standardized packages before marketing. Observations during this study indicated that there is adherence to this requirement with feed manufacturers using nylon bags to package produce and or other durable packaging materials. The packages are labeled with the trade name of the product, its contents, and the weight of the bags and a specification of quality and manufacturers name. Although the units of packaging may be similar across feed millers, marketing is liberised resulting in price differences across companies for the same unit of a particular product.

Marketing and distribution strategies used by feed millers in Nairobi and the peri-urban areas include: direct marketing to end users (direct distribution-wholesale), marketing through a bulk supplier (indirect distribution), marketing through sales agents (retailers-indirect marketing) and a combination of direct marketing and indirect marketing strategies. The livestock feed producers have distribution networks within Nairobi, the peri-urban districts surrounding Nairobi and in other major market centres. The distributors and stockists of livestock feed are mainly agro-vets.

Quality of feeds has been of major concern in the recent past **(see Section 5.4)**. The regulation of the industry is currently inadequate, thus unethical practices in the industry have resulted in low quality feed stuff and in some cases contamination with disease causing pathogens and materials: salmonella, industrial contaminants, heavy metals, mycotoxins, dioxins, pesticides, growth promoters and veterinary drugs. The formation of Association of Kenya Feed Manufacturers and the increasing regulatory control by Kenya Bureau of Standards are envisaged to address quality issues and consumer concerns.

The cost of commercial feeds is also of great concern to all the stakeholders and feed users in livestock sub-sector. High feed costs affect competitiveness of Kenya's livestock industry at the international arena and limits farmers capacity to purchase the feeds.

5.3.3. Livestock feed pricing

Farmers using market waste as livestock feed obtain such "feeds" at low to no prices while others have informal arrangements with hoteliers to truck away the waste. However, commercial feeds are not obtained for free. The study collected prices on some commercial feeds available in Nairobi market as opportunity cost/prices[12] **(Table 18)**. According to traders interviewed, the prices of livestock feed has been on the rise since year 2000, and also marginal increases are expected in the future subject to costs of raw materials. However, opportunities for using commercial livestock feed is "large" due to the growing dairy industry and improved milk prices.

5.4. Institutional and Policy Environment

5.4.1. Regulatory and legislative framework

Animal feed stuffs are currently administered under "Fertilizers and Animal Foodstuffs Act" [CAP 345, Laws of Kenya]. This Act of Parliament regulates the importation, manufacture and sale of agricultural fertilizers and animal foodstuffs and substances of animal origin intended for the manufacture of such fertilizers and foodstuffs. The Act puts restriction on the importation, manufacture, compounding, mixing or selling any fertiliser or animal foodstuff other than from those declared under the Act by the Minister.

[12] Prices collected from Kenya Farmers Association Ltd, Kiambu Fertilisers Ltd and Agro-Feeds Ltd. in Nairobi on 02/9/09

Table 18: Examples of livestock feed products sold in Nairobi and the peri-urban areas

Animal feed type	Unit	Price range (KES)	Average price (KES)
Dairy meal	70kg-bag	1350-1550	1450
Maize germ	60kg-bag	1050-1200	1125
Wheat bran	40kg-bag	450-650	550
Wheat pollard	60kg-bag	1050	1050
Soy bean meal	50kg-bag	1450-1500	1475
Cotton seed cake	50kg-bag	1300-1400	1350
Sunflower seed cake	50kg-bag	1300-1400	1350
Copra cake	50kg-bag	1400	1400
Fish meal	50kg-bag	1600	1600
Bone meal	50kg-bag	950-1000	975
Molasses	20kg-pack	350-380	365
Mineral supplement (Unga high phosphorus)	5kg	750	750
Mineral supplement Macklick super	5kg	780	780

In the fertilisers and animal foodstuffs rules (L.N.212/1972 Part I (Schedule r.2), the following are the approved animal foodstuffs: Alfalfa (lucerne), barley and barley meal, bean meal, cassava and cassava meal, clover meal, compounded cakes or meals from approved products, cotton cakes or meals, dried brewery grains, dried distillery grains, green fodder crops, dried yeast, extracted linseed meal, bone flour, dried blood, meat and bone or carcass meal, fish meal and fish residue meal, maize products (maize grains, maize germ etc), oat products, liver meal, locust bean meal, mineral feeding supplements, nut cakes or meal (coconut, copra, palm kernel and ground nut cakes and meal), pea meal, pyrethrum marc, rape cake or meal, rice bran or meal, sorghum products, soya cake or meal, sugar-beet treacle and sugar-beet molasses, sugar-cane treacle and sugar-cane molasses, sunflower seed cakes or meal, wheat and wheat products, white fish meal and dried beet pulp.

Majority of the approved animal feedstuff products in the Act are agricultural-based and or animal based. This law is outdated and needs review to align it with the current organizational structure of the Ministry in charge of livestock development, technological advances over the years, trade liberalization and global trends and concerns on health of human and animals; and environmental protection **(MoLD, 2008)**.

5.4.2. Principal policy setting and regulatory actors

Ministry of Livestock Development

The Ministry of Livestock Development sets policies and regulations in the livestock sector in Kenya. The Ministry has drawn a draft livestock feeds policy with clauses on feed production, conservation, regulatory framework, research and extension and roles of institutions involved in feeds regulation **(MoLD, 2008)**. The policy promotes forage development and conservation, use of crop residues and compounded feedstuffs, feed additives, feed biotechnology and water for livestock. On the development of compounded feed stuffs, the Ministry undertakes the following:

- Promotes farming of various crops for use as raw materials for compounding feedstuffs.
- Facilitates the importation of feed grade yellow maize for the manufacture of animal feeds during periods of low national cereals production.
- Assures quality and safety of locally produced and imported animal feeds through regulation of imports and registration of feed millers and suppliers of feed ingredients.
- Strengthens the Association of Kenya Feeds Manufacturers (public-private sector organization) to enable it effectively carry out self- regulation of the feeds industry.

The Ministry also sets regulations and standards on feed quality control. In the 2008 draft Livestock Feeds Policy, the Ministry envisaged the establishment of a Feeds Inspectorate Service to ensure quality and safety of feedstuffs offered for sale and review current feedstuff standards in collaboration with Kenya Bureau of Standards. The Ministry has prepared a Feeds stuff Act that seeks to separate animal feeds from the "Fertilizers and Animal Foodstuffs Act [CAP 345, Laws of Kenya]" since the two commodities are different and regulatory control required is also different.

Kenya Bureau of Standards: The Kenya Bureau of Standards (KEBS) is a statutory body, in the Ministry of Industrialisation, established under the Standards Act (CAP 496) of the laws of Kenya. KEBS offers the following services: Standards development and harmonization; testing services; calibration services; enforcement of standards; product certification to the Diamond Mark and Standardization Mark of Quality; import inspection services; education and training in standardization, metrology and conformity assessment; and management system certification services (Quality Managements Systems ISO 9001, Environmental Management Systems ISO 14000, Occupational Health and Safety OHAS 18000 and Food Safety Management Systems ISO 22000).

KEBS has over the years coordinated the development/writing of various Feed standards through the Animal Feed Technical Committee (TC) which comprise of representatives from feed manufacturers, research institutions, suppliers of supplements, consumer organizations and Ministry of Livestock and Department of Veterinary services. The following Kenya Feed Standards have been developed over the years.

- Code of Practice for Animal feed Production, Processing, Storage and Distribution-KS 01-1674
- Specification for Poultry Feed-KS 01- 61
- Specification for Dairy Feed-KS 01- 62
- Specification for Pig feed-KS 01- 138
- Specification for Dog Feed-KS 01- 674
- Specification for Ostrich feed-KS 01 - 1650
- Specification for Salt and Mineral Supplements-KS 01- 458
- Specification for Meat and Bone Meal-KS 01- 838
- Specification for Meat Meal-KS 01-943
- Specification for Blood Meal-KS 01-786
- Specification for Bone Meal-KS 01-785
- Specification for Fish Meal-KS 01-784
- Specification for Oil seed cake-KS 01-673
- Specification for Wheat Bran-KS 01-952
- Specification for Maize Bran-KS 01-1085
- Specification for Molasses-KS 01-954

Products are certified to the Diamond Mark which is a voluntary certification for products that over the years have shown excellence in performance and quality. KEBS also offer the Standardization Mark (mandatory) based on conformance to the requirements of the respective product standard and the KS 1647: Code of Practice for Animal feed Production, Processing, Storage and Distribution. KEBS certification marks are recognized through the East African Community. Enforcement of Kenya Standards is a function of the Quality Assurance and Inspection Department at KEBS.

5.4.3. Other actors-private and public-private partnerships

Association of Kenya Feed Manufacturers: The Association of Kenya Feed Manufacturers (AKEFEMA) was started in August 2004 and has 23 fully paid up members and about 50 potential members. AKEFEMA was formed in response to changed policy environment that recognized the role of feed manufacturers and the need

for industry self regulation. AKEFEMA brings together, for cooperation and coordination, all businesses involved in the manufacturing of animal feeds; promote, support, encourage and undertakes research on raw materials used for manufacture of animal feeds and research into processes of animal feed manufacture; and collects, analyses and disseminate the best available information on animal feeds manufacturing.

AKEFEMA recognises the need for collective and collaborative efforts by feed manufacturers through AKEFEMA, Ministry of livestock and the Kenya Bureau of Standards. AKEFEMA has participated in the preparation on the new proposed Feeds Stuff Act, which is now at the Attorney General's Office for review and subsequent forwarding to parliament for enactment. Once finalized this will be the anchor for self regulation within the industry. To enhance self regulation in the industry, AKEFEMA is preparing a code of conduct for feed manufacturers.

Public and Private Sector Partnership: The feeds industry has various players in the chain. They include millers, suppliers of additives and ingredients, researchers, professional associations, farmers and regulatory agencies. These players have different motivations but by working together they can develop rules for transparent operation of the industry and ensure that producers benefit and consumers are assured of safe products of animal origin. In the 2008 Livestock Feeds Policy, the Ministry of Livestock Development envisages to establish a Feeds Industry Advisory Committee consisting of a mix of stakeholders to review developments in the industry and advice the Minister on issues requiring administrative or legal action. This committee will be entrenched in the proposed Feeds Act.

5.5. Challenges in Livestock Feed Production and Marketing

5.5.1. Use of waste as livestock feed

Palatability, digestability, and nutritional value are important factors to take into account when processing organic waste streams into livestock feed. Factors that limit the use of feed from organic waste are nutritional and technical in nature **(El Boushy and van der Poel (2000)**. The nutritional factors include variability in nutrient level and quality, presence of naturally occurring anti-nutritional and or toxic factors, presence of pathogenic micro-organisms and the need for supplementation. Technical factors include seasonal and unreliable supply of organic waste, bulkiness, wetness and/or powdery texture and processing requirements, and inadequate research and development efforts.

Various other challenges have been found in using waste as livestock feed. According to a survey of 195 urban and non-urban farmers in Nairobi, the difficulty in waste storage was mentioned by 30% of the farmers as a constraint in using organic city waste as livestock feed (**Baud *et al*. 2004**). Long transportation distances was seen as a constraint by 23.3% of the farmers while the economics of using waste as feed was mentioned by 18.4% of the respondents as a constraint. Other constraints in decreasing importance were 'too much rains' (10% of respondents), farm too small, lack of transport, lack of knowhow and contamination (6.7% of respondents) and enough feed supply from the farm, lack of understanding with dealers and lack of labour (3.3% of respondents) (**Baud *et al*. 2004**).

Contamination of waste has also been mentioned by other authors **(e.g. Peters, 1998)**, who indicates that waste often contains inorganic material, which may be toxic. Such waste poses a threat to both human and livestock health. Furthermore, pathogen growth can rapidly occur in kitchen waste in warm climates, and may infect livestock. Therefore, it is not recommended to use kitchen waste as animal feed without separating it from inorganic material (**UNCHS, 1989**)

5.5.2. Production of livestock feed from waste

From the findings of a feed milling industry survey, it is clear that availability, high cost and low quality of raw materials are the most important factors constraining the feed milling industry in the Nairobi region **(Githinji *et al.,* 2009)**. In order of importance, the constraining factors in the Nairobi region are as follows **(Githinji *et al.,* 2009)**:

- Availability of raw materials;
- High cost of raw materials;
- Low quality of raw materials;
- High cost of electricity;
- Debtors;
- High transport cost;
- Credit control;
- Lack/high cost of laboratory services; and
- Lack of know-how in feed manufacturing technology.

Costs of raw materials are often high as part of these raw materials is imported (**MoTI, 2001)**. Other constraining factors that have been mentioned in the Nairobi region are: counterfeiting, competition, delay in clearing imports and high taxes on inputs **(Githinji *et al*., 2009)**.

These challenges in feed production are confirmed by **MoTI (2001)**, but expanded to include the following challenges:

- Inadequate extension activity;
- Lack of appropriate credit facilities;
- Uneven distribution of livestock feeds and provender millers;
- Inadequate and inaccessibility to mineral supplementation;
- Inadequate supply of clean water for the livestock;
- Unavailability of local sources of vitamins, amino acids macro and micro-nutrients;
- Inadequate research information;
- Frequent drought situations;
- Lack of appropriate technical know-how in water harvesting, storage and irrigation; and
- Lack of market information.

5.6. Conclusions

Based on the available information, the potential of using city waste for feed production is large, as there are such large quantities available. Furthermore, waste is already used as a feed-source by many individuals and their animals. However, as such little commercial business is derived from converting city waste into feed, and selling it to livestock farmers. The question that remains is whether there is a potential to actually commercialise such activities. This could be looked into in a future study, where the Nairobi region food milling industry and other stakeholders would be involved subject to the provisions of the newly proposed Feeds Bill and envisaged regulatory framework of the livestock feed sub-sector.

The commercial feed milling industry is a vibrant sub-sector in Kenya partly driven by growing dairy industry and a liberised market for feed and milk products. There is thus a potential to use city waste in feed milling to exploit this growing market, but legislative and regulatory framework need to be taken into account to “penetrate the feed milling industry” and to guard human and livestock health.

The use of cheap organic city waste in the feed milling industry could potentially translate into low costs of feedstuff depending on the logistics and processing technologies involved, and decrease the competition for food between humans and animals due to use

of “alternative feeds based on new technology and the use of waste and discards” (**Nelleman *et al*., 2009)**. It is also envisaged that using organic city waste in feed milling would reduce quantities of imported raw materials for feed milling and thus save Kenya foreign exchange.

Challenges to be addressed in using waste directly for feeding animals, or for feed production are the availability and quality of the material (e.g. related to animal and human health), its costs and its transportation and storage. Limited information is available on how to tackle these challenges and thus, it is recommended to look into these issues with interested value chain actors in an applied research project.

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APPENDIX 1: CHECKLISTS USED IN THE STUDY

A: Checklist for Data Collection: Waste Recycling through Composting in Urban and Peri-urban Areas of Nairobi

1. Background information

- Name of producer/ seller
- Location of the producer/seller (District, Division etc.; mapping)
- Contacts of the producer/seller
- Historical background of the producer/seller
    - When did the activity start
    - Ownership and acquisition of the site where composting is done

2. Operations of composting activity

- How composting process is organized; Number of people involved in the activity
- Sources of organic wastes used in composting and how sourcing is arranged (inflows)
- If purchased, what are the units of sales and prices of organic wastes for composting
- Types and quality of organic wastes used in composting; and estimated proportions
- Methods of composting (composting systems); successful and non-successful systems
- Compost fortification (if practiced)
- Busy months (in terms of production) in a calendar year; busy days, busy periods
- Photo documentation

3. Composting outputs and utilisation

- Quantity of compost produced per half year period
- Types of consumers of compost (public-private linkages) and where they come from
- Potential users of compost
- How the compost produced is used (used on-farm; sold etc.)
- Composting and linkages with urban and peri-urban agriculture
    - Locality in urban Nairobi and peri-urban environments
    - Crops grown

4. Economics of compost production

- Labour (site preparation/pits; collection of materials; layering; watering; turning etc)
- Cost of materials for composting
- Compost produced
- Cost of packaging materials
- → focus on final product costs (to compare with e.g. fertilizer) and main cost items that may change (e.g. waste which is free at the moment may have a price in the future)

5. Marketing aspects of composting

- Methods of preparing compost for the market (packaging, labeling etc)
- Quality criteria (as perceived by consumers + producers)
- Estimates of compost consumers/buyers per month (specific time period)
- Busy months (in terms of compost sales) in a calendar year; High and low periods of compost sales
- Units of sale of compost and price per unit; willingness to pay
- Estimated sales per half year period (volumes)
- Trends in compost market development (past and future prospects)
- Compost marketing strategies; and proposed value addition recommendations

6. Constraints and Potentials for use of urban waste for composting

- Potentials/advantages of using urban waste for composting
- Challenges in using urban waste for composting

7. Producer perceptions on policies affecting urban and peri-urban composting/organic waste recycling

- Administration requirements by City Council (by-laws affecting location, operations and production and sale of compost)
- NEMA regulations known to producers/sellers (if any)
- Other policies

N/B: Potential sites for visits

- Organisations and institutions producing and or promoting compost
- Roadside flower businesses
- Landscaping sites; golf course
- Urban gardening sites
- Formal business entities: Landscaping, interior design, Agrovets, animal feeds, agricultural input suppliers and sellers etc
- Nursery operators;
- Urban and peri-urban gardening sites;
- Large scale growers e.g. of flowers?

8. Inventory and institutional mapping of compost producers/sellers

Primary and secondary data (activities and location) collection on:

- Composting installation plans/sites
- Fertiliser dealers/producers; blenders; importers and dealers
- Nurseries within urban and peri-urban areas
- Promoters of composting
- Compost equipment dealers
- Potential implementing partners (innovators/technical partners; capacity)

B: Checklist for Data Collection: Waste Recycling through Biogas Generation in Urban and Peri-urban Areas of Nairobi

1. Background information

- Name of producer/ seller
- Location of the producer/seller (District, Division etc.; mapping)
- Contacts of the producer/seller
- Historical background of the producer/seller
    - Start date for the activity
    - Ownership and acquisition of the site where biogas production takes place
    - Number of people involved in the activity

2. Operations of biogas generating activity

- How biogas production process is organized; Number of people involved in the activity
- Sources of organic wastes used in biogas generation and how sourcing is arranged (inflows)
- Units of sale and prices of organic wastes for biogas generation
- Types and quality of organic wastes used in biogas generation; and estimated proportions
- Types of biogas digesters; successful and non-successful systems
- Busy months (in terms of production) in a calendar year; busy days, busy periods
- Photo documentation

3. Biogas outputs and utilisation

- Quantity of biogas produced; quantity of the remainder (by-products/digestate) produced per half year period
- Utilisation of biogas and remainder (by-products/digestate) - used on-farm; sold etc.
- Types of consumers of biogas and digestate (public-private linkages) and where they come from
- Potential users of biogas and remainders (by-products/digestate)
- Biogas generation (incl. remainders) and linkages with urban and peri-urban agriculture
    - Location of biogas producers/users in the urban Nairobi and peri-urban environments
    - Crops grown using digestate/by-products

4. Economics of biogas production

- Labour (site preparation/pits; collection of materials; etc)
- Cost of materials for biogas generation
- Biogas and remainders produced
- → focus on final product costs (to compare with e.g. fertilizer) and main cost items that may change (e.g. waste which is free at the moment may have a price in the future)

5. Marketing aspects of biogas generation

- Quality criteria of the digestate/by-products (as perceived by consumers + producers)
- Estimates of the number of biogas/digestate consumers/buyers per month (specific time period)
- Busy months (in terms of digestate sales) in a calendar year
- High and low periods of digestate/remainer sales
- Unit of sale of biogas/digestate and price per unit; willingness to buy
- Estimated sales per half year period
- Trends in biogas/digestate market development (past and future prospects)
- Biogas/digestate marketing strategies

6. Constraints and potentials of using urban waste for biogas generation/digestate

- Potentials/advantages of using urban waste for biogas generation
- Challenges of using urban waste for biogas generation

7. Producer perceptions on policies affecting urban and peri-urban biogas generation/organic waste recycling (if any)

- Administration requirements by City Council (by-laws affecting location, operations and production and sale of biogas/remainders)
- NEMA regulations known to producers/sellers (if any)

N/B: Potential sites for visits

- Biogas/digestate producers and (potential) users in urban and peri-urban areas

8. Inventory and institutional mapping of biogas producers/sellers

Primary and secondary data (activities and location) collection on:

- Biogas installation plans/sites
- Biogas producers, users and dealers
- Promoters of biogas generation
- Biogas generation equipment dealers
- Potential implementing partners (innovators/technical partners; capacity)

C: Checklist for Data Collection: Waste Recycling through Feed Production in Urban and Peri-urban Areas of Nairobi

1. Background information

- Name of producer/ seller
- Location of the producer/seller (District, Division etc.; mapping)
- Contacts of the producer/seller
- Historical background of the producer/seller
    - Start date for the activity
    - Ownership and acquisition of the site where feed production is done
    - Number of people involved in the activity

2. Operations of feed production activity

- How feed production process is organized; Number of people involved in the activity
- Sources of organic wastes used in feed production and how sourcing is arranged (inflows)
- Units of sales and prices of organic wastes for feed production
- Types and quality of organic wastes used for feed production; and estimated proportions
- Methods of feed production; successful and non-successful systems
- Feed fortification (if practiced); additions
- Busy months (in terms of production) in a calendar year; busy days, busy periods
- Photo documentation

3. Feed production outputs and utilisation

- Quantity of feed produced per half year period
- Types of consumers of feed (public-private linkages) and where they come from
- Potential users of feed
- Utilisation of feed produced (used on-farm; sold etc.)
- Feed production and linkages with urban and peri-urban agriculture
    - Location of feed producers/consumers in urban Nairobi and peri-urban environments
    - Animals using feed produced

4. Economics of feed production

- Labour (site preparation/pits; collection of materials; etc)
- Cost of materials for feed production
- Quantity of feed produced
- Cost of packaging materials

5. Marketing aspects of feed production

- Methods of preparing the feed for the market (packaging, labeling etc)
- Quality criteria (as perceived by consumers + producers)
- Estimates of feed producers/consumers per month (specific time period)
- Busy months (in terms of feed sales) in a calendar year
- High and low periods of feed sales
- Units of sale of feed and price per unit; willingness to buy
- Estimated sales per half year period
- Trends in feed market development (past and future prospects)
- Feed production marketing strategies; and proposed value addition recommendations

6. Constraints and Potentials for use of urban waste for feed production

- Potentials/advantages of using urban waste for feed production
- Challenges in using urban waste for feed production

7. Producer perceptions on policies affecting urban and peri-urban feed production/organic waste recycling (if any)

- Administration requirements by City Council (by-laws affecting location, operations and production and sale of feed)
- NEMA regulations known to producers/sellers (if any)

N/B: Potential sites for visits

- Organisations and institutions producing and or promoting feed
- Feed users (farmers with animal production systems)

8: Inventory and institutional mapping of feed producers/sellers

Primary and secondary data (activities and location) collection on:

- Livestock feed production installation plans/sites
- Livestock feed producers; grinders/millers; importers and dealers
- Feedlots within urban and peri-urban areas
- Promoters of livestock feed
- Livestock feed equipment dealers
- Potential implementing partners (innovators/technical partners; capacity)

APPENDIX 2: LIST OF ORGANISATIONS AND RESOURCE PERSONS CONTACTED/INTERVIEWED

15th June – 10th July 2009

Institution/Organisation	Location	Category of organisation	Person contacted	Contacts	Theme/subject area	Relevant Activities	Year of starting activity
ECOH Holdings Ltd	Urban Muhoho Avenue, South C, Nairobi	Company	Collins Mwenda	P.O. Box 4314-00506, Nairobi 20-601617 0722870071 Fax: 20 601 641 cmwenda@ecoholdings.org	• Composting	• Composting domestic waste in Athi River and environments in a bio-reactor • Packaging and selling pelletised/granulated YAD®, compost from urban waste • Packaging and selling leachates from composting process (EcoH Balance®) • Conducting research in collaboration with KARI Kabete on YAD® compost • Linkages with flower farms • Compost production and sales	• 2004
Kenya Institute of Organic Farming	Peri-urban, but operates nationally Juja	NGO	John W. Njoroge	P.O. Box 34972-00100 Nairobi 0733-799072 0733-817240 20-4183194 kiof@iconnect.co.ke	• Composting • Organic farming	• Composting (use of livestock manure; farm wastes) • Composting methods • Compost production and sales	• 1986; field programmes in 1987
Penta Flowers Ltd	Peri-urban Juja and Thika areas	Private Flower production and export Company	Tom F. Ochieng	P. O. Box 40452 - 01000 Thika. +254-67-24010	• Composting	• Vermi composting from remains of Rose flowers • Use of leachate from vermi-composting	• Vermi-composting in 2007

Institution/Organisation	Location	Category of organisation	Person contacted	Contacts	Theme/subject area	Relevant Activities	Year of starting activity
						• Sources and markets of organic fertilisers • Compost production	
Practical Action Eastern Africa (Formerly ITDG)	Urban, but operates regionally	International NGO; Consulting	Paul Chege Gerald Muriuki	P.O. Box 39493-00623 Nairobi, Kenya AAYMCA Building (2nd Floor), Along State House Crescent, Off State House Avenue 20-2713540 20-2715293 20-2719313 20-2719413 Chege: 0722-509 244 practicalaction@practicalaction.or.ke	• Sanitation and biogas production • Solid waste management (composting; recycling of paper/plastics)	• Sanitation and waste management in Nairobi/ Nakuru/ Lake Victoria Region • Biogas plant and sanitation project in Kibera • Solid waste management (recycling of paper/plastics) in Nairobi • Composting-commercial production (Mazingira compost®) in Nakuru	• Sanitation and biogas in Kibera in 2003
East African Seed Co. Ltd	Urban, but operates regionally Kijabe Street Branch	International Private Company	Sales	P.O. BOX 45125-00100 Nairobi – Kenya 020-2214941 20-2215084 info@easeed.com/ sales@easeed.com	• Sales of input • Sells Phymix organic fertiliser obtained from: Phytomedia International P.O. Box 79509 Nairobi Tel: +254-20-214013 + 254-20-246468 e-mail: phymyx@gt.co.ke	• Organic fertilisers/ compost and their prices • Inorganic fertilisers and their prices	• Started in 1972; started selling organic fertiliser in the year 2000's
Kenya Organic Agriculture Network (KOAN)	Urban ICIPE premises,	Network organisation	Eustace Kiarii	C/O Environmental Liason Centre International	• Organic faming • Marketing of organic	• Members of KOAN involved in production and	• 2004

Institution/Organisation	Location	Category of organisation	Person contacted	Contacts	Theme/subject area	Relevant Activities	Year of starting activity
	Kasarani			P.O. Box 72461, City Square 00200 Nairobi 0735-721376 0720-703501 Fax: 20-2451645 koansecretariat@elci.org	products	marketing of composting • Compost production/marketing standards and legal, policy and regulations in place	
Road Side Flower/landscaping vendors	Urban (Thika Road)	Individual entrepreneurs			• Roadside flower business	• Manure sourcing and prices • Compost use	•
District Livestock Production Offices (Kiambu and Githunguri)	Peri-urban	Public	Lucy Chege (DLPO, Githunguri) Mr. Kiarie (Kiambu) James Kariuki (Kiambu)	Tel: 066-22030 020-2127533 DLP Githunguri: +254-727- 408994	• Biogas	• Biogas production • Local livestock feed formulation	•
Kenya High Yield Farmers Foundation	Githunguri Town Nyamuthanga House 2nd Floor Peri-urban	CBO	Joseph Kimani Sebastian M. Kimani Farmer Biogas Facilitator GTZ-PSDA	P.O. Box 802-00216 Githunguri +254-725-574044	• Biogas	• EU-PSDA Biogas Promotion • Biogas production (Fixed dome digesters) • Entrepreneurs who have adopted biogas	• 2006
Kibera Community Self Help Programme (KICOSHEP)-primary school	Urban, Kibera	NGO	Manager Head teacher	P.O. Box 49531-00100 Nairobi 0723 778193 (Manager in Kibera) 0726-118378 (Head teacher in Kibira) 0722-777361 (head office, Wilson Airport) kicoshep@karibunet.com kicoshep@kenyaweb.com		No longer makes compost?? Waste are put in a garbage pit	•
Roadside Flowers/Landscaping	Urban, Ngong Road	Private entrepreneurs	Michael	+254-722-893961 (Michael)	• Flower business	• Manure sourcing and prices	•

Institution/Organisation	Location	Category of organisation	Person contacted	Contacts	Theme/subject area	Relevant Activities	Year of starting activity
						• Compost use	
Kayole Environmental Management Association (KEMA)	Urban, Kayole Estate	Association	S.N. Munywe	+254-733972719 Kayole_environmentmf@yahoo.com	• Composting • Plastic recycling	• Recycling of plastic waste • Waste collection (domestic/market) and composting	• 1999; registered in 2000
City Garbage Recyclers Self Help Group	Urban Along Nile Road (Maringo/Ofafa Jericho)	Self-Help Group	Joseph +254-712-390448 Andrew Macharia (Coordinator)	P.O. Box 78521-00507 Nairobi +254-20-6751345 +254-722-792820 mumbicgr@hotmail.com	• Composting • Urban farming	• Compost production from domestic/market waste • Urban farming (multi-storey farming) • Compost marketing (organofert®) • Plastic recycling • Production of briquette	• 1996
Divisional Agricultural Office, Westlands	Urban Westlands District Headquarters	Public	Margaret Mwaura (Div. Crops Officer) Rose Nyangwara Gladys Nalchulo (DAEO)	Margaret +254-720-571981 Rose +254-722-436809) Gladys +254-723-776690	• Composting • Urban farming	• Composting • Urban gardening	•
Kangemi High School	Urban Kangemi, Westlands District	Public	Mr. Atsola (Agricultural teacher)	Kangemi High School P.O. Box 29267-006257 asatsola@yahoo.com Atsola: +254-722-347966	• Composting • Urban farming	• Composting using cattle manure and kitchen waste • Urban gardening (vegetables and compost)	•
Pioneer technologies	Urban Giwa House, 1st Floor Next to Khoja Mosque, Moi Avenue/ Muranga Road	Private Company	Mr. Mbuthia	P.O. Box 32910-00600 Nairobi Tel: +254-722552505; 0722-498846; 0738-554641 Mbuthia: +254-712174880	• Biogas	• Biogas (tubular, fixed dome and floating drum digesters) • Promotes tubular digesters	•

Institution/Organisation	Location	Category of organisation	Person contacted	Contacts	Theme/subject area	Relevant Activities	Year of starting activity
	Junction						
Simlaw seeds	Kijabe Street, Nairobi	Private Company		P.O. Box 40042, NAIROBI Kijabe Street - Near Globe Cinema Round about Tel: +254 (20) 215066 / 67 / 83 Fax: +254 (20) 332 219 Mobile: 0722 - 200 545 E-mail: simlaw@kenyaweb.com	• Sales of input • Sells Phytomix organic fertiliser obtained from: Phytomedia International P.O. Box 79509 Nairobi Tel: +254-20-214013 + 254-20-246468 e-mail: phymyx@gt.co.ke	• Organic fertilisers/ compost and their prices • Inorganic fertilisers and their prices	•
Divisional Agricultural/livestock offices, Kasarani	Urban Kasarani District Headquarters, Kasarani	Public	Mr. Kihobe		• Biogas • Urban farming	• Livestock and biogas • Urban farming/crop farming	•
Korogocho Poverty Eradication Development Group	Urban Korogocho, Close to Chiefs Office Kasarani District	Community group (Self Help Group)	Mr. Phillip Mango (chairman)	Mango: +254-720125937	• Biogas from human waste	• Communal biogas latrines (Biocentres) ✓ Toilets and wash rooms ✓ Biogas from human excreta ✓ Water kiosks ✓ Upper rooms for cottage industry or resturants	•
Kisumu Ndogo Development Group (KNDG) and ALFA	Urban Korogocho Kasarani District	Community group (CBO)		C/O Umande Trust Olympic Estate, Kibera. P.O Box 43691-00100 Nairobi, Tel: 254-020-6751287 Email: info@umande.org	• Biogas from human waste	• Communal biogas latrines (Biocentres) ✓ Toilets and wash rooms ✓ Biogas from human excreta ✓ Water kiosks ✓ Upper rooms for cottage industry or	•

Institution/Organisation	Location	Category of organisation	Person contacted	Contacts	Theme/subject area	Relevant Activities	Year of starting activity
						restaurants	
Katwekera Tosha (= Total Sanitation Hygiene Acess)	Urban Kibera, Langata District	Community group-CBO	Anette Okumu (Group member employed at the biocentre) Daniel Ongoro (Umande Trust)	Kibera or contact through Umande Trust Olympic Estate, Kibera. P.O Box 43691-00100 Nairobi, Tel: 254-020-6751287 Email: info@umande.org	• Biogas from human waste	• Communal biogas latrines (Biocentres) ✓ Toilets and wash rooms ✓ Biogas from human excreta ✓ Water kiosks ✓ Upper rooms for cottage industry or restaurants	•
Ushirika wa Usafi Laini Saba (Water and Sanitation)	Urban Kibera Laini Saba, Behind AMREF Hospital, Langata District	Community group-CBO	Mr. Bernad Asanya	Bernad: +254-720069472 asanyabenard@yahoo.com ushirikawausafaikibera@yahoo.com	• Biogas from human waste • Solid waste management (community cooker)	• Water provision/sales • Sanitation; bio-latrines (toilets/shower) • Solid waste management • Community cooker (incinerator) • Biocentre (yet to be completed)	•
Youth Reform Self Help Group	Urban Kianda Village, Kibera, Langata District	Community group-Self Help Group	Chairman, Secretary and head of organic farming project	Kibera	• Composting • Organic farming • General solid waste management	• Composting • Organic farming • Domestic and business stalls garbage collection • Sale of water • Biolatrines (toilets + showers)	•
Vision Brothers self Help Youth Group	Urban Kianda Village, Kibera, Langata District	Community group: Self Help Group	Chairman, Secretary 3 group members	P.O. Box 8361-00100 Nairobi Chairman: +254-715-869622 Treasurer: +254-733547951	• Urban gardening using compost	• Urban vegetable gardening using compost • Irrigation using treadle pump	•
Ministry of Agriculture, EU-GTZ Biogas Promotion (GTZ-PSDA)	Urban Woodlands Road Off Lenana Road,	International cooperation enterprise	Eng. Romas Radtke Evalyne	Promotion of Private Sector Development in Agriculture (PSDA)	• Biogas	• Survey, design and installation of fixed dome digesters	•

Institution/Organisation	Location	Category of organisation	Person contacted	Contacts	Theme/subject area	Relevant Activities	Year of starting activity
	Nairobi	(public-private sector)	Kinyanjui +254-712701602	Woodlands Road, Kilimani P.O. Box 41607 01000 Nairobi T +254 20 27 31 826 F +254 20 27 31 836 M +254 714 16 34 74 E r.radtke@gtzpsda.co.ke		• Energy saving cook stoves (*jikos*) • Private sector promotion in agriculture, especially for small and medium-sized enterprises	
Keekonyoike Slaughter House	Peri-urban Kiserian Town, Magadi Road	Private Company	Mr. Peter Wanderi	Mr. Peter Wanderi +254-721-258933	• Biogas	• Biogas generation from slaughter house • Slaughter house/Abattoir	•
Roadside Flowers/Landscaping	Urban, Ngong Road, Karen	Private entrepreneurs	Individual entrepreneurs		• Flower business	• Manure sourcing and prices • Compost use	•
Kibera Public Space Project: New Nairobi Dam Community Group	Undungu Society Primary School premises, Kibera	Community group-CBO	Project Coordinator Mr. Ibrahim Maina Nyaburi	Ibrahim Maina: + 254-720588128 Ibramish@yahoo.com	• Composting for sale and urban farming • Toilet and washrooms • Biogas (construction in July '09) • Garbage collection	• Composting for sale • Sanitation (toilets and washrooms) • Biocentre (to be constructed in July 09 with technical support from Umande Trust) • HIV/AIDS awareness • Education • Advocacy • Peace and reconciliation • Basket weaving • Youth programme: Social arts for the youth (football), drug abuse awareness, vocational training • Urban farming	•
Kuku Women Group	Urban Dandora Phase I Nairobi	Community group-Self Help Group	Coordinator-Ms. Anne Wanjiku	Kuku Women Group P.O. Box 57938-00200 Nairobi	• Composting		

Institution/Organisation	Location	Category of organisation	Person contacted	Contacts	Theme/subject area	Relevant Activities	Year of starting activity
			Ms. Waturi-Treasurer Ms. Mary Wanjiku-Secretary	Group Coordinator: +254-725016926 Group Secretary: +254-721332889 Group treasurer: +254-714780030			
Mukuru cycling centre [7 sub-groups]	Urban Dandora Dumping Site, Nairobi				• Recycling of paper into Briquettes • Plastic recycling	• Waste paper recycling into briquettes • Waste paper segregation for sale • Soft and hard plastic recycling • Composting-initiated by women but later abandoned	•
Kenya Farmers Association	Urban Haile Selassie Avenue, Nairobi	Farmers Association (Private)		K GGCU Building, Gr Floor, P. O. Box 41228 Haile Selassie Avenue, Muthurwa, Nairobi, 00100, Kenya +254 20 2223741	• Input suppliers • Sale of Mijingu fertilisers	• Agricultural input supply and sales • Agricultural equipment supply	•
Kiambu Fertilisers Ltd	Wenega Lane, Off Haileselassie Avenue	Private Company		+254-20-2252428 +254-20-2210136	• Input suppliers • Sale of organic inputs (Phymix)	• Agricultural input supply and sales • Agricultural equipment supply • Sale of organic inputs (Phymix)	•
Roadside Flowers/Landscaping	Urban, Major Roads in Westlands, Kasarani, Nairobi East, Dagoretti, Athi River, Kajiado and Langata Districts	Private entrepreneurs	Individual entrepreneurs		• Flower business	• Manure sourcing and prices • Compost use	•

Institution/Organisation	Location	Category of organisation	Person contacted	Contacts	Theme/subject area	Relevant Activities	Year of starting activity
Tegemeo Scouts Youth Self Help Grop	Urban Korogocho Market Nairobi	Community-Self Help Group	Mr. James Sila Mr. David Wanaina	James: +254-721531182 David: +254-723680153	• Biogas from human waste	• Communal biogas latrines (Biocentres) ✓ Toilets and wash rooms ✓ Biogas from human excreta ✓ Upper rooms for cottage industry or restaurants-not yet operational	•
Lunga Lunga Youth Group	Urban Bio-Tower Project	Community-Youth Group	Mr. Kamweru	Kamweru: +254-710932468	• Biogas from human waste	• Communal biogas latrines (Biocentres) ✓ Toilets and wash rooms ✓ Biogas from human excreta ✓ Upper rooms for cottage industry ✓ Piping biogas to a neighbouring restaurant/small hotel	•
Renewable Energy Engineering Contractors (REECON)	Peri-Urban Juanco Centre Ngong Hills	Private Company	Ms. Amy Masila (Business Development Manager)	P.O. box 210-00208 Ngong Hills +254-20-8016612 +254-729-603858 +254-737-677448 Amy: +254-728-825688 recon@mitsuminet.com	• Biogas	• Biogas plant design and construction • Waste and waste water management	•
Divisional Agricultural Office, Ngong	Peri-Urban Ngong District Headquarters	Public	Ms. Lea (Divisional Crops Officer)	Agricultural Office, Ngong Hills	• Composting	• Composting • Crop farming	•
EM Technologies Ltd	Embu Hqs office; Runyenjes/Ena-Factory	Private Co run by a religious organisation	Mr. John Nchebere (Sales and marketing) Mrs. Murugi	P.O. Box 1365-60100 Embu, Kenya Tel/fax: +254-68-41074 Mobile +254-721-687235 embu@emteckenya.com emteckenya@gmail.com	• Composting using Effective Micro-organisms	• Training on use of EM • Compost production and sales (Mazao Bora®) • EM products sales	•
Kenya Organic Agriculture	Runyenjes/Ena	Training	Principal	P.O. Box 32-60125	• Composting	• Use of EM in	•

Institution/Organisation	Location	Category of organisation	Person contacted	Contacts	Theme/subject area	Relevant Activities	Year of starting activity
and Environmental Technologies Institute (KOAETEC)	River Bordering EM Technologies	Institution/ college		Kubukubu, Embu Tel: +254-725-301195	• Use of EM	composting • Use of EM in organic farming	
Good Shepherd Sisters	Karolina, Embu	Faith-based organisation (Catholic Organisation)	Sr. Jane Kailu	Tel. + 254-725-469790 + 254-735-285691 anampiujoan@yahoo.com	• Composting • Organic farming • Use of EM	• Composting • Use of EM	•

APPENDIX 3: EXAMPLES OF SELECTED COMPOSTING METHODS, DURATION TO MATURITY AND PRODUCTION LEVELS BY SOME ORGANISATIONS INTERVIEWED

Organisation	Composting method	Type of waste	Additives used	Reported time to maturity of compost	Product	Potential capacity (production)*	Actual production	Selling price of compost	Application rate given by producer
ECO Holdings Ltd	Controlled anaerobic composting in a bioreactor followed by aerobic composting; pellets the compost using a local pellet mill	Market and domestic waste	EM (culture with yeast)	??	Palletised/ granulated compost (YARRD®)	50 bags (50kg each) of palletised compost per day	10-15 tonnes/month [120-180 tonnes/year]	One 50kg palletised compost + 1 pack of leachate at KES 1800	YARD® basal application at 4, 50kg-bags/acre
				Leachate harvested during composting	Leachate from composting ECOH balance®)	??	??		ECOH balance®) applied as foliar feed at 2-leaf stage for maize
	Bin (container) composting (anaerobic for 2 weeks; followed by aerobic for a further 3 days	Kitchen wastes	EM (culture with yeast)	3-4 weeks	Ordinary natural/solid compost		Not sold; Trains households who in turn make their own compost		
Kenya Institute of Organic Farming (KIOF)	Shallow pit Composting (aerobic composting) (Unit of 1 ½ -2 m wide x 0.3 m deep x any length	Mix of vegetation materials; *boma* manure	Ash, egg Shells; kitchen waste	6-9 weeks	Ordinary natural/solid compost	30 tonnes compost over 3 months Produced by students	60-120 tonnes Annually	Compost used within farm; Sold compost at KES 3000 per tonne (without transport) and KES 28000 for 7-tonnes inclusive of transport	10-20 tonnes/ hectare; 0.5 to 1.0 kg per hole of 2-3 seeds of cereals; 15kg (1-bucket) in a three-metre furrow for potatoes
Kayole Environmental Management	Windrow composting (variant of open	Domestic and market waste	*Tithonia sp.* for enhancing phosphorus	6 weeks composting and 2 months	Ordinary natural/solid compost	21 tonnes over three months	84 tonnes per year	KES 20 per kg; compost packaged in	??

Organisation	Composting method	Type of waste	Additives used	Reported time to maturity of compost	Product	Potential capacity (production)*	Actual production	Selling price of compost	Application rate given by producer
Association (KEMA)*	pile composting)-aerobic composting above ground (unit of 4 m wide x 2 m high x any length)		and nitrogen content	storage-total (6-14 weeks)				units of 5-kg; 10-kg; and 50-kg bags	
					Leachate	??	??	??	
PENTA Flowers Ltd	Vermi-composting (aerobic composting); Materials are shred using a "shredder" machine and then composted.	Rose flower waste; coffee husks	Uses worms	6 months	Natural/solid compost	> 12 m^3 every 6 months	12 m^3 every 6 months OR 24 tonnes per year	Not sold; Instead the company sometimes buy "humus"	Spread in Rose Flower beds at 2g/m^2; incorporated slightly in existing flower beds
				Leachate harvested during composting	Leachate from composting	> 6500 litres per week	6500 litres per week Or 78000 litres/ per year	Not sold	Mixed with inorganic fertilisers and applied as a drip (40% leachate; 60% inorganic fertilisers); Mixture applied at 260 litres/ha
City Garbage Recyclers Self Help Group	Open pile composting (above ground)-aerobic composting (Unit of 5 ft wide x 5 ft high x any length) Compost turned after 3 weeks and again after 3 weeks	Domestic and market wastes	Uses EM	6 weeks [1 ½ months]	Natura/solid compost (OrganoFERT® Mbolea Hai)	?? Compost made continuously	??	KES 20 per kg Sold in units of 25kg-bags and 50-kg bags	??
Kangemi High School	Open pile composting (above ground)-aerobic	Farm wastes; livestock manure;	None	12 weeks (3 months)	Solid compost	> 10 wheelbarrows per unit time;	≈ 1 tonne 20	Not sold	??

Organisation	Composting method	Type of waste	Additives used	Reported time to maturity of compost	Product	Potential capacity (production)*	Actual production	Selling price of compost	Application rate given by producer
	composting	kitchen waste				made twice in a year	wheelbarrows		
Youth Reform Self Help Group	Vermi-composting On raised trays and drums; local earthworms are collected from river banks	Domestic and wastes from kiosks	Worms	4 weeks	Natural/solid compost Leachates (are collected 14-21 days from the start of composting	?? Not reported;	??	??	??
Kibera Public Space Project: New Nairobi Dam Community Group	Open pile composting (a variant)-above ground surface composting; Waste stay for 1 week in first station; shovelled to 2nd station where they stay for one week; shovelled to a third station where they stay for one week (EM added) and again shovelled to fourth station where they stay for one week and mature Bin/container composting	Domestic and market waste	EM	4 weeks	Natural/solid compost	> 1-2 pick-ups per month	20-24 tonnes annually	KES 20 per Kg Packaging done on demand	??
Kuku Women Group	Open pile composting-aerobic composting	Domestic and market waste; Dandora dumpsite	None	9 weeks	Natural/solid compost	> 10 90kg-sacks per 9 weeks	5 tonnes annually	KES 20 per Kg Packaging done on demand	??
EM Technologies	Open pile Composting-	Farm waste; All types of	EM1 (EM	4-6 weeks	Natural/solid compost	Compost made	??	KES 250 per 5kg pack	??

Organisation	Composting method	Type of waste	Additives used	Reported time to maturity of compost	Product	Potential capacity (production)*	Actual production	Selling price of compost	Application rate given by producer
Ltd.	fermentation process; Also promotes aerobic composting; Also makes Vegetation compost in-situ in a hole of 2-3 feet cube using EM 1	biodegradable waste	Composta®)		Mazao Bora® EM Fermented Plant Extract	throughout the year in response to market demand 1 litre EM Composta for 200kg compost			
Good Shepherd Sisters	Open pile composting (composting in shallow pits) -aerobic composting	Farm waste (crop waste and livestock manure)	EM 1 (EM Composta®)	9 weeks	Natural/solid compost	??	??	Do not sell; for farm use	20-25 tonnes/ha

* Was not producing compost at time of visit

Commercial product: Phytomix®

Retailers: East African Seed Co. Ltd.; Simlaw Seeds (Kenya Seed Co. Ltd); Kiambu Fertilisers Ltd.

Product type	Brand name	Quality	Description	Application rate	Frequency/comments
Natural/ solid compost	Phytomix®	Organic matter: 17-30%	Maize, mixed crops, kitchen gardens (kales), potatoes, tomatoes, cabbages	250-1000kg/acre (0.6-2.5 t/ha)	During planting
		Macro elements: N, P, K, Ca, Mg	French beans, sugar snaps, Capsicums, Okra	250-1000kg/acre (0.6-2.5 t/ha)	Once every 90 days (A handful per planting hole every 90 days)
		Micronutrients (various)	Melon, Squash, Cucumbers	250-1000kg/acre (0.6-2.5 t/ha)	Once each season
		Humic and Fulvic acids: 3.20- 8.21%	Carrots	100-180 kg/acre (0.3-0.4 t/ha)	Once every planting season
		CEC (Meq): 38-44%	Coffee, Citrus, Mangoes, Roses, pineapples	800-1200 kg/acre (2.0 -3.0 t/ha)	Once every 6 months
		pH:6.7-6.9	Arabicum, eryngium, Tuberose, Ornis	250-1000 kg/acre (0.6-2.5 t/ha)	Once during planting

APPENDIX 4: ROADSIDE NURSERIES, MANURE VENDORS AND MANURE PRICES IN NAIROBI CITY

District	Major Road	Description	Relative population of vendors	Manure source and description	Onsite manure unit of sale	On-site price per unit (KES)
Kasarani	Thika Road	Between GSU Round about and Githurai 45; Areas close to Drive-in; Areas close to Kasarani Stadium	+++	Kajiado, Kimbo 20 bags of manure in one pick-up	One 90kg-bag Cattle manure	140
					One 90kg-bag (Cattle manure)	100
Kasarani	Mwiki Road	Mwiki areas	+++	Eastern part of Nairobi; from Masai Manyattas; individual farm households keeping poutry		
Kasarani/ Nairobi East	Outer Ring Road	Along the road sites: Tumaini estates, Savannah, Avenue Park Estates, Pipeline Estate etc	+++	Eastern part of Nairobi; from Masai Manyattas; individual farm households keeping poultry	One 90kg-bag (Poultry manure)	600
Langata/Kajiado North	Ngong Road	From City Mortuary Round About to Ngong Town	+++	Masai areas: Ngong, Kajiado, Kiserian, Masai Manyattas, Other areas: Dagoretti slaughter house areas, Areas close to Lenana	7-tone lorry (cattle manure)	8000
					7-ton lorry red soil	3000-3500
					One 90kg-poultry manure	200
					One pick-up (1-2 tonnes) cattle manure	1200
Westlands	Kaptagat Road-Kangemi		+++			
Westlands	Lower Kabete Road	• Lower Kabete-Kabagare Road Junction • Lower Kabete Road close to Hill-view Estate/cross Road • Kibagare River	+++	Kajiado and other places in Masai living areas	One pick-up (Cattle manure)	1200

District	Major Road	Description	Relative population of vendors	Manure source and description	Onsite manure unit of sale	On-site price per unit (KES)
		Valley • Lower Kabete-Peponi Road Junction				
Westlands	Ngecha road	Close to junction between Ngecha Road and Getathuru Road	++	Masai areas (Kajiado, Narok)	One 90-kg sack (Cattle manure)	300
Westlands	Getathuru Road		+++	Narok	One-pick up (mixed cattle, goat and poultry manure)	1600
				Narok	One-90 kg manure (mixed cattle, goat and sheep manure)	300
Westlands	Peponi Road	Close to Peponi Rise Thigiri Ridge-Peponi Road Junction	++			
Westlands	Ringroad Parklands	Ring Road close to Nakumatt UK	+++	Narok	One pick-up (Cattle manure)	1800
				Narok	One 90-kg sack (Cattle manure)	400
Westlands	Limuru Road	Parklands Hawkers market; Area close to Gigiri/Karura Forest	+++	Mai Mahiu, Narok	One pick-up (Cattle manure)	2000
Westlands	James Gichuru Road		++		One pick-up (Cattle manure)	2000
Westlands	Gitonga Road		++			
Westlands/ Kasarani	Kiambu Road		++			
Westlands	Kingara Road	Close to Dagoretti Corner	++			
Langata	Langata Road	Close to Victor Garden Centre; Karen Primary school	+++			
Kajiado	Rongai Road	Opposite Nairobi National Park	+++			
Westlands	Mbagathi Road					
Nairobi East/Langata	Mombasa Road	Dotted spots along the road	+			

District	Major Road	Description	Relative population of vendors	Manure source and description	Onsite manure unit of sale	On-site price per unit (KES)
Athi River District	Namanga Road	Athi River close to Kitengela;	++	Kajiado District; Masai Manyatta	One pick-up (Cattle manure)	3000
Westlands	Arboretum Drive-Ring Road Junction	Inside Arboretum and surroundings	++			
Westlands	James Pritt Road	Kilimani Location	++			
	Argwings Kodhek Road	Dotted along the Road	+			
Westlands	Gitanga Road	Dotted along the Road	++			
Westlands	Olenguruone Road	Dotted along the Road	+++			

Manure sold at low price in Manyattas e.g. KES 600; but transportation costs raise manure prices; +++ = Relatively high (≥ 10); ++ = Medium; + = Low (< 5 persons)

APPENDIX 5: RETAIL PRICES OF INORGANIC FERTILIZERS-I

Basal fertilisers	**Unit**		***East African seeds***	**Price (KES)/kg**
23-23-0	50-kg bag	50	3100	62
17-17-17	50-kg bag	50	3600	72
20-20-0	50-kg bag	50	3100	62
DAP (18-46-0)	50-kg bag	50	3000	60
			Kiambu Fertilisers Ltd	
23-23-0	50kg-bag	50	2900	58
17-17-17	50kg-bag	50	2900	58
20-20-0	50kg-bag	50	2900	58
DAP (18-46-0)	50kg-bag	50	2750	55
TSP (0-46-0)	50kg-bag	50	3500	70
Top dressing			*East African seeds*	
CAN (26-0-0)	10kg-bag	10	500	50
Urea (46-0-0)	50kg-bag	50	3000	60
			Kenya Farmers Association	
CAN(26-0-0)	50kg-bag	50	2000	40
Mijingu rock phosphate (28-32% P_2O_5)	50kg-bag	50	2500	50
			Kiambu Fertilisers	
CAN (26-0-0)	50kg-bag	50	1900	38

APPENDIX 5: AVERAGE VALUES OF RETAIL PRICES OF INORGANIC FERTILISERS-II

Fertiliser description	East African seeds	Kiambu fertilisers LTD	Kenya Farmers Association	Average	N	P	K
	Price (KES/100kg)	Price (KES/100kg)	Price (KES/100 kg)	Price KES/100kg)	Price/kg	Price/kg	Price/kg
Basal fertilisers							
23-23-0	6200	5800	-	6000	130	57	0
17-17-17	7200	5800	-	6500	127	56	106
20-20-0	6200	5800	-	6000	150	66	0
DAP (18-46-0)	6000	5500	-	5800	161	28	0
TSP (0-46-0)	-	7000	-	7000	0	67	0
Mijingu Rock Phosphate (28-32% P_2O_5)			5000	5000	0	73	0
Top dressing							
CAN (26-0-0)	5000	3800	4000	4300	165	0	0
Urea (46-0-0)	6000	-	-	6000	130	0	0

APPENDIX 6: MAJOR AGRICULTURAL INPUTS AND EQUIPMENT VENDORS IN NAIROBI

A: Major Agricultural inputs suppliers in Nairobi[1]

#	Agricultural inputs/fertilisers and chemical Suppliers
1	**Acupharm Supplies Kenya** Ginger House 3rd Flr Rm317 Lagos Rd, City Centre, Nairobi P. O. Box 43848 - 00100 Nairobi GPO. Tel: +254-20-315274
2	**Agrevo East Africa Ltd** The Chancery Bldg Valley Rd, Milimani, Nairobi P. O. Box 60022 - .
3	**Agrichem And Tools Ltd** Alpha Centre Godown No 87 Mombasa Rd, Embakasi, Nairobi P. O. Box 49430 - 00100 Nairobi GPO. Tel: +254-20-820495 Mobile: +254-727531010
4	**Agriscope (Africa) Ltd** Corner Plaza 1st Flr Parklands Rd, Parklands, Nairobi P. O. Box 39647 - 00623 Parklands. Tel: +254-20-4453860
5	**Agro Chemicals Africa Ltd** Parklands, Nairobi P. O. Box 13550 - Nairobi. Tel: +254-20-3743546
6	**Agro Shamba Services Ltd** Nyota Bldg 2nd Flr Accra Rd, City Centre, Nairobi P. O. Box 7164 - Nairobi.
7	**Agro-Inputs Ltd** Kenbanco Hse 2nd Flr, City Centre, Nairobi P. O. Box 55917 - 00200 City Square. Tel: +254-20-2242218 Fax: +254-20-2242218
8	**Agrochemical Association Of Kenya** Cooper Centre Kaptagat Rd, Kabete, Nairobi P. O. Box 13809 - 00800 Westlands. Tel: +254-20-4184966 Fax: +254-20-4181213
9	**Agrorganics Ltd** Embakasi, Nairobi P. O. Box 67219 - 00200 City Square.
10	**Amiran (K) Ltd** North Airport Rd, Embakasi, Nairobi P. O. Box 30327 - 00100 Nairobi GPO. Tel: +254-20-824840 Fax: +254-20-824856 Mobile: +254-733660001
11	**Anagro (K) Ltd** Murang'a Rd, Eastleigh, Nairobi P. O. Box 7339 - 00300 Ronald Ngala St. Tel: +254-20-317817 Mobile: +254-722802532
12	**Aniplant Services Ltd** Old East Bldg 1st Flr Tom Mboya St, City Centre, Nairobi P. O. Box 67922 - 00200 City Square. Tel: +254-20-2246015

13	**Arysta LifeScience Kenya Ltd** Wood Ave Court, Wood Ave, Off Argwings Kodhek Rd, Milimani, Nairobi P. O. Box 30335 - 00100 Nairobi GPO. Tel: +254-20-3873247 Fax: +254-20-3876165 Mobile: +254-722820752
14	**Aventis CropScience Kenya Ltd** Lion Place Waiyaki Way, Westlands, Nairobi P. O. Box 30438 - 00100 Nairobi GPO.
15	**Bayer East Africa Ltd** Outering Rd, Karen, Nairobi P. O. Box 30321 - 00100 Nairobi GPO. Tel: +254-20-8560667 Fax: +254-20-8561636 Mobile: +254-722427137
16	**Benken Agencies (K) Ltd** Kariobangi Light Industries Kamunde Rd off Outering Rd, Kariobangi, Nairobi P. O. Box 11566 - 00400 Tom Mboya St. Tel: +254-20-788054
17	**Brolands Co** Park Rd, Parklands, Nairobi P. O. Box 51570 - 00600 Ngara Rd. Tel: +254-20-6764419
18	**Cape Suppliers Ltd** New Rehema Hse 1st Flr, Westlands, Nairobi P. O. Box 61958 - 00200 City Square. Tel: +254-20-4451319
19	**Chemtura (PTY) Ltd** Plaza 20002nd Mombasa Rd, Industrial Area, Nairobi P. O. Box 3273 - 00506 Nyayo Stadium. Tel: +254-20-650559 Fax: +254-20-2073324
20	**City Farming Ltd** Nanyuki Rd, City Centre, Nairobi P. O. Box 3633 - 00200 City Square. Tel: +254-20-551462 Fax: +254-20-551480 Mobile: +254-722565609
21	**Cyanamid Transnational Corporation** Shell & BP Hse 3rd Flr, Harambee Ave, City Centre, Nairobi P. O. Box 47341 - Nairobi.
22	**Dama Agro Agencies** City Centre, Nairobi P. O. Box 61632 - 00200 City Square.
23	**Dera Chemical Industries (K) Ltd** Lusaka Cls/Pemba St, Industrial Area, Nairobi P. O. Box 45145 - 00100 Nairobi GPO. Tel: +254-20-558702
24	**Dilon Kenya Ltd** Asili Co-op Hse Rm 118 Moi Ave, City Centre, Nairobi P. O. Box 38217 - 00100 Nairobi GPO. Tel: +254-20-2247145
25	**Dipchem Ltd** Mang HotelGr Race Course Rd, City Centre, Nairobi P. O. Box 49830 - 00100 Nairobi GPO. Tel: +254-20-312892 Fax: +254-20-2216213

26	**East Afro Agrostock Ltd** State Hse Cre, Milimani, Nairobi P. O. Box 55517 - 00202 Kenyatta Hospital. Tel: +254-20-2716583
27	East African Seeds Co. Ltd Kijabe Street P.O. BOX 45125-00100 Nairobi – Kenya 020-2214941 20-2215084 info@easeed.com/sales@easeed.com
28	**Elgon Chemicals Ltd** Off Mombasa Rd, Industrial Area, Nairobi P. O. Box 46826 - 00100 Nairobi GPO. Tel: +254-20-533793
29	**Farmchem Ltd** Wundanyi Rd Off Lunga Lunga Rd, Industrial Area, Nairobi P. O. Box 18407 - 00500 Enterprise Rd Nairobi. Tel: +254-20-552711 Fax: +254-20-551207 Mobile: +254-722520837, 0733520837
30	**F M C International A G** Trans-National Plaza 9th Flr Mama Ngina St, City Centre, Nairobi P. O. Box 46179 - 00100 Nairobi GPO. Tel: +254-20-2229180 Fax: +254-20-2229409
31	**Farmers Guide** Landhies Rd, City Centre, Nairobi P. O. Box 41717 - 00100 Nairobi GPO. Tel: +254-20-2245097
32	**Fedo Agencies** North Airport Rd Behind Transami, Embakasi, Nairobi P. O. Box 1977 - 00200 City Square. Tel: +254-20-825461 Mobile: +254-720837271
33	**Geitwa Supplies Co** Haile Selassie Ave, City Centre, Nairobi P. O. Box 30666 - 00100 Nairobi GPO.
34	**Gilzak Enterprises** Uthiru Shopping Centre, Uthiru, Nairobi P. O. Box 8659 - 00300 Ronald Ngala St.
35	**Henchem Ltd** Nacico Co-Op Plaza Gr Flr Landhies Rd, City Centre, Nairobi P. O. Box 14690 - 00100 Nairobi GPO. Tel: +254-20-316744 Fax: +254-20-2240455
36	**Huplan (K) Ltd** Mago Hse Gr Flr, Gaberone Rd, City Centre, Nairobi P. O. Box 51958 - 00200 City Square. Tel: +254-20-343119
37	**Interchem Co Ltd** Chania Bldg Kamae Ln Off Luthuli Rd, City Centre, Nairobi P. O. Box 28054 - 00200 City Square. Tel: +254-20-2230013

38	**Juanco Group of Companies** Juanco Centre Ngong Rd, Jamuhuri, Nairobi P. O. Box 381 - 00502 Karen. Tel: +254-20-2048774
39	**Jumbo Agrovet** Mang' Hse Haile Selassie Ave, City Centre, Nairobi P. O. Box 54190 - 00200 City Square. Tel: +254-20-2221848
40	**Kamro Agrovet Ltd** Gill Hse Gr Flr, Tom Mboya St, City Centre, Nairobi P. O. Box 6892 - 00300 Ronald Ngala St. Tel: +254-20-341870 Fax: +254-20-2213809 Mobile: +254-722776902
41	**Kenya Farmers Association Ltd** K.GGCU Bldg Gr Flr Haile Selassie Ave, City Centre, Nairobi P. O. Box 41228 - 00100 Nairobi GPO. Tel: +254-20-2223741
42	**Kiambu Fertilizers Co Ltd** Weruga Ln off Haile Selassie Ave, City Centre, Nairobi P. O. Box 18181 - 00500 Enterprise Rd. Tel: +254-20-2252428 Fax: +254-20-2252428
43	**Lachlan Kenya Ltd** Old Airport Rd, Off Mombasa Rd, Nairobi P. O. Box 49470 - 00100 GPO Nairobi. Tel: +254-20-2073912 Fax: +254-20-2060260 Mobile: +254-722209474 +254-202073914
44	**Larichem (E A) Ltd** Kijabe St Off Globe Cinema Roundabout, City Centre, Nairobi P. O. Box 78657 - Nairobi. Tel: +254-20-2245884 Fax: +254-20-313260
45	**Lawre Plants Line Services Ltd** Cross Ln, City Centre, Nairobi P. O. Box 75648 - 00100 Nairobi GPO.
46	**Mbaki Agric Inputs Distributors Ltd** AACC Bldg 1st Flr Waiyaki Way, Westlands, Nairobi P. O. Box 39389 - 00623 Parklands. Tel: +254-20-4444639 Fax: +254-20-4444635
47	**Misk Investment Ltd** Enterprise Bldg 5th Flr Enterprise Rd, Industrial Area, Nairobi P. O. Box 54166 - 00200 City Square. Tel: +254-20-551634
48	**Monsanto Kenya Ltd** Tuskys Head Office Complex Mombasa Rd, Embakasi, Nairobi P. O. Box 47686 - 00100 Nairobi GPO.
49	**Murimi Munini Stores** Next to Ukwala Supermarket, City Centre, Nairobi P. O. Box 53976 - 00100 Nairobi GPO.
50	**Murphy Chemicals (E A) Ltd** Baba Dogo Rd, Ruaraka, Kahawa, Nairobi P. O. Box 20495 - 00200 City Square. Tel: +254-20-8564979 Fax: +254-20-8562199 Mobile: +254-722570768

51	**Nikifarm Care E A Ltd** City Centre, Nairobi P. O. Box 63588 - 00619 Muthaiga. Tel: +254-20-2213003 Fax: +254-20-2215581
52	**Nova Industries Ltd** Likoni Rd Ind Area, Industrial Area, Nairobi P. O. Box 18510 - 00500 Enterprise Rd. Tel: +254-20-555399 Fax: +254-20-555858
53	**Nyutu Agrovet Ltd** Nacico PlazaGr Landhies Rd, City Centre, Nairobi P. O. Box 18360 - 00500 Enterprise Rd. Tel: +254-20-312567 Fax: +254-20-312567 Mobile: +254-722788413
54	**Organix Ltd** Musembe Rd, Parklands, Nairobi P. O. Box 14494 - 00800 Westlands. Tel: +254-20-3741482 Fax: +254-20-3742605
55	**Orion East Africa Ltd** Orion Drv/Outering Rd, Kariobangi, Nairobi P. O. Box 8422 - 00300 Ronald Ngala St. Tel: +254-20-785414
56	**Planvet Agro Chemicals** Cross Rd Near Crossland Travellers, City Centre, Nairobi P. O. Box 50874 - 00200 City Square. Tel: +254-20-2213863 Mobile: +254-733701907
57	**Pro-Phyto** NSSF Bldg 11th Flr Block 'A' Eastern Wing, Milimani, Nairobi P. O. Box 13980 - 00800 Westlands. Tel: +254-20-2716141 Fax: +254-20-2724072
58	**Rockem Ltd** Railway GodownShed No 2 Haile Selasse Ave, City Centre, Nairobi P. O. Box 47090 - 00100 Nairobi GPO. Tel: +254-20-343472 Fax: +254-20-344084 Mobile: +254-733807480
59	**Roret Agrovet Stores** Ngoiwa Rd Sotik, Western, Sotik P. O. Box 169 - 20406 Sotik. Tel: +254-52-54213
60	**Safina (E A) Ltd** Wakulima Hse Gr Flr Haile Selassie Ave, City Centre, Nairobi P. O. Box 8354 - 00200 City Square. Tel: +254-20-2210417 Fax: +254-20-2224147
61	**Saroc Ltd** Lusaka Rd, Industrial Area, Nairobi P. O. Box 18228 - 00500 Enterprise Rd. Tel: +254-20-557383
62	**Shamba Agrovet** Eastleigh, Nairobi P. O. Box 56095 - 00200 City Square. Tel: +254-20-6767792

63	Simlaw seeds P.O. Box 40042, NAIROBI Kijabe Street - Near Globe Cinema Round about Tel: +254 (20) 215066 / 67 / 83 Fax: +254 (20) 332 219 Mobile: 0722 - 200 545 E-mail: simlaw@kenyaweb.com
64	**Sisbro Co** Kariobangi Light Industries Komarock Rd, Kariobangi, Nairobi P. O. Box 69518 - 00400 Tom Mboya St. Tel: +254-20-785009
65	**Syngenta East Africa Ltd** Mogadishu Rd off Lunga Lunga Rd, Industrial Area, Nairobi P. O. Box 30393 - 00100 Nairobi GPO. Tel: +254-20-532750 Fax: +254-20-532753 Mobile: +254-722205117
66	**Timau Agro Industries Limited** Milimani, Nairobi Tel: +254-20-2720635
67	**Topscore Chemicals (K) Ltd** Libra Hse Mombasa Rd, Industrial Area, Nairobi P. O. Box 56301 - 00100 Nairobi GPO.
68	**Trans - Pacific Investments Co** Mabuli Hse 1st Flr Muhoho Ave, Nairobi West, Nairobi P. O. Box 42622 - 00100 Nairobi GPO. Tel: +254-20-603872 Mobile: +254-722523475
69	**Unga Farm Care (E A) Ltd** Dakar Rd, Industrial Area, Nairobi P. O. Box 41788 - 00100 Nairobi GPO.
70	**Vefa Agro Supplies** Duruma Rd, City Centre, Nairobi P. O. Box 28195 - 00200 City Square. Tel: +254-20-2240919

Source: Nairobi Directory 2009, Kenya Postel Directories Ltd, Nairobi; ETC EA, 2006: KAPP Report;
[1]Business entities sell different types of inputs including equipment

B: Major Agricultural Equipment Suppliers in Nairobi[1]

	Agricultural Equipment Suppliers
1	**Agri Appliances** City Centre, Nairobi P. O. Box 20030 Nairobi
2	**Agri Kenya Ltd** Jabavu Rd, Milimani, Nairobi P. O. Box 61515 - 00200 City Square
3	**Agricraft Kenya Ltd** Kamba Bus Bldg Kitui Rd, Industrial Area, Nairobi P. O. Box 46627 - 00100 Nairobi GPO.
4	**Agriquip Agencies (E A) Ltd** Lusaka Rd, Industrial Area, Nairobi P. O. Box 30612 - 00100 Nairobi GPO. Tel: +254-20-535710
5	**Al Rabihal Agricultural Industries Ltd** Athi River, Eastern, Athi River P. O. Box 41008 - 00100 Nairobi GPO
6	**Bala Singh & Daya Singh Co Ltd** Dunga Rd, Industrial Area, Nairobi P. O. Box 46104 - 00100 Nairobi GPO.
7	**China National Complete Plant** Chania Bldg 5 Chania Ave, Jamuhuri, Nairobi P. O. Box 47030 Nairobi
8	**Cimbria East Africa Ltd** 10 Muiri Ln off Langata Rd, Lang'ata, Nairobi P. O. Box 24580 - 00502 Karen. Tel: +254-20-890476 Fax: +254-20-891249 Mobile: +254-733557137
9	Agrochemical Association of Kenya Coopers Centre Waiyaki Way, Kabete, Nairobi P. O. Box 66437 - 00800 Westlands
10	**Citizens Network For Foreign Affairs** Ojijo Plaza3rd Ojijo Rd, Parklands, Nairobi P. O. Box 14184 - 00800 Westlands. Tel: +254-20-3740268 Fax: +254-20-3740343
11	**Danpet Agricultural Suppliers** Off Enterprise Rd, Industrial Area, Nairobi P. O. Box 28597 - 00200 City Square.
12	**Duka La Wakulima** Lunga Lunga, Mombasa, Lunga Lunga P. O. Box 69 - Lunga Lunga.
13	**Elite Tools Ltd** Pemba Rd off Lusaka Rd, Industrial Area, Nairobi P. O. Box 64466 - 00620 Mobil Plaza. Tel: +254-20-557870 Fax: +254-20-557424
14	**Farm Engineering Industries Ltd** Enterprise Rd, Industrial Area, Nairobi P. O. Box 19030 - 00500 Enterprise Rd. Tel: +254-20-535745 Fax: +254-20-536604 Mobile: +254-733638709

15	**Farm Input Promotions Africa Ltd** Arboretum Drive, Milimani, Nairobi P. O. Box 5646 - 00200 City Square. Tel: +254-20-2730700
16	**Flying Horse Ltd** Chuka Rd off Dar-Es-Salaam Rd, Industrial Area, Nairobi P. O. Box 16567 - 00620 Mobil Plaza. Tel: +254-20-555814 Fax: +254-20-555867
17	**FMD East Africa** Bunyala Rd, City Centre, Nairobi P. O. Box 18346 - 00500 Enterprise Rd. Tel: +254-20-2216657 Fax: +254-20-2217096 Mobile: +254-722207848
18	**Glory Agricultural Supplies Ltd** Mang Hotel Bldg Gr Flr Haile Selassie Ave, City Centre, Nairobi P. O. Box 56399 - 00200 City Square. Tel: +254-20-2244460
19	**Graham Agricultural Distributors Ltd** KNCC Godown No 1, Yarrow Rd Off Nanyuki Rd, Nairobi West, Nairobi P. O. Box 10741 - 00100 Nairobi GPO. Tel: +254-20-651218
20	**Growth Tech Ltd** Libra Hse Mombasa Rd, Industrial Area, Nairobi P. O. Box 28833 - Nairobi. Tel: +254-20-828026
21	**Hardi Kenya Ltd** Ruaraka, Nairobi P. O. Box 47409 - 00100 Nairobi GPO. Tel: +254-20-8562098 Fax: +254-20-8561410 Mobile: +254-720715826
22	**Hill Barrett & Co Ltd** Mobil Plaza 1st Flr Muthaiga Rd, Parklands, Nairobi P. O. Box 63333 - 00100 Nairobi GPO. Tel: +254-20-3748266 Fax: +254-20-3740820
23	**Holman Brothers (E A) Ltd** Bunyala/Dunga Rd, Industrial Area, Nairobi P. O. Box 42044 - 00100 Nairobi GPO.
24	**Hurlingham Lawn Mower Services** Pan Africa Insurance Bldg Argwings Kodhek Rd, Milimani, Nairobi P. O. Box 22206 - 00400 Tom Mboya St.
25	**Interspar Ltd** Next to Sheth Agencies Kirinyaga Rd, City Centre, Nairobi P. O. Box 2452 - 00100 Nairobi GPO. Tel: +254-20-2224759 Fax: +254-20-2224759 Mobile: +254-725870023
26	**Jagdish C A Patel** Kombo Munyiri Rd, Eastleigh, Nairobi P. O. Box 42440 - 00100 Nairobi GPO.
27	**Jasho One Investments Ltd** NHC Hse 1st Flr, City Centre, Nairobi P. O. Box 58447 - 00200 City Square. Tel: +254-20-2228363

28	**Kandia Fresh Produce Suppliers Ltd** Avenue Park Phase 1, Outering Rd, Embakasi, Nairobi P. O. Box 42806 - 00100 Nairobi GPO. Tel: +254-20-821356 Fax: +254-20-821357
29	**Kenya Farmers Association Ltd** K.GGCU Bldg Gr Flr Haile Selassie Ave, City Centre, Nairobi P. O. Box 41228 - 00100 Nairobi GPO. Tel: +254-20-2223741
30	**Kijabe Farm Machinery Services** Accra/River Rd, City Centre, Nairobi P. O. Box 14455 - 00100 Nairobi GPO. Tel: +254-20-316995
31	**Kimaara Industries Ltd** KNTC Godown No 10 Runyenjes Rd off Nanyuki Rd Ind Area, Industrial Area, Nairobi P. O. Box 47568 - 00100 Nairobi GPO. Tel: +254-20-552450 Fax: +254-20-555648
32	**Lagum Distributors Ltd** Weruga Lane off Haile Selassie Ave, City Centre, Nairobi P. O. Box 48813 - 00100 Nairobi GPO. Tel: +254-20-2210630
33	**Land Mawe Ltd** Factory St, Industrial Area, Nairobi P. O. Box 40589 - 00100 Nairobi GPO.
34	**Lima Ltd** Nanyuki Rd, Industrial Area, Nairobi P. O. Box 18346 - .
35	**Lolli & Co Ltd** Outering Rd Next to Hardi Kenya, Kahawa, Nairobi P. O. Box 63514 - 00619 Muthaiga. Tel: +254-20-8563035
36	**Maua Agritech Ltd** Parklands, Nairobi P. O. Box 1464 - 00606 Sarit Centre. Tel: +254-20-6751149
37	**Nakuru Equipment Supplies Ltd** Dar-Es-Salaam Rd, Off Enterprise Rd, Industrial Area, Nairobi P. O. Box 18636 - 00500 Enterprise Rd. Tel: +254-20-553409
38	**Nyagah Mechanical Engineers Ltd** Kariobangi Light Industries Outer Ring Rd, Kariobangi, Nairobi P. O. Box 61972 - 00200 City Square. Tel: +254-20-789386
39	**Sametract (Cassini & Tonolo) Ltd** Bamburi Rd, Industrial Area, Nairobi P. O. Box 14325 - 00800 Westlands. Tel: +254-20-533081 Fax: +254-20-551475 Mobile: +254-733724611
40	**Sasco Products E A Ltd** Mansion Bldg Biashara St, City Centre, Nairobi P. O. Box 60414 - 00200 City Square.
41	**Shamba Agrovet** Kombo Munyiri Rd, Eastleigh, Nairobi P. O. Box 56095 - 00200 City Square. Tel: +254-20-6762537

42	**Sihra Engineering Works Ltd** Lunga Lunga Rd, Industrial Area, Nairobi P. O. Box 16074 - Nairobi. Tel: +254-20-553076
43	**Steel Form Ltd** Nanyuki Rd, Industrial Area, Nairobi P. O. Box 18537 - 00500 Enterprise Rd.
44	**Techno Enterprise (K) Ltd** Industrial Area, Nairobi P. O. Box 44303 - 00100 Nairobi GPO. Tel: +254-20-536445
45	**Toro Agencies** Mango Hse Gaberone Ln/Luthuli Ave, City Centre, Nairobi P. O. Box 67196 - 00200 City Square.
46	**Tui Agricultural Engineers Ltd** Butere Rd Ind Area, Industrial Area, Nairobi P. O. Box 40270 - 00500 Enterprise Rd. Tel: +254-20-555403
47	**Vegpro (K) Ltd** Cargo Centre, Embakasi, Nairobi P. O. Box 32931 - 00600 Ngara Rd. Tel: +254-20-822831 Fax: +254-20-822731
48	**Venus Industries Ltd** Lusingeti/Likoni Rd, Industrial Area, Nairobi P. O. Box 78124 - 00100 Nairobi GPO.
49	**Victory Agrovet & Gen Ltd** Keruga Ln off Haile Selassie Ave, City Centre, Nairobi P. O. Box 74588 - 00200 City Square.

Source: Nairobi Directory 2009, Kenya Postel Directories Ltd, Nairobi; ETC EA, 2006: KAPP Report;
[1]Business entities sell different types of inputs including equipment

APPENDIX 7: ROADSIDE NURSERIES, MANURE VENDORS AND MANURE PRICES IN NAIROBI

District	Major Road	Description	Relative population of vendors	Manure source and description	Onsite manure unit of sale	On-site price per unit (KES)
Kasarani	Thika Road	Between GSU Round about and Githurai 45; Areas close to Drive-in; Areas close to Kasarani Stadium	+++	Kajiado, Kimbo 20 bags of manure in one pick-up	One 90kg-bag Cattle manure	140
					One 90kg-bag (Cattle manure)	100
Kasarani	Mwiki Road	Mwiki areas	+++	Eastern part of Nairobi; from Masai Manyattas; individual farm households keeping poutry		
Kasarani/ Nairobi East	Outer Ring Road	Along the road sites: Tumaini estates, Savannah, Avenue Park Estates, Pipeline Estate etc	+++	Eastern part of Nairobi; from Masai Manyattas; individual farm households keeping poultry	One 90kg-bag (Poultry manure)	600
Langata/Kajiado North	Ngong Road	From City Mortuary Round About to Ngong Town	+++	Masai areas: Ngong, Kajiado, Kiserian, Masai Manyattas, Other areas: Dagoretti slaughter house areas, Areas close to Lenana	7-tone lorry (cattle manure)	8000
					7-ton lorry red soil	3000-3500
					One 90kg-poultry manure	200
					One pick-up (1-2 tonnes) cattle manure	1200
Westlands	Kaptagat Road-Kangemi		+++			
Westlands	Lower Kabete Road	• Lower Kabete-Kabagare Road Junction • Lower Kabete Road close to Hill-view Estate/cross Road • Kibagare River	+++	Kajiado and other places in Masai living areas	One pick-up (Cattle manure)	1200

District	Major Road	Description	Relative population of vendors	Manure source and description	Onsite manure unit of sale	On-site price per unit (KES)
		Valley • Lower Kabete-Peponi Road Junction				
Westlands	Ngecha road	Close to junction between Ngecha Road and Getathuru Road	++	Masai areas (Kajiado, Narok)	One 90-kg sack (Cattle manure)	300
Westlands	Getathuru Road		+++	Narok	One-pick up (mixed cattle, goat and poultry manure)	1600
				Narok	One-90 kg manure (mixed cattle, goat and sheep manure)	300
Westlands	Peponi Road	Close to Peponi Rise Thigiri Ridge-Peponi Road Junction	++			
Westlands	Ringroad Parklands	Ring Road close to Nakumatt UK	+++	Narok	One pick-up (Cattle manure)	1800
				Narok	One 90-kg sack (Cattle manure)	400
Westlands	Limuru Road	Parklands Hawkers market; Area close to Gigiri/Karura Forest	+++	Mai Mahiu, Narok	One pick-up (Cattle manure)	2000
Westlands	James Gichuru Road		++		One pick-up (Cattle manure)	2000
Westlands	Gitonga Road		++			
Westlands/ Kasarani	Kiambu Road		++			
Westlands	Kingara Road	Close to Dagoretti Corner	++			
Langata	Langata Road	Close to Victor Garden Centre; Karen Primary school	+++			
Kajiado	Rongai Road	Opposite Nairobi National Park	+++			
Westlands	Mbagathi Road					
Nairobi East/Langata	Mombasa Road	Dotted spots along the road	+			

District	Major Road	Description	Relative population of vendors	Manure source and description	Onsite manure unit of sale	On-site price per unit (KES)
Athi River District	Namanga Road	Athi River close to Kitengela;	++	Kajiado District; Masai Manyatta	One pick-up (Cattle manure)	3000
Westlands	Arboretum Drive-Ring Road Junction	Inside Arboretum and surroundings	++			
Westlands	James Pritt Road	Kilimani Location	++			
	Argwings Kodhek Road	Dotted along the Road	+			
Westlands	Gitanga Road	Dotted along the Road	++			
Westlands	Olenguruone Road	Dotted along the Road	+++			

Manure sold at low price in Manyattas e.g. KES 600; but transportation costs raise manure prices; +++ = Relatively high (≥ 10); ++ = Medium; + = Low (< 5 persons)

APPENDIX 8: COMMUNITY GROUPS GENERATING BIOGAS FROM HUMAN WASTE UNDER WATER AND SANITATION PROGRAMS VISITED DURING THE STUDY

Description	Korogocho Poverty Eradication Development Group	Kisumu Ndogo Development Group (KNDG) and ALFA	Katwekera Tosha (Katwekera Total Sanitation Hygiene Access)
Location	Korogocho, Nairobi	Korogocho, Nairobi	Kibera, Nairobi
Type of organisation	CBO	CBO	CBO
No. of members	30	Two groups (≈50)	Has 150 members drawn from 5 Self Help Groups
Year started	2009	Registered 2002	Started in 2007 and registered in 2008
Status	Under construction (90% complete)	Complete and operational	Complete with waste retaining and treatment tank
Group organisation	Run by a central committee with elected officials	Run by a central committee with elected officials	The CBO has a governing Council (Executive Committee) and four sub- Committees: Business management, Procurement, Tendering and Works. Membership to sub-committees and Governing Council is drawn from the various self help groups through regular elections Has employed workers (drawn from her membership) to run the facility
Donors	GOAL (Ireland??)	• African Evangelistic Enterprise • CONCERN International (2005) • GOAL Kenya (2009)	Land for construction obtained from the Provincial Administration
Technical aid/constructor	Umande Trust	Umande Trust	Umande Trust
Activities of the biocentre	Activities planned include: • Toilet facilities at a fee • Bathrooms at a fee • Biogas generation (potential to supply within 500m radius)	• Has an office in the biocentre • Toilet facilities at a fee • Bathrooms at a fee • Biogas generation • Cleaning estate corridors/ sanitation • Awareness creation on sanitation facilities	• Has an office in the biocentre • Toilet facilities at a fee • Bathrooms at a fee • Runs a business centre integrated in the biocentre • Biogas generation • Awareness creation on proper sanitation and on HIV/AIDS
Status of biogas production and use	• Fixed dome digester under construction	• Biogas generated is not currently being used • Planning to use biogas in business centre which is part of the biocentre	• Biogas generated is used to heat water in the bathrooms, running a rented hotel/kiosk • Not currently being used for cooking • Planning to use biogas in business centre which is part of the biocentre

Income generation activities		• Sells water at KES 15 per 20-litre bucket • Charges public at KES 2 per head for using toilet facilities	• Has rented the biocentre offices to a Youth group at a cost of KES 3500 per month • Has rented a hotel to an entrepreneur • Generates money from the Social Hall, which is part of the biocentre • Charges bathrooms at KES 10 per head • Charges toilet use at KES 2 per adult and KES 1 per child • Income generated used for maintaining the facility, payment of employed workers and paying out dividends to each member annually
Challenges faced	N/A	• Inadequate funds to equip the business centre already built in the biocentre • Piping the biogas requires some finances • Water supply to the biocentre is not constant	• Low awareness/under use of the facility • Facility not fully utilised

APPENDIX 8 CTD.

Description	Ushirika wa Usafi Kibera Laini Saba	New Nairobi Dam Community Group	Tegemeo Scouts Youth
Location	Kibera, Nairobi	Kibera, Nairobi	Korogocho
Type of organisation	CBO	CBO	SHG
No. of members	300 drawn from Laini Saba	150 (50 youth; 50 women weavers; and 50 compost making sub-group)	27 with 17 active
Year started	???	2006	Composting group registered in 2001; New registration made in 2008 as "Tegemeo Scouts Youth"
Status	Complete biolatrine	In the pipeline; approvals made for construction to begin in second half year 2009	Biocentre is complete and operational; however drying bed for digestate is yet to be constructed; Operations began in January 2009
Group organisation	The group is run by elected Board of 17 members meeting monthly while AGMs are held every 3 months. The group has a Project Clerk that oversees the operations of the Group and has 12 employed staff comprising water attendants, toilet attendants, Watchman for biolatrine and School teachers; Six other people have been employed as Cooker operators. The employed staff meets every Friday with Project Clerk	Structured leadership comprising a Council (Executive committee), Project Coordinator (the CEO) and programme managers in charge of various activities undertaken by the CBO (Composting, weaving, training etc).	The group has elected executive committee. The Committee meets every Friday while every Mondays there is an AGM
Donors	Maji na Ufanisi; UNDP, NCPDA and Planning Systems Ltd sponsored incinerator.	??? Government allocated land to CBO through Provincial Administration	French Development Agency
Technical aid/constructor	Umande Trust constructed Biolatrines	Umande Trust	Umande Trust
Activities of the biocentre	• Group has 8 water storage tanks (Areas 1-4) and sells water at KES 2 per 20litre • Group operates 2 sanitation Blocks (Area 1- pit latrine Area 4- biolatrine) with one black generating biogas • Operates a community Cooker (Incinerator) located in Area 1	• Sanitation (toilet/biogas; garbage collection) • HIV/AIDS awareness creation • Education on environmental issues; • Advocacy, peace and reconciliation • Basket weaving from water hyacinth	• Runs a biocentre with toilets and bathrooms for income generation • Runs piggery • Are involved in composting using EM; though due to market problems, production has been temporarily discontinued awaiting new strategy. • The composting group was

		• Youth activities (football; drug abuse awareness; vocational • training) • Farming (to be started) • The biocentre will have the following components: ✓ Toilets ✓ Bathrooms ✓ Office space ✓ Hotel and kitchen ✓ Sports and DSTV watching at a fee ✓ Computer training room ✓ Saloon room ✓ Recreation area • Surplus biogas will be distributed to neighbours	registered in 2001.
Status of biogas production and use	Biogas generated is used for cooking for pupils in a nursery school	The Biolatrine construction is yet to begin	• The Biogas generated from the biocentre is piped into a kitchen with a biogas burner, but has not been commercialized for income generation • Plans to use the biogas to operate a kiosk/hotel in one of the rooms in the biocentre • Plans to pipe excess biogas to neighbours in the future and to build digestate drying bed
Income generation activities	• Charges KES 3 per head for toilet use • Charges KES 5 per head for bathrooms inclusive of soap • Generates money from a social hall • Has six rental rooms for income generation • Generates money from running the incinerator • Income generated is used for paying allowances for employed staff, allowances during board and other meetings as stipulated in the	• Sales of compost • Basket weaving • Sanitation (toilets) and garbage collection • Donor funding for different activities e.g. for peace and reconciliation activities	• Generates income from toilet facilities • Generates income from bathroom facilities

	group's constitution, maintaining facilities and giving dividends to members at the end of the financial year		
Challenges faced	• High cost of exhausting the biolatrine as the facility has no retention tank or other means of disposing the sludge/digestate • Maintenance of toilet operations has been a challenge as some of the employed staff are not genuine • Some of the bathroom showers have been vandalized • Existence of water cartel that makes the group not to have water at all times		• The drying bed for digestate has not been built due to financial constraints • Water to the biocentre is intermittent

APPENDIX 8 CTD.

Description	Lunga Lunga Youth Group (Bio-tower Project)
Location	Mukuru-Lunga Lunga
Type of organisation	Youth Group
No. of members	120
Year started	2006
Status	Registered Youth Group
Group organisation	Group is run by a committee of 8 people; there are sub-committees
Donors	Land acquired through the Councillor and Provincial Administration
Technical aid/constructor	Umande Trust; Members provided labour on volunteer basis during construction
Activities of the biocentre	• Toilet facilities • Bathroom facilities • Biogas generation • Business centre • Plans to start organic farming
Status of biogas production and use	• Biogas produced is piped into one neighbouring Hotel on a pilot basis; used for cooking; four other hotes/kiosks are requesting to be connected • Demand for biogas is high with neighbouring hotels/kiosks making request
Income generation activities	• Levies on toilet facilities; KES 2 per head; About 15-200 use the toilet facilities daily • Plans to use the business centre room for generating income e.g. video shows
Challenges faced	• There is some biogas leakage from the digester-requires repairs • Toilet doors need to be put in place in some of the toilets • Inadequate funds to operationalise the business centre on commercial basis

APPENDIX 9: LIVESTOCK FEED PRODUCERS (MILLERS) IN THE URBAN AND PERI-URBAN AREAS OF NAIROBI

Region	Name	District	Town	Postal Address	E-mail Address	Land line	Contact person	Year started
Greater Kiambu	Tosha Products (K) Ltd	Kiambu	Kikuyu	P.O. Box 540 -00902 Kikuyu	tosha.feeds@gmail.com	(020) 3587252/ 2416755 (0)722 991 722	Alex Kamau	2004
	Lima Feeds Ltd	Kiambu West	Ngecha	P.O. Box 291-0218 Ngecha	limafeeds@yahoo.com	(020) 2063556 (0)722 639 078	Charles Githuka Ngugi	2004
	Ngenia Feeds Ltd	Kiambu West	Limuru	P.O. Box 23 -00220 Ngesha	ngeniafeeds@yahoo.com	(0)722 446 911	Simon Kangethe	2007
	Jasho Feeds Ltd	Kiambu West	Limuru	P.O. Box 255 Kikuyu		(0)727 121 297	Paul Kariuki	2007
	Haki kwality Feeds Ltd	Kiambu East	Githunguri	P.O. Box 510 Githunguri		(0)733 473 379	Josphat Karonji	2006
	Muoroto Feeds Ltd	Kiambu	Githunguri	P.O. Box 82 -00216		(020) 2025728 (0)725 420 763	Jonathan Wamae	2002
	Jupiter Manufactures (K) Ltd	Kiambu	Kikuyu	P.O. Box 1631		(020) 8016344 (0)722 574 902	Peter Nganga	2008
Nairobi	Joeliz Bone Meal Ltd	Nairobi East	Nairobi	P.O. Box 17873 -00500		(020) 558014 (0)733 767 767	James Ngugi Gachoka	2005
	Healthier feeds	Nairobi East	Nairobi	P.O. Box 784 -00518		(0)722 383 207	John Sitati	2004
	Osho Chemicals Industries Ltd	Nairobi East	Nairobi	P.O. Box 49916 -00100	oshochem@oshochem.com www.oshochem.com	(020) 532939/ 532940/ 531428 (0)726 880 480		2006
	Tarime Supplies Ltd	Nairobi	Nairobi	P.O. Box 57547 -00200	tarimesuplies@yahoo.coom	(0)722 282 814	Musyoka	2006
	Sigma Feeds Ltd	Nairobi	Nairobi	P.O. Box 18138 -00500	sigmafeeds@wananchi.com	(020) 891572/ 891712/ 890640 (0)733 600 894/ (0)721 560 251	K.P. shah	1984
	Nairobi Feeds Ltd	Nairobi West	Kawangware	P.O. Box 326 Uthiru		(0)721 685 132/ (0)720 392 520	John Chege	2003
	Joma Feeds Ltd	Nairobi East	Nairobi			(0)722 652 905	Magret Waithera	2002
	Mavoloni Ostrich Farm Ltd	Nairobi East	Nairobi	P.O. Box 77292 -00611		(020) 2013102 (0)722 720 533	Joseph Kimani	1994
	Karlsmarts Laboratory Services	Nairobi	Nairobi		kirmarts@yahoo.com www.kirmarts.com	(020) 2099025/ 8034258/ 3556938 (0)720 681 319/ (0)733 706 232	Joseph Gitaiga	2006
	Athi Feeds Ltd	Kajiodo	Kitengela	P.O. Box 13404 -00800	athifeeds@yahoo.com	(020) 3539090 (0)724 321 421/ (0)720 416 797	Prof. Gachuiri	2006

Region	Name	District	Town	Postal Address	E-mail Address	Land line	Contact person	Year started
	Carevet Systems Ltd	Nairobi	Nairobi	P.O. Box 52334 -00200		(0)722 511 979	Francis Githinji	2001
	Stanpur (K) Ltd	Embakasi	Nairobi	P.O. Box 50831 -00200		(0)721 613 062	Stanley Githonga	2008
	Coast Feeds Ltd	Nairobi East	Nairobi	P.O. Box 17630 -00500		(020) 20586	Farid Salim/ Fasal Salim	2007
	Bio-medica Laboratories Ltd	Nairobi	Nairobi	P.O. Box 66627 -00800	bio-med@africaonline.co.ke	(020) 2018540 (0)727 034 566	Kamau Mwangi	2008
	S. Rocky General contractors Ltd	Nairobi	Nairobi	P.O. Box 21157	s.rocky360@hotmail.com	(020) 6763372 (0)722 882 231	S. Wanyee Roki	2005
Nairobi	Economy Farm Products (K) Ltd	Nairobi East	Nairobi	P.O. Box 64982 -00200	economyfeeds@yahoo.com	(020) 552258/ 652386 (0)722 209 838/ (0)735 337 753	John Gathogo	1998
	Hemco Feeds (K) Ltd	Nairobi	Nairobi	P.O. Box 12199 -00400		(0)722 703 944/ (0)722 970 510	Gakere Mwangi	1999
	Sirari Feeds Ltd	Nairobi	Nairobi	P.O. Box 32 -00515		(020) 557918 (0)722 722 892	Joseph Mwangi	2005
	Nutrimix Ltd	Nairobi West	Nairobi	P.O. Box 830 00517 Nairobi	info@nutrimix.co.ke	(020) 2733950/1 (0)722 759 454	Martin Kinoti	2004
	Modernways Ltd	Nairobi	Nairobi	P.o. Box 27503-00506 Nairobi	purchasing@modernways.co.ke	(020) 3871183 (0)736 100 091	Ashworth	2006
	Pioneer feeds Ltd	Nairobi	Embakasi	P.O Box 4606-00506	info@pioneerfeeds.com www.pioneerfeeds.com	(020) 2024620/3 (0)722 799 299	Karuri Joseph	2006
	Unga Farm care (EA) Ltd	Nairobi	Nairobi	41788-00200	information@unga.com	(020) 3933000/651206 (0)722 205 535	L. Mkundi	1980
	Wann feeds Ltd	Nairobi west	Nairobi	52852-00200	wannifeeds@yahoo.com	(020) 891442/ (0)722 754 442	J. Mwangi	1996
	Kengrow Ltd	Nairobi	Nairobi	42897-00100	rajesh@kengrowlimited.com	(020) 533686 (0)721 306 888 /(0)733 649 940	H. Rajesh	2005
	Valueplus Feeds ltd	Kiambu	Githunguri	722 Kitunguri		(0)733 324 751	Samuel Githau	2007
	Pembe Flour mill Ltd	Nairobi	Nairobi	17955-00500	Adress-pembe@pembe.co.ke	(020) 551933/43/53 (0)724 257 064	Salim Abubakar Bajaber	1997
	ABS TCM	Nairobi	Nairobi	76478-00508	abstcm@iconnect.co.ke www.abstcm.com	(020) 3871692/3 (0)722 700 355	Nathaniel Makoni	2001
	Taifarmfarm Millers	Nakuru	Nakuru	7153-20100		(0)712 977 111	P.Kuria	2008
	Tumaini Millers (K) Ltd	Nakuru	Nakuru	7288-20110		(0)722 966 739	John Mwangi	2008
Thika	Ohami millers Ltd	Thika	Thika	P.O. Box 1600-01000	hgpatel@wananchi.com	(0670) 30300 (0)733 725581	Salome Njoroge	1999

Region	Name	District	Town	Postal Address	E-mail Address	Land line	Contact person	Year started
	Njuca Consolitated Ltd	Thika	Thika	P.O. Box 55 -01020	info@njuca.co.ke	(020) 3550934 (0)720 210 646/ (0)722 822 045	Dipak Patel	2005
	Bindzp Enterprises Ltd	Thika	Thika	P.O. Box 12		(067) 22104 (0)722 783 578	M.K Njoroge	2007
	King feeds Industries Ltd	Thika	Thika	P.O. Box 3784 -01002		(0)721 709 528/ (0)720 668 111	Ashok Patel	1982
	Muus Kenya Ltd	Thika	Thika	P.O. Box 625		(020) 2365025 (0)733 440 041/ (0)722 560 604	Stephen Waithiru Baiya	2008
	Legorn feeds International Ltd	Thika	Thika	P.O. Box 1253 -01000		(020) 2363949 (0)713 108 722	J.K. Mungai	1997
	May Feeds Ltd	Thika	Thika	P.O. Box 4893 -01002	mayfeeds@wananchi.com	(020) 8220001/ 2 (0)722 740 550	Kangfan Patel	1997
	Trust Feeds Ltd	Thika	Thika	P.O. Box 144		(067) 31018/ 31003 (0)721 208 900/ (0)725 623 088	Mararo I.C.	2005
	New day Products Ltd	Thika	Thika	P.O. Box 4618		(020) 20895669 (0)724 431 371/ (0)722 331 795	Samwel Mwangi	2002
	Salama Feeds Ltd	Thika	Thika	P.O.Box 1248 -01000		(067) 30238 (0)722 889 083	Kariuki	2004
	Thika Farmers group Ltd	Thika	Thika	P.O. Box 696 -01100		(067) 21794 (0)720 840 197	Rosemary Kirika	1994
	Chania Feeds Manufacturers Ltd	Thika	Thika	P.O.Box 1780 -01000	chaniafeeds@wananchi.com	(020) 2011547 (0)722 828 383	C.M. Mwendia	2004
	Treasure Industries Ltd	Thika	Thika	1182-00232	info@treasurefeeds.com	(020) 2062451 (0)721 433 519/ (0)733 720 518	Shem Mwaura Njoroge	2001

Source: Githinji *et al.*, 2009

APPENDIX 10: MAJOR LIVESTOCK FEED VENDORS IN NAIROBI AND PERI-URBAN DISTRICTS

1	**Alltech Biotechnology E A Ltd** Bandari Plaza, Mezz 3, Woodvale Grv, Westlands, Nairobi P. O. Box 13995 - 00800 Westlands. Tel: +254-20-4449082 Fax: +254-20-4449082
2	**Aniko Superfeeds Ltd** Jamuhuri, Nairobi P. O. Box 21585 - 00505 Ngong Rd. Tel: +254-20-3874589
3	**Belfast Millers Ltd** Bamburi Rd, Industrial Area, Nairobi P. O. Box 18453 - 00500 Enterprise Rd. Tel: +254-20-558488
4	**Chakula Industries Ltd** Baba Ndogo Rd, Ruaraka, Nairobi P. O. Box 45858 - 00100 Nairobi GPO.
5	**Champion Feeds Ltd** Eastern, Thika
6	**Chefima Ltd** Off Garage Rd, Industrial Area, Nairobi P. O. Box 20179 - 00200 City Square. Tel: +254-20-533545 Fax: +254-20-533545
7	**Economy Farm Products (K) Ltd** KNTC Godown No. 11l Runyenjes Rd, Off Nanyuki Rd, Industrial Area, Nairobi P. O. Box 64983 - 00620 Mobil Plaza. Tel: +254-20-552258 Fax: +254-20-551091 Mobile: +254-722209838
8	**Goldstar Feeds Ltd** Enterprise Rd, Industrial Area, Nairobi P. O. Box 61767 - 00200 City Square. Tel: +254-20-552105 Fax: +254-20-556769
9	**Hemco Feeds (K) Ltd** Hemco Hse, Kariobangi Light Industries, off Komarock Rd, Kariobangi, Nairobi P. O. Box 12199 - 00400 Tom Mboya St. Tel: +254-20-788715 Fax: +254-20-785021
10	**Jama Feeds Ltd** Off Garissa Rd, Eastern, Thika P. O. Box 12 - 01000 Thika. Tel: +254-67-72066
11	**Joeliz Bonemeal Ltd** Lunga Lunga Rd, Industrial Area, Nairobi P. O. Box 17873 - 00500 Enterprise Rd. Tel: +254-20-554723
12	**Kanini Kega Animal Feeds Kikuyu** Karuri, Eastern, Karuri P. O. Box 20908 - 00204 Athi River.
13	**Kimandi Traders Ltd** Weteithie Hse, Cross Rd, Eastern, Thika P. O. Box 172 - 01000 Thika. Tel: +254-67-30318 **Mayfeeds Kenya Ltd** Garissa Rd, Eastern, Thika P. O. Box 4893 - 01027 Donyo Sabuk. Tel: +254-67-22030

14	**Muus (K) Ltd** Thika Rd, Eastern, Thika P. O. Box 625 - 01027 Donyo Sabuk. Tel: +254-67-21271 Fax: +254-67-30092
15	**Muwanji Ltd** P. O. Box 14202 - 00800 Westlands. Tel: +254-66-22387
16	**Ngecha Feeds Ltd** Kikuyu Township Karuri, Eastern, Karuri P. O. Box 1215 - 00902 Kikuyu.
17	**P G Harris & Co** Pumwani Rd, City Centre, Nairobi P. O. Box 22743 - 00400 Tom Mboya St. Tel: +254-20-2242089
18	**Pioneer Overseas Corporation** Off Kapiti/Goldern Rd, Industrial Area, Nairobi P. O. Box 53384 - 00200 City Square. Tel: +254-20-550869
19	**Qarrey Trading Co Ltd** Old Factory Rd, Industrial Area, Nairobi P. O. Box 41557 - 00100 Nairobi GPO. Tel: +254-20-533677 Fax: +254-20-533676 **Roromo Farmers Store** Kimosu Rd Limuru, Eastern, Limuru P. O. Box 269 - 00217 Limuru.
20	**Sava Industries Ltd** Likoni Rd, Industrial Area, Nairobi P. O. Box 18661 - 00500 Enterprise Rd. Tel: +254-20-558870
21	**Sigma Feeds Ltd** Karen, Nairobi P. O. Box 18138 - 00500 Enterprise Rd. Tel: +254-20-891572
22	**Sosdetan Star Feeds Ltd** Industrial Area, Nairobi P. O. Box 61767 - 00200 City Square. Tel: +254-20-551704
23	**Tamfeeds Ltd** Karen Off Langata Rd, Karen, Nairobi P. O. Box 24371 - 00200 City Square. Tel: +254-20-882375 Fax: +254-20-884437
24	**Taphy's Animal Feeds** Ngong Rd, Karen, Nairobi P. O. Box 39143 - 00623 Parklands. Tel: +254-20-883800
25	**Thuita Stores** Uhuru St, Eastern, Thika P. O. Box 1834 - 01027 Donyo Sabuk.
26	**Trust Feeds Ltd** Factory St, Eastern, Thika P. O. Box 144 - 01000 Thika. Tel: +254-67-31003 Fax: +254-67-31018 Mobile: +254-733725581
27	**Unga Feeds Ltd** Dakar Rd, Industrial Area, Nairobi P. O. Box 41788 - 00100 Nairobi GPO.

28	**Vegetable Oil Industries Ltd** Enterprise Rd, Industrial Area, Nairobi P. O. Box 61767 - 00200 City Square. Tel: +254-20-606009
29	**Vijam Industries Ltd** Off Sasio Rd, Industrial Area, Nairobi P. O. Box 78206 - Nairobi
30	**Wakulima Shop** Kimuso Rd Karuri, Eastern, Karuri P. O. Box 269 - 00217 Limuru. Tel: +254-66-71079
31	**Wama Feeds Ltd** Karuri Karuri, Eastern, Karuri P. O. Box 1834 - 01027 Donyo Sabuk. Tel: +254-67-30128
32	**Wann Feeds** Kuwinda Rd Off Langata Rd, Lang'ata, Nairobi P. O. Box 52852 - 00200 City Square. Tel: +254-20-891442

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