Chapter 6

Urban Waste as a Resource: The Case of the Utilisation of Organic Waste to Improve Agriculture Productivity Project in Accra, Ghana

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Abstract Poor municipal solid waste management continues to be a daunting issue for municipal authorities in Ghana. Major cities generate 2000 tonnes of mixed municipal waste per day, of which about 80% is collected and disposed of at open dump sites and/or at the limited number of landfills available. About 60% of this waste is organic. The Utilization of Organic Waste to Improve Agricultural Productivity (UOWIAP) project sought to co-create knowledge through a private-public engagement for the development of organic waste value chain opportunities to sustainably manage municipal organic waste and, at the same time, improve urban farm soils and increase food productivity in the Ga-West Municipal Assembly in the Greater Accra Region of Ghana. Through the project, identified key stakeholders in the waste and agricultural sectors, such as market traders, informal waste collectors, unemployed persons, farmers, landscapers, media, agricultural extension

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officers, Municipal Assembly officers and the general public, were engaged and made aware of sustainable organic waste management processes, including organic waste segregation from source, collection and compost production. Four formal markets were selected for the piloting of organic waste segregation from source. Interested persons were trained in organic waste collection, compost production and entrepreneurship. The lessons learned draw attention to the need for a massive effort to generate demand for compost use as this will invariably drive removal of organic waste from the unsorted waste stream.

Keywords Market waste · Waste to resource · Waste segregation · Community project · Compost · Pollution prevention

1 Introduction

The challenge of municipal solid waste management continues to be a daunting issue and is of global concern. Increasing population and urbanisation, and the accompanying high rate of waste generation, have engendered serious concerns regarding the attainment of the Sustainable Development Goals. According to the World Bank, the global urban population in 2012 was about 3 billion, generating about 1.3 billion tonnes of solid waste annually (Hoornweg and Bhada-Tata 2012). Waste generation in sub-Saharan Africa was estimated to be approximately 62 million tonnes annually, reflecting an average of 0.65 kg/capita/day (Hoornweg and Bhada-Tata 2012). With a projected urban population of about 4.3 billion by 2025, municipal solid waste generation is estimated to exceed 2.2 billion tonnes (Hoornweg and Bhada-Tata 2012). The estimated projections raise concerns about the anticipated exponential increase in the volume of waste that will be produced in the near future.

The end-of-pipe approach to waste management in the twentieth century can be blamed for the outcomes and the impact of waste management observed today. The release of greenhouse gas emissions from waste landfills and its effect on climate change, the burden of gastro-intestinal diseases, the indiscriminate dumping of waste especially in developing countries and the heavy financial cost of waste management have been overwhelming (Starovoytova 2018). Faced with this daunting situation, global efforts have been directed towards reversing this trend and finding sustainable approaches to waste management.

Recent global trends in city waste management have seen a focus on managing waste in a socially and environmentally acceptable manner (Vergara and Tchobanoglous 2012), to promote public health and enhance resource use efficiency. Various frameworks and concepts have been developed to guide the sustainable management of waste. Examples include the waste hierarchy framework which outlines the most preferred waste management strategies, such as waste recovery, reduction, reuse and prevention, towards the apex of the pyramid, and the unwanted methods, such as landfilling, at the base of the pyramid. Zero waste and circular economy concepts are nowadays driving the international waste management approaches.

Waste governance is also becoming regionalised (Vergara and Tchobanoglous 2012). In developed nations, where citizens produce far more waste, the waste generated is often managed formally at a municipal or regional scale. In developing nations, where citizens produce less waste, most of which is organic, a combination of formal and informal actors is often involved in the management of waste. Thus, effective waste management strategies should vary depending on the local waste characteristics, which vary with cultural, climatic and socio-economic variables and institutional capacity.

In Ghana, solid waste generation currently ranges between 0.2 and 0.8 kg/person/day, with an estimated volume of 13,500 tonnes of solid waste being produced daily nationwide (Miezah et al. 2015). The waste composition of Ghana is predominantly organic (60%), followed by plastics (14%), paper (5%), metals (3%) and glass (3%). Major cities in Ghana generate 2000 tonnes of mixed municipal waste per day, of which 80% is collected (Cofie et al. 2009). Collected waste is disposed of either by open dumping or in the few available landfills. Ghana currently has only five engineered landfills; however, most of them are dysfunctional. Accra, for example, has no landfill site; therefore, most of the waste collected from the city is taken to Kpone in Tema, a city 24 km from Accra.

In line with recent global trends, Ghana is working on promoting waste recovery for reuse and recycling. The informal sector is actively involved in this approach to waste management. Waste pickers often collect plastics, metals and cans from the municipal waste stream and sell them to recycling companies or for reuse purposes. In Ghana, there is the potential of harnessing large volumes of organics from the municipal waste stream: compost production can divert organic waste away from landfill. Compost production can create employment and revenue opportunities for the unemployed population, farmers and waste pickers who may take part in the recovery, processing and utilisation (Gabbay 2010). Nevertheless, composting as a waste management tool is only feasible in cases where there is a strong and stable demand for compost at the local level.

The Institute for Environment and Sanitation Studies at the University of Ghana, the MDF West Africa Training and Consultancy, the Ministry of Food and Agriculture (MOFA) and the Ga-West Municipal Assembly partnered, with the funding support of the Ministry of Foreign Affairs of the Netherlands, through the Netherlands Organisation for Scientific Research (NWO) and the Food and Business Applied Research Fund, to co-create knowledge and demonstrate organic waste valorisation in an urbanised location in the city of Accra. The overall goal of the UOWIAP project was to co-create knowledge in order to promote the development of organic value chain opportunities, to enhance the food security and livelihoods of the peri-urban poor in the Ga-West Municipality. The project's objectives were to:

- Co-create knowledge for sustainable organic waste management in the municipality
- Develop organic waste value chain opportunities by engaging unemployed youth and urban farmers in the Ga-West Municipality
- Divert organic waste from the market waste stream for compost production for the local market

population into the peri-urban Greater Accra Metropolis has created severe challenges in waste management, urban agricultural productivity, land management and general socio-economic development. Population inflows into the study area, the Ga-West Municipality, have brought the population density to the unprecedented level of 711 persons/km², compared to the population density within the city of Accra of 90/km² and the national density of 79/km² (Ga-West Municipal Assembly 2010). A significant number of the population live in scattered rural settlements covering about 60% of the land area of 462 km². The municipality is noted for intense agricultural activities. Today, cultivated farmlands and rural neighbourhoods are gradually becoming small towns, with increasing commercial activities.

The municipality is faced with many challenges. These include farmers losing their farmlands to commercial and residential developers and sand winners. The situation has resulted in a reduced land area for farming, loss of soil fertility because of continuous cropping and increased inorganic fertiliser usage, leading to low agricultural productivity. The municipality also faces waste management challenges where volumes of uncollected municipal waste, often left in the open, are burnt amongst open-air residences or clog up natural and artificial waterways.

Agriculture remains the main occupation in the municipality, supporting around 55% of the economically active population. Within this context of declining agricultural productivity, loss of livelihoods and poor environmental sanitation in the Ga-West Municipality, there are existing opportunities to:

- Increase livelihood opportunities by reclaiming sand-won land and creating waste management jobs
- Boost soil productivity by training farmers in composting and sustainable, organic soil management
- Manage environmental sanitation by promoting the valorisation of organic waste
- Improve public health through community outreach on understanding the benefits of organic produce

2.1 Strategic Focus and Methods Used

The project addressed four strategic areas:

- (i) Stakeholder identification and engagement for knowledge co-creation with project partners
- (ii) Training and skills development for organic waste value chain development
- (iii) Business model development
- (iv) Project awareness creation

Prior to project implementation, a baseline study was conducted to ascertain the prevailing situation regarding the profile of vulnerable groups in the municipality, waste management practices in the local markets and compost production and use in the municipality amongst farmers. Community fora were held at different levels

within the municipality to create awareness of the project, to solicit community support and to seek ideas for sustainable strategies needed to facilitate its implementation and the recruitment of unemployed youth for skills training. Media coverage (television, radio and news print) of community engagement activities was also used to create awareness of the project amongst the public. Findings from the baseline study informed the project implementation direction, subjects and study markets and the selection of farms. The project implementation plan was structured as follows:

1. Stakeholder workshops and meetings:
 - (a) Project implementation planning.
 - (b) Assess and receive input during various stages of project, including results dissemination.
 - (c) Knowledge co-creation sections.
2. Waste collection and compost production training:
 - (a) Develop curriculum and content for compost production and entrepreneurship training.
 - (b) Recruit and train the unemployed in organic waste collection and compost production.
 - (c) Conduct compost production training for farmers' groups and agricultural extension officers.
 - (d) Closely monitor farmers' progress and obstacles.
3. Entrepreneurship and business creation support infrastructure
4. Youth composting scheme pilot:
 - (a) Acquire land to use as a composting site.
 - (b) Collaborate with partners to obtain the materials and infrastructure necessary to pilot the waste collection and composting.
 - (c) Train youth on waste separation and how to educate their customers, on collection and on processing/reselling.
 - (d) Build capacity for groups to manage and maintain composting facilities, produce quality compost and appropriately price and market it.
5. Community outreach:
 - (a) Conduct advocacy campaigns for waste separation from source and organic fertiliser usage.
 - (b) Develop strategies to involve local media, markets and schools in the promotion of organic foods (e.g. posters, leaflets and community FM stations).
6. Monitoring and evaluation of youth composting and farmer training pilots

The project was implemented for 3 years. The first year was used for sensitisation, study subject engagements, knowledge co-creation activities, developing methodologies and training, pilot testing and improvement of methodologies. In the second year training continued and field experimentation was conducted to

demonstrate the value of crops and organic waste opportunities. Feedback loops were also implemented to improve the methodologies employed. The third year was for the establishment of a small-scale business venture by the trained groups. The project was structured as a trans-disciplinary pilot study.

2.2 *Project Actors*

The main project actors were all located within the municipality. Different key stakeholders were involved based on the different roles they play in the development of the waste value chain. These included the governmental agency staff, such as the Environmental Health Officers, Planning Officer and Youth Employment Officer of the Municipal Assembly, the Director of the MOFA and his extension officers. Others included local community leaders, community members, market queens and leaders and traders, waste pickers and caretakers of skips for waste collection, farmer groups and individual farmers, youth groups, schools and local radio stations. External stakeholders comprised the project team from the University of Ghana and MDF West Africa Training and Consultancy, the media and the general public.

3 Data Collection and Analyses

The study design was cross-sectional and it employed the use of both quantitative and qualitative methodologies. Various methodologies were adopted and tailored for the specific components of the project. For example, in order to assess the food-insecure in the study communities, participatory maps, focus group discussions, semi-structured individual interviews and key informant interviews were used.

A two-stage sampling technique was used. The first stage involved a purposive sampling of eight communities after reconnaissance visits to the district: this is where the researchers chose specific people who had knowledge of waste separation and composting to participate in the project. Two focus group discussions were organised in each of the selected communities, separate ones for men and women. Participants in focus group discussions were also selected voluntarily to obtain a good representation of key members within the communities. The results of the focus group discussions were important in developing the questionnaire for the individual interviews. Transect walks were organised with some community members to identify key locations within the communities, as well as settlement patterns. The second stage of data collection considered a random sampling to select the households for the interviews. According to the United Nations Food and Agriculture Organization (FAO) (2004, p. 50), households normally “comprise individuals who live in the same dwelling and who have common arrangements for basic domestic

and/or reproductive activities such as cooking and eating”. In each household, the head of the household and one other adult, in most cases the wife, were interviewed.

For market surveys, three formal markets (designated sites and markets approved by the Municipal Assembly) in the municipality and one other market in a neighbouring municipality market were engaged. Visits were conducted to the neighbouring markets to identify market leaders in order to engage and observe first-hand the state of waste management in the selected site. A survey was also conducted amongst the traders to solicit their views for, and inputs to, the project. Questionnaires were also developed to assess the waste generated from the markets and the willingness of traders to engage in waste segregation. The questionnaires consisted of both open-ended questions and closed-ended questions and centred on demographics and socio-economic characteristics, solid waste management practices and willingness to segregate and pay for segregated waste to be collected.

Another survey was also carried out to assess the profile of the farmers in the municipality. Data was collected by conducting a face-to-face interview with farmers. A pre-tested structured questionnaire and an unstructured questionnaire were developed and administered to 155 farmers (four zones), to collect data on household characteristic, types of crops cultivated in the district, land size, crop yield and source of capital for farming. The sampling method used was purposive random sampling: the researchers identified specific farmers who were willing to answer the questions.

All data was entered into SPSS version 20 (SPSS, Chicago, IL, USA) and analysed using descriptive and logistic regression statistics. Actual counts and percentages were used to describe the characteristics of the sample. Inferential statistics were set at $P < 0.05$.

4 Baseline Situation

4.1 Profile of Vulnerable Groups in the Municipality

The profiling of vulnerable groups was carried out to help target groups who could be engaged in organic waste business. The study therefore sought to understand the characteristics of the vulnerable groups in the municipality. Perceived vulnerability and poverty are context-specific. In some communities, participants indicated that a poor person is one “who cannot afford three square meals a day”. In some areas a person was presumed to be poor if they do not own land. Especially in rural areas, a person was deemed to be poor if they do not own their house. According to some respondents, some people cannot afford three square meals a day and cannot care for their dependents and therefore are classified as poor people. These include the unemployed, lazy, disabled, weak or aged people.

Men were perceived as being more vulnerable to poverty. Almost 48% of study subjects believed that men form the majority of poor people, as compared to women,

because men often have fewer livelihood options. In one of the study communities, everyone in the community, including the chief, classified themselves as poor. According to the participants, both the youth and the aged face similar problems because they have no lands on which to farm. Results from the interviews showed that the majority of the poor are identified to be mainly farm labourers, unemployed and beggars.

4.2 Waste Management Practices in Local Markets

A total of 108 questionnaires were administered in the three selected markets. The respondents included 88 females and 20 males. The majority of them were within the age group of 21–40 years. Most of the respondents were married. A substantial number of them (20%) had no formal education. Out of those with some form of education, the majority of them (36%) had attained middle school/junior high school level. Most of them were traders but a few (12%) were artisans who engaged in vocations such as hairdressing and sewing.

Regarding their waste management practices, the study revealed that over 90% of the interviewees dump the waste they generate into a communal skip in the markets. A few of them (7.5%) burn the waste and (0.9%) dump it indiscriminately. Those who dump at the communal skip pay to do so. The survey also revealed that only 20.8% of market women segregate their waste. Segregated wastes – mainly cassava and plantain peels – are given out for animal feed. The majority of the market traders also indicated that they have no education in waste management. Key stakeholders who were identified as being involved in market waste management included the skip supervisors, waste pickers, private service providers and market traders.

All market traders dump their mixed waste in skips provided by the Municipal Assembly. However, in two of the markets, the traders had engaged individuals who help to maintain the dump site. There was no waste dump site in the third market; as a result the traders use a communal skip placed a few metres away from the market. There was a female leading the waste dump site management in one of the markets. This woman engages young men, who support her in maintaining the dump site.

Engagement with the dumpsite managers revealed their willingness to support the project with any waste segregation effort, such as maintenance of bins for only segregated waste. However, their major challenge was the difficulty in controlling the type of waste dumped as many of the neighbouring households do not have toilets. After several consultations with stakeholders, it came out clearly that to achieve success in the area of segregated waste, the market women need to find their own designated location to position bins solely for the collection of organic waste. This site should not be close to the official dumpsite, so the market women can manage the waste collection process.

4.3 Farmers' Profile

From the survey data, the majority (63.9%) of the farmers interviewed were males, with only 36.1% being female. The results show that the majority of the farmers were within the 31–60 years age group. The 51–60 years age group (30%) formed the majority, followed by the 41–50 years age group (24%) and the 31–40 years age group (23%), with farmers above 70 years forming the smallest age group, at 2%. The majority of the farmers had no formal education (34.2%), with most of them having a basic school level of education. Only 15% of them had a secondary education. Larger part of farmers within the municipality rent (32%) and lease (32%) their farmlands. Another 31% of respondents indicated that they inherited their land; 4% reported that they clear freely available lands, whilst only 1% indicated that they bought their land strictly for farming (Fig. 6.2). When questions about the number of years allowed to cultivate on rented lands were posed, the majority (47%) of respondents indicated that they are allowed to cultivate on the land for more than 5 years, whilst 35% indicated that they are allowed to cultivate for 1–2 years; the smallest group (18%) said that they are allowed to cultivate for between 3 and 4 years.

Generally, farmlands are small and fragmented. Cumulatively, the majority (35%) of the farmers have between 4000 and 8100 m² of farmlands, followed by farm size of 12,000 and 16,200 m² (29%). Only 6% of the respondents indicated that they have farms sized <4000 m² (Fig. 6.3).

Fig. 6.2 Source of farmland acquisition

Fig. 6.3 Proportion of farmers with various farm sizes

UOWIAP Field Work Progress Report 2016

Most farmers (36.1%) cultivate at least two crops in a year, whilst 33% indicated that they cultivate three crops per season. Only 2.5% of farmers cultivate more than five different crops per season, whilst 5.1% and 22.5% produce one and four crops per season, respectively. From the survey, the major crops/vegetables cultivated in the area are maize (*Zea mays*), pineapple (*Ananas comosus*), okra (*Abelmoschus esculentus*), cassava (*Manihot esculenta*), tomatoes (*Solanum lycopersicum*), pepper (*Capsicum*), garden eggs (*Solanum melongena*), lettuce (*Lactuca sativa*) and cabbage (*Brassica oleracea* var. *capitata*).

Farmers' Knowledge and Utilisation of Compost

When the question of the use of compost was posed to farmers, it was found that only 12% of them acknowledged its use. More than a half of the farmers (63%) indicated that they do not use any form of organic fertiliser on their farms, whilst 37.4% indicated that they apply some form of organic manure, which is mainly animal droppings. Danso et al. (2006) earlier reported that very few urban farmers in Ghana make use of compost.

Surprisingly, the municipality is home to one of the largest compost manufacturing companies in Accra, yet its patronage by the farmers remains low. Composting at the small-scale level is non-existent in the municipality. The willingness of farmers to use compost observed in this study reveals that the Ga-West Municipality has the potential to be a major compost hub, in both production and utilisation. Many of the farmers interviewed complained about the loss of soil fertility and acknowledged the fact that compost is likely to improve their soil quality. However, when presented with a maximum price scenario, this study found a variation in the willingness to buy. Since most farmers are producing on less than 18,000m² farm plots, it is not surprising that they expressed an unwillingness to pay anything above a GH¢ 40.00 (about 8 USD – at an exchange rate of 1 USD to 4.9 GH¢) for 50 kg. Doing so would increase their cost of farming and, inevitably, produce a perceived reduction in their profit margins. The lack of experience with compost or previous exposure to compost use could also account for the reservation in committing much money to it, because of the fear of not getting the expected income from using compost. Cofie et al. (2009) also identified the lack of a ready market as one of the major constraints to the successful operation of composting projects.

4.4 Public Views on Compost-Grown Foods

The success of organic agriculture, and by extension compost use, depends to a large extent on consumer demand (Bonti-Ankomah and Yiridoe 2006). This study revealed that all consumers were willing to buy compost-grown crops. These decisions were based on the assumption that organic crops taste better and are preferred, health-wise, to those grown with inorganic fertiliser. This supports the conclusion of Bonti-Ankomah and Yiridoe (2006) that consumer preference for organic crops is

influenced by inherent product characteristics, such as the taste and appearance of the product.

About 73% of the youth in the municipality were willing to go into composting as a source of income. Analysis revealed that the need for income and composting knowledge were factors that significantly influenced the decision to go into composting. It is expected that the monetary benefit of composting would be a motivating factor that would draw people to composting, including those already engaged in some other forms of economic activity. It is therefore reasonable for the aforementioned percentage of the respondents to express a willingness to go into composting as an economic venture, even when 49% were already economically active.

Knowledge of the composting process, as a factor influencing the decision to go into composting, is significant, considering the observation that there was no previous knowledge of composting amongst the participants of the study. This confirms the study by Nartey (2013) that people are willing to go into composting when they are equipped with the necessary training. The labour required during composting, the duration of composting and the space for composting are identified as factors that are likely to deter youth from going into composting. Since income is a significant factor in the decision to go into composting, the lengthy composting period and the labour-intensive nature of the process will deter people from engaging in it. Also, space for composting is a likely deterring factor due to the likely hostile reaction of neighbours to the idea of waste being accumulated in their neighbourhood and the contentious issues normally related to land.

4.5 Exploration of Business Models

The project partner, MDF West Africa, conceptualised four business models that could potentially be implemented by the project. These models are presented in Fig. 6.4. Box 6.1 explains the money-making opportunities for the four models. In

Fig. 6.4 Proposed business models for organic waste valorisation for unemployed youth

Box 6.1 Business model options

- Option 1: Segregation and collection give enough money if there is a big plant.
- Option 2: Only if one has enough money and the markets around are well organised.
- Option 3: One needs a good network in distribution.
- Option 4: Is only possible if one has big investment (money) and good market.

general, the four models differed based on the capacity of the entrepreneur (in terms of planning, organisation and funding). Option 1 explored the situation where the trained personnel could focus on promoting and collecting only segregated waste from the market and delivering to a producing plant for a fee. Whilst this was a potential option for the trainees, since there was an already existing plant, this option could not be implemented because the compost plant already had its staff and system of operation. Option 4 was also not an option to consider since it required substantial investment. Options 2 and 3 were therefore potential options that were tested with project support.

5 Observations from Project Implementation

5.1 Knowledge Co-creation

Knowledge co-creation was a key strategy employed to gain community support for the project, to facilitate implementation and to promote sustainability. The strategy was developed by the relevant actors. For instance, dealings with market traders were led by the traders' leadership, who engaged their colleagues, Municipal Assembly staff, waste pickers in the markets and waste collectors and with the project team devised their own workable strategies. Similarly, farmer engagement was based on open fora and several group meetings held with farmers and extension services of MOFA. This promoted ownership of the project and enhanced implementation process management and the acceptability of the project.

5.2 Youth Engagement and Skill Training

Youth engagement was quite challenging, even with the support of the Youth Employment Officers at the Municipal Assembly and radio and community fora. The youth were generally not interested in the waste business because it was viewed

as a lower-level, dirty job, with minimum returns. They complained about stigmatisation and that the general public did not respect persons engaged in waste business, especially waste pickers.

To encourage participation, the criteria for selection were enhanced to include interested persons rather than a focus on youth. Some financial incentives were given to support trainees' travel to the training centre. In this way, the project attracted diverse groups of persons, which included some unemployed youth, retirees and persons seeking to learn skills for self-reliance. It was also interesting to observe that about 60% of those that enrolled to participate in the 3-month programme were women. Compost production trainings were also held in several communities within the municipality, with the support of project staff and the extension officers of MOFA; the main participants in these community trainings were men. Persons enrolled at the training centre undertook three modular curricula that entailed knowledge and skills learning in relation to organic waste collection, compost production and entrepreneurship (Figs. 6.5 and 6.6). The project registered a total of 65 persons who reported voluntarily to the training centre to be trained.

However, only 31 completed the training and were awarded certificates. The high dropout rate was a result of various issues. Some of the attendees thought the process was tedious, but many of them dropped out because they were not satisfied with the financial incentive given to them to support their travel to and from the training centre.

Fig. 6.5 Trainees using tricycle for waste collection

Fig. 6.6 Trainees undergoing compost production training

5.3 Engagement of Market Traders and Waste Segregation

With the support of the Environmental Health Officer of the municipality, the market queens took the lead in mobilising and identifying the best locations to site waste bins for temporary storage of their segregated food waste generated in the market. In one of the markets, the leaders took full responsibility for the protection and maintenance of the bins. They also made sure recalcitrant traders were not allowed to dump mixed waste into the bins. The commitment levels of the market women were impressive and within a few months of project implementation, many of the traders began to show consistency in segregating organic waste from their waste stream, though a few still remain reluctant to change their practice. The waste segregation is continuing in two of the markets, with the programme being disrupted in one of the markets due to market reconstruction and the other market dealing with leadership challenges.

5.4 Farmer Engagement and Training

Over 1750 farmers were provided with the technology for composting farm waste by the agricultural extension officers. Forty farmers are experimenting with farm waste composting on their farms. However, the purchase of compost by farmers is currently low. Farmer engagement and training activities were led by the agricultural extension officers. A household survey was conducted in October 2017: 175 farmers were randomly sampled from four working zones of the district office of MOFA using the purposive random sampling method, to assess farmers' perceptions of compost and its adoption level.

Almost one-third of the farmers surveyed (29%) were of the ages of 51–60 years, with only 2% of them above 70 years. The major crops cultivated by the farmers are cassava (*Manihot esculenta*), maize (*Zea mays*), garden eggs (*Solanum melongena*), pineapple (*Ananas comosus*), okra (*Abelmoschus esculentus*), tomatoes (*Solanum lycopersicum*) and pepper (*Capsicum*). The study revealed that over 80% of farmers

were aware of the benefits of the use of compost. They stated benefits such as soil moisture retention, improvement of soil nutrients and increase in crops' shelf lives, amongst others. However, out of a total of 175 farmers interviewed, only 23.4% of them have adopted and are using compost, with the majority not using it. Questions on why they were not using compost were posed to people who had not adopted compost. Analysis of the factors influencing the low compost adoption and utilisation rate by farmers revealed factors such as the labour-intensive nature of compost preparation, a general lack of interest, the use of fertiliser and a lack of water for making compost, raw materials and knowledge on compost preparation. Also, access to extension services and land size were found to significantly influence compost adoption.

5.5 On-Farm Experimentation

Two field experiments were conducted at the University of Ghana research farm to evaluate the influence of compost and nitrogen fertiliser on plant height yield and biomass of maize (*Zea mays* L.). The study area was within the coastal savannah ecological zone of Ghana. The experiments were run during the minor season in 2016 and major season in 2017. The test crop was maize (Fig. 6.7). Four concentrations of nitrogen (N) were considered with three levels of compost during the major season (Table 6.1). However in the minor season, two levels of compost were applied (0 and 4000 kg/ha). Basal application of phosphorus (P) and potassium (K) was carried out for all plots; N was split-applied to respective plots and compost was applied to respective plots. Initial soil sampling was carried out before the establishment of trial.

The experimental design was a randomised complete block design, with 12 and 8 treatments and 3 replications during the major and minor seasons, respectively. Each treatment was separated from the other with a 1 m buffer strip (alley) between plots and a 1.5 m buffer strip between replication, to prevent cross-contamination between treatments.

Fig. 6.7 Farm experimentation

Table 6.1 Treatment combination used in field experiment in 2017 major season

Treatment combination	N (kg/ha)	C (kg/ha)
N1C1 (control)	0	0
N2C1	40	0
N3C1	80	0
N4C1	120	0
N1C2	0	4000
N2C2	40	4000
N3C2	80	4000
N4C2	120	4000
N1C2	0	6000
N2C2	40	6000
N3C2	80	6000
N4C2	120	6000

The results of the field experiments showed that the application of compost increased plants' growth, with a greater plant height in plots which received compost compared with those without compost application. The increase was greater during the major season compared to the minor season.

Generally speaking, nitrogen significantly ($P < 0.05$) increased the grain yield of maize up to 80 kg N/ha. Grain yield responded positively to N application, with yields ranging from 1124 kg/ha in N1C1 (control) to a maximum yield of 3651 kg/ha in N4C3 (120 kg N/ha and 6000 kg C/ha) during the major season. There was a significant increase ($P < 0.01$) in grain yield when N was applied, irrespective of the application of compost. Significant ($P < 0.05$) interactive effects of N and compost on grain yield were also observed. Similarly, nitrogen fertiliser and compost significantly increased the total biomass accumulation. The application of 6000 kg compost increased total biomass by 28% compared to treatment without compost application. In addition, compost significantly increased the total nitrogen uptake. The logistic (logit) model was employed to analyse the data due to the nature of the variable: whether farmers perceived compost to be good and had adapted or otherwise. For such a dichotomous outcome, the logit model is the most appropriate analysis tool. The logit model considers the relationship between a binary dependent variable (compost adoption) and a set of independent variables, whether binary or continuous.

5.6 The Business Model

Based on the assumption that the trainees had received comprehensive training in waste collection, composting and entrepreneurship, Business Model 2 was selected by the first batch of trainees for experimentation. They were responsible for

Fig. 6.8 Youth group busy sieving and bagging compost for delivery

collecting, processing and producing compost, creating awareness of the product and marketing the product. After 3 months of experimentation it was difficult for them to sell their product because the farmers who were the initial target customers were not eager to use compost, i.e. there was no demand for the compost. Based on the experience of the first batch, the second batch of trainees experimented with Option 3.

A small-scale compost production business venture was set up by a six-member group of trainees, who have taken it up as an income-generating activity (Fig. 6.8). Also, one of the trainees also set up a production unit in his home. The project provided support for the trainees by offering them tricycles on hire purchase and providing them with basic tools and technical support. To date, they have produced about 78 tonnes of compost and have sold compost worth about 2500 USD.

6 Key Outcomes and Achievements

Through the UOWIAP project, organic waste value chain opportunities have been created in the municipality, particularly amongst the public. Youth groups who engaged in the compost production and sale are enthused about the opportunities.

Fig. 6.9 Weight of waste collected by youth group over a 6-month period between October 2017 and March 2018

Between October 2017 and March 2018, one of the groups had diverted about 62 tonnes of organic waste from landfill to compost production (Fig. 6.9).

The general feedback from clients who purchased compost was very positive. The following are examples of comments received:

“Your product is much better than that from a common brand of compost on the market”.

– comment from a grounds supervisor.

“Make sure you always maintain the quality of your compost, it is very good.”

“I grow oriental vegetables in my home garden and had good yield when I used your compost.”

The visibility of the project is also increasing as various stakeholders continue to pay visits to the project site to see the project. Visitors to the sites include a pawpaw exporters association, real estate agencies, other university units such as the West African Centre for Crop Improvement and a group of 12–15 participants of the Valorisation and Innovation in Africa (VIA Water) project from about six countries.

The fact that a few farmers have begun experimenting with compost production on their farms is a success story for the project. Farmers in the municipality have been trained on the benefits of compost use for soil health and nutrient. The project has also increased the number of farmers who have adopted compost use and production. Farm experimentation increased by between 12% and 20%.

Knowledge co-creation efforts were very helpful in strategy development, especially with the waste collection and awareness creation components of the project. The direction given by traders informed collection frequency and time and the establishment of a cordial working relationship between the youth group and the traders.

7 Challenges

Driving behavioural change towards good environmental sanitation is a complex issue that needs innovative strategies and intense stakeholder engagement to achieve success. Outlined below are some pertinent challenges faced in the implementation of the project.

7.1 Stakeholder Engagement with Government Agencies

The experience with engaging governmental agencies faced challenges, which varied from issues with project staff mobility to the business-as-usual approach to work. Within the project period, about four government agency representatives on the project were transferred to other jurisdictions and this hindered project activity continuity, especially in the area of monitoring and supervision and further engagement. Secondly, certain components of the study were to be incorporated into government staff's normal programmes of work, which also significantly delayed implementation. For instance, the Agricultural Extension Services for many months did not receive their budgetary allocations and hence on many occasions did not have funds to fuel their vehicles and motorbikes to engage in their routine jobs. The bureaucracy and the general business-as-usual approach to work within the governmental institutions also delayed processes.

7.2 The Low Level of Awareness of the Value of Compost

There were misconceptions amongst the farmers about compost value as regards soil quality. Many of the farmers considered the compost's effect on soil to be slow and did not support the fast yields expected, as with the application of chemical fertilisers. The value of compost as a soil conditioner was only marginally appreciated. The adoption of new technologies by farmers generally takes time. Likewise, the practicality of composting on farms needs further investigation. One of the major concerns raised by farmers in relation to composting is the availability of water. Farm composting can be practised during the non-farming season and this coincides with the dry season.

Because of the low level of awareness and use of compost nationwide, there is low demand for compost. Also, the limited market space for organically produced foods is a disincentive, and farmers are forced to sell at the same price as inorganic fertilised food. This situation needs to be addressed through massive campaigns (education and awareness creation) to create demand for organic foods.

7.3 Practice of Non-segregation of Waste from Source

Non-segregation is a major drawback to waste valorisation. In Ghana, the practice of waste segregation occurs on a very limited scale and the large volumes of municipal waste generated are mixed. This problem is related to the fact that municipalities have no systems in place that promote waste segregation from source and the behaviour of producing mixed waste is entrenched in many Ghanaians.

8 Sustainability Pathways

To ensure project sustainability, a strong commitment to promote waste segregation is required from the Municipal Assembly. The Municipal Assembly is responsible for waste management and has the mandate to create an enabling environment to promote the expected behaviour in order to promote sustainable waste management. They must invoke their powers to set the necessary by-laws for waste segregation from source, and they must enforce them. The Municipality Assembly engages the private sector to collect waste from the municipality and therefore can direct the private sector through contractual agreements to begin the collection and treatment of segregated waste, whilst providing the necessary support for them.

There is also a need to create demand for compost products, such as organic foods. The post-project implementation phase is ongoing, with efforts taking place to develop a national compost use campaign. Through a partnership with the University of Oregon advertising team and other stakeholders, a prototype campaign has been developed to target middle-income urban dwellers to demand organic foods. Farmer education and sensitisation to use compost is also ongoing through the MOFA extension services. The project is also working to engage further with MOFA on the government's "planting for food and jobs" initiative.

9 Conclusions

The educational and awareness programme undertaken by the project, against the backdrop of the current knowledge and experiences of the stakeholders with respect to the mounting municipal waste menace, has heightened the need to find appropriate solutions to the waste challenge. This, together with the right support for composting, would help in addressing the problem. The experiences of the project suggest the need to build the capacities of compost producers, farmers, market participants and other parties on sustainable municipal organic waste management. The following measures are necessary:

1. The Municipal Assembly, as a matter of urgency, must begin to drive waste segregation from source by putting in place necessary by-laws and providing resources for enforcement. They should also engage the private sector in collecting segregated waste.
2. There should be continuous sensitisation of traders at the local markets on the value of segregating the waste they generate. In this regard, the municipal authorities and market management should make available prescribed containers at designated sites at the market place and ensure that they are used appropriately.
3. There should be intensified and wider educational coverage of compost use amongst farmers in the urban and peri-urban areas.
4. The unemployed youth should be given continuous technical training in compost production and compost market opportunities should be created for them.
5. Extension services should be provided with the necessary logistics and resources.

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