2
Urban Compost: A Socio-economic and Agronomic Evaluation in Kumasi, Ghana

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INTRODUCTION

Uncollected and poorly managed solid and liquid wastes are a health and environmental hazard, especially to the urban poor who live near informal, and often illegal, waste dumps. The lack of facilities to collect, transport and treat municipal, agricultural and industrial wastes poses a major challenge to the rapidly expanding cities of West Africa. To address this, new and innovative methods of collection, transport, processing and storage need to be identified. Composting of municipal wastes and using the compost for agricultural purposes is a quickly growing and viable option to managing urban wastes in both the developed and developing world (Drechsel and Kunze, 2001). Composting provides the environmental benefit of diverting waste from landfill sites, and health benefits by reducing the survival and spread of pathogens in wastes. Furthermore, the end product is a valuable soil fertilizer. The use of urban composts in urban and peri-urban agriculture (UA and UPA) effectively closes the nutrient cycle in urban areas and reduces nutrient losses to the environment (Drechsel and Kunze, 2001).

Kumasi is the second largest city in Ghana, with a population of 1,017,000 and a growth rate of 3.1 percent (Ghana Statistical Service, 2002). It has a semi-humid tropical climate, with average annual rainfall of about 1500 mm. Its central location in the country and relatively well-developed infrastructure make it a major market and distribution centre for Ghana and other West African countries. Within the peri-urban area, which covers an area of approximately 40 km radius around the city centre (Blake and Kasanga, 1997), are many agri-food industries such as breweries, saw mills and commercial poultry farms, which produce large quantities of organic wastes. The daily domestic waste generation in Kumasi is about 610 tonnes. The two main markets generate an additional 250 tonnes per day, most of which is organic; thus, the total city-wide generation is about 860 tonnes per day (KMA-WMD, 2000). Farming and trading are the main income-generating activities in Kumasi. Commercial crop production is dominated by vegetable horticulture and staple crops such as plantain, maize and cassava. In partially waterlogged valley bottoms, sugarcane and taro are also grown.

Kumasi is an ideal city to promote composting as a waste management strategy due to the large amount of organic wastes that are generated, the high biodegradable organic fraction of solid waste ranging between 65 and 75 percent and the extensive agriculture within its peri-urban boundaries (Salifu, 2001). A pilot composting plant was established in the Buobai suburb of Kumasi in 2001 by the IWMI and Kumasi Metropolitan Assembly (KMA). Different composts were produced from market wastes, household solid wastes and dewatered human sewage from septic and public toilets. During the inception of this composting project, the stakeholders wished to know the farmers' perceptions and demand for compost in Kumasi. At the onset of compost production, its agronomic potential and benefits to urban and peri-urban farmers had to be evaluated. This paper presents results of two composting studies.

OBJECTIVES

The objectives of this project were to conduct a social, economic and agronomic evaluation of compost made from urban organic solid wastes and fecal sludge, as well as an evaluation of its potential benefits in urban agricultural systems of Kumasi.

The social and economic evaluations were conducted through individual interviews and focus group discussions with relevant stakeholders. The objectives of these interviews were to: examine and document the farmers' perceptions, knowledge and socio-cultural acceptability of the compost; estimate the farmers' WTP for the compost compared with other common soil inputs; determine the socio-economic factors affecting farmers' WTP; and determine the demand for compost by farmers. Agronomic benefits of the compost were evaluated in seed germination and phytopathology experiments in the screenhouse and field trials. The objectives of these experiments were to: determine the success of germination and growth of vegetables to increasing rates of compost; determine whether the compost suppresses root knot nematodes, *Fusarium wilt and Sclerotium rolfsii* in lettuce and tomato plants; compare the fertilizer value of the compost with that of poultry manure; and determine the residual nutrient effects of compost applications on lettuce yield and soil fertility.

METHODOLOGY

Data collection from field interviews and focus group discussions

Interviews and focus group discussions with stakeholders, farmers and potential customers used a partially pre-coded questionnaire to elicit WTP and determine attributes of farmers' perception and farming practices. Additional data were collected from government institutions, IWMI urban and peri-urban agriculture (UPA) library, Ghana office of the Food and Agriculture Organisation of the United Nations (FAO), Ghana Organic Agriculture Network (GOAN) library and farmer associations. A total of 200 individual interviews were conducted with farmers from different urban farming systems in and around Kumasi. Few women were involved in agriculture in Kumasi; therefore, specific attempts were made to interview as many women as possible to elicit their opinions. The contingent valuation method (CVM) was used during interviews with farmers to estimate the price they would pay for compost based on their knowledge of similar products such as poultry manure or black soil. The CVM approach involved surveying individuals to determine whether and how much they are willing to pay for compost under different hypothetical scenarios (Whittington et al, 1990; Asenso-Okyere et al, 1997; Alberni and Cooper, 2000). Farmers were asked whether they were willing to pay for compost as a soil improver and how much they were willing to pay for a 50-kg bag. A bidding game was introduced in situations where farmers found it difficult to understand and provide their bids. This bidding game helped to determine the zero

WTP, and the mean and maximum amount the farmers would pay for the compost (Field, 1994; Hanley et al, 1997; Akpalu, 2000; Nugent, 2001).

Further questions focused on socio-economic characteristics, income, experience with compost and perception of compost quality. Since the dependent variable was a dichotomy (yes – 1 or no – 0), it was deemed appropriate to use a probit model instead of traditional regression models. The probit model was used to explain the factors that could affect farmers' WTP for compost (Kennedy, 1990) (Table 2.1). The probit model is defined as:

$$\Pr(y = 1|x) = \Phi(xb)$$

where Φ is the standard cumulative normal probability distribution and xb is the probit score and takes care of the explanatory variables (Pindyck and Rubinfeld, 1983). The parameters in the probit model were estimated by maximum likelihood methods (Pindyck and Rubinfeld, 1983; Hailu, 1990).

Compost production and analysis

The compost plant produced four types of compost with differing ratios of household waste, market waste and dewatered fecal sludge. The first compost produced and evaluated in field trials was made from a 3:1 ratio of market waste and dewatered fecal sludge. Organic market wastes were obtained from the main waste bins of the Kumasi Central Market. The sludge was obtained from public toilet septic tanks and was dewatered on a drying bed at the compost plant. Details of the dewatering facilities and compost production are described in the IWMI report (2003). The compost, poultry manure and test soils were analysed using established methods at the Soil Research Institute (SRI) in Kumasi and are presented in Table 2.1.

Table 2.1 *Chemical characteristics of soil fertility amendments*

Treatment	*TKN (%)*	*Org (%)*	*COrg (%)*	*MP (%)*	*K (%)*	*EC (ms/cm)*	*pH*
Compost	1.06	6.75	11.64	1.84	3.22	n.a.	7.3
Potting mixture	0.06	n.a.	0.75	n.a.	n.a.	0.31	7.0
Poultry manure	1.14	4.91	8.50	n.a.	n.a.	7.86	7.4

EC, electrical conductivity; TKN, total Kjeldahl nitrogen.

Germination experiment

The eight common vegetables used in the germination experiment were tomato (*Lycopersicon esculentum*), sweet pepper (*Capsicum annuum*), okra (*Hibiscus sabdariffa/esculentus*), carrot (*Daucus carota*), garden eggplant (*Solanum melongena*), lettuce (*Lactuca sativa*), cabbage (*Brassica oleracea capitata alba*) and spring onion (*Allium cepa*). Thirty seeds of each vegetable were planted into trays filled with one of five soil treatments. The soil treatments were a mixture of potting soil and fresh compost at 0, 12.5, 25, 50 and 100 percent. The seeds were loosely placed on the surface and lightly covered with soil. Okra seeds, being the largest seeds used, were soaked in water overnight (16 h) before planting. Seedling trays were placed in a screenhouse for three weeks, where temperatures ranged between 25 and 30°C, and watered daily to maintain sufficient moisture.

Germination was counted every day for 15 days and was considered successful when the seed radicle protruded from the surface of the soil. The average time to emergence (ATE) was calculated as:

$$\text{ATE} = \frac{[\sum(\text{number of germinated seeds on } i\text{th day} \times i\text{th day})]}{(\sum \text{ germinated seeds on last day})}$$

After three weeks seedlings were harvested by uprooting and washing the root soil. The length of the primary taproot, shoot and fresh weights were also measured.

Nematode suppression experiment

A factorial experiment was designed with two vegetables (lettuce and tomato plants), six soil treatments and two nematode treatments (with and without nematodes present) and replicated four times. The six soil treatments were prepared with potting mixture and the following fresh-weight percentages of compost: 0, 6.25, 12.5, 25, 50 and 100 percent. For each vegetable, two three-week-old seedlings were transplanted into a half-litre pot containing a different soil treatment. Into half of the pots, a 1-ml aliquot of nematode egg suspension, prepared using established methods, was injected into the soil 1 cm from the seedlings. Pots were kept in a screenhouse for six weeks, with temperatures ranging between 25 and 30°C, and watered every two days to maintain sufficient moisture. At harvest, plants were uprooted and shoot, root lengths and fresh weights determined. The incidence and severity of nematode root-galling was rated using a five-point scale.

Field fertilizer experiment

Two field experiments were conducted with the farmers of the Gyenyasi Farmers Cooperative. This cooperative has about 16 farmers, who produce lettuce, cabbage and spring onions in a 2-ha plot. Fourteen raised lettuce beds belonging to three farmers were divided into 30 plots, with sizes ranging from 7.5 to 12 m^2. The fertilizer treatments included the compost and poultry manure applied at rates of 1, 2 and 4 kg m^{-2} on each crop for three crops, compost applied at 2.5, 5 and 10 kg m^{-2} on the first crop, and a control with no compost applied.

The first experiment compared the compost and poultry manure applications on three crops. Since farmers evaluate the impact fertilizers based on how much they have to carry into the field, the two fertilizers were compared on a weight basis and not a nutrient basis. The second experiment compared lettuce yields over three harvests from a single application of compost to the first crop. Lettuce plants were watered daily with approximately 61 m^{-2} of irrigation water containing about 28 mg N l^{-1}. The equivalent fertilization was about 50 kg N ha^{-1} per month. Hand weeding was done on the same day each week and no pesticides were applied on the first crop. An outbreak of septoria leaf spot (*Septoria lactucae* Pass.) in the second and third crops required the use of Dithane fungicide. Composite soil samples were taken for chemical analyses and bulk density determined from each plot at the beginning of the experiment and after each cropping season. The fresh yield of all lettuce plants within a 1-m^2 grid was determined four weeks after transplanting.

Statistical analysis

Descriptive and inferential statistical tools were used to analyse interview data using SPSS software. The data from the CVM survey were analysed with a probit model. Correlations and means comparisons were conducted for the different explanatory variables to avoid multi-colinearity in the probit model. Due to difficulties in obtaining sufficient materials and labour, the germination experiment was not replicated and only one experimental unit per treatment was available. The unreplicated data were analysed by regression analysis. The effects of different compost treatments on nematode galling and yield were evaluated using ANOVA procedures. All the treatment comparisons were carried out at the P = 0:05 significance level.

RESEARCH FINDINGS

Social perceptions of compost made from urban organic wastes

Generally, the farmers had a good perception of the quality of compost regardless of how much experience they had using it. There was consensus that compost improved soil quality and increased crop yield. The major reasons given for this were: compost resembles 'black soil', which is known to farmers as a good soil input; high quantities of 'night soil' mixed with compost enriched the biofertilizer; they perceived long-term effects on the soil; and they associated compost use with benefits related to waste reduction and urban sanitation. About 42 percent of the farmers thought that handling compost did pose the same risks associated with the handling of chemical fertilizers.

The 20 percent of farmers who had no experience with compost perceived it to be ineffective, largely due to cultural beliefs or health concerns of the night-soil component of the compost. They believed that handling compost with night soil would lead to spreading of diseases such as HIV, typhoid and cholera. Furthermore, these farmers assumed that consumers would avoid crops on which compost had been used for fear of infections. Other reasons for being sceptical about the compost were the high labour requirements for compost production (57 percent); insufficient amount of raw materials to produce compost (28 percent); and the small market for organic products in the Kumasi region (15 percent). A similar survey in Kumasi found that farmers had the same perceptions and reasons for accepting compost made from urban wastes (Warburton and Sarfo-Mensah, 1998).

The majority of farmers indicated that compost would be moderately (51 percent) or very difficult (10 percent) to apply to soils compared with chemical fertilizers, which could easily be applied with irrigation water. Poultry manure was smelly, cloddy and inconvenient to apply when wet, whereas compost could be spread more easily using rakes. Many farmers perceived compost to be expensive (48 percent), but were willing to handle it (42 percent) and believed it could control the incidence of pest and diseases (42 percent). The cost of establishing a compost plant and the increased cost of transporting the material were the main economic concerns of farmers. Few were unwilling to handle the compost (6 percent) or believed it could not control the incidence of pests and diseases (2 percent). However, the majority of farmers were indifferent about handling compost (52 percent) or had no opinion about its ability to control pests and diseases (56 percent). Their claim was that, since they had not used it before, they could not judge its effectiveness at controlling pests and diseases.

Farmers' willingness to pay for compost

There was a positive correlation between how farmers perceived compost and their WTP for it. About 70 percent of them expressed positive WTP, while 30 percent were unwilling to pay even though they perceived it as a good soil input. Farmers were unwilling to pay for it largely for economic reasons. They were generally satisfied with the high returns achieved from their current soil input and did not see a need to replace or try new ones. Many suggested that it should be the government's responsibility to subsidize or supply inputs free to farmers.

Comparing WTP bids across different farming systems in Kumasi revealed that urban vegetable farmers expressed the lowest mean WTP (US$0.10), although their systems were profitable, with annual revenues ranging between US$600 and $1000 per hectare. Peri-urban vegetable farmers proposed the highest mean WTP (US$3; Table 2.2). The lower bid from urban vegetable farmers may have been influenced by the cheap and readily available poultry manure in urban farming systems.

A previous study in Kumasi found that more than 90 percent of the urban vegetable farmers preferred poultry manure because of the low price (US$0.01 per 10 kg) and availability (Drechsel and Kunze, 2001). On the other hand, the peri-urban vegetable farmers used expensive chemical fertilizers, which cost about US$2.80 per 10 kg. Although the nutrient content was greater in chemical fertilizers, the cost of nitrogen was still cheaper for the poultry manure than the chemical fertilizer.

The poultry industry in Kumasi may have the potential to provide large amounts of bio-fertilizer. There are about 300 registered commercial poultry farms in and around Kumasi (Kindness, 1999), and manure production by the largest farm alone is about 50 tonnes per week (Drechsel, 1996).

Decision variables for farmers' WTP

Farmers' experience of the use of compost had significant influence on the WTP for compost, as did gender and household dependency. However, their perceptions as related to compost, household income, level of education and age were all significant variables that influenced WTP (Table 2.3).

Table 2.2 *Farmers' willingness-to-pay for 50 kg of compost*

Farming system	*Mean WTP US$ (Std. Dev.)*
Vegetable farming, urban	0.10 (0.10)
Vegetable farming, peri-urban	3.00 (1.10)
Staple crops, urban	2.00 (1.60)
Staple crops, peri-urban	2.70 (1.00)
Backyard, urban	1.40 (0.10)
Ornamentals	0.60 (0.40)

Table 2.3 *Probit model of explanatory variables of farmers' WTP for compost in Kumasi*

Independent variables	*Regression coeff.*	*Standard error*	*t-statistics*[1]
Perception	0.566	0.077	7.3**
Location	0.062	0.051	1.2

Gender	–0.043	0.044	–0.98
Education	0.178	0.067	2.1**
Age	0.043	0.022	2.0*
Income	0.000	0.000	–2.2*
Household dependency	–0.078	0.043	–1.8
Compost experience	–0.119	0.105	–1.1
Soil inputs	–0.127	0.043	–2.9**

[1]Coefficient is significant at 5 percent (*) and 1 percent (**).

As expected, a positive perception of compost implied a higher probability of WTP for the compost. Similarly, farmers with higher income were willing to pay more than poorer farmers. Farmers who could read and write have a higher probability of paying for compost than those who could not read or write. This was most likely because more educated farmers were better informed about innovations and better understood the advantages and disadvantages of compost. Older farmers had a lower WTP than younger farmers, possibly due to older farmers not valuing the need to invest in the land they were using, whereas younger farmers were more motivated to invest in their land to realize long-term benefits. The present soil input the farmer was using had a significant impact on his or her WTP for compost. This was primarily because farmers used inexpensive soil fertility improvement inputs which were familiar to them. The farmers who were not interested in applying compost to their crops had less security on the plots they farmed and long-term investment in soil quality was not a priority to them.

Demand for compost in Kumasi

Demand for compost in Kumasi was estimated through WTP bids by farmers for both the subsidized and unsubsidized compost plants. Compost produced from Kumasi was valued at US$5 per 50 kg bag and its demand was 940 tonnes per year. Peri-urban farmers were willing to pay US$4 per 50 kg bag, which created a difference of US$2 with the prevailing market prices. This meant that, by sustaining demand for compost at this higher price, the government would have to subsidize the prices by US$2, which would lead to an explosion in demand estimated at 11,000 tonnes per year.

Although the compost plant is centrally located with respect to the urban farming areas of Kumasi, the distances between it and the farms are still large, plus the road access to these farms is often poor. Even with subsidized compost production, high transportation costs make it difficult for those living beyond a 35-km radius of the compost plant to afford to buy compost (Figure 2.1). Since peri-urban farms are located beyond a 40-km radius of the city (Adam et al, 1999), it appears unlikely that composting of urban waste in Kumasi would be a realistic option for recycling nutrients from urban areas to peri-urban and rural areas.

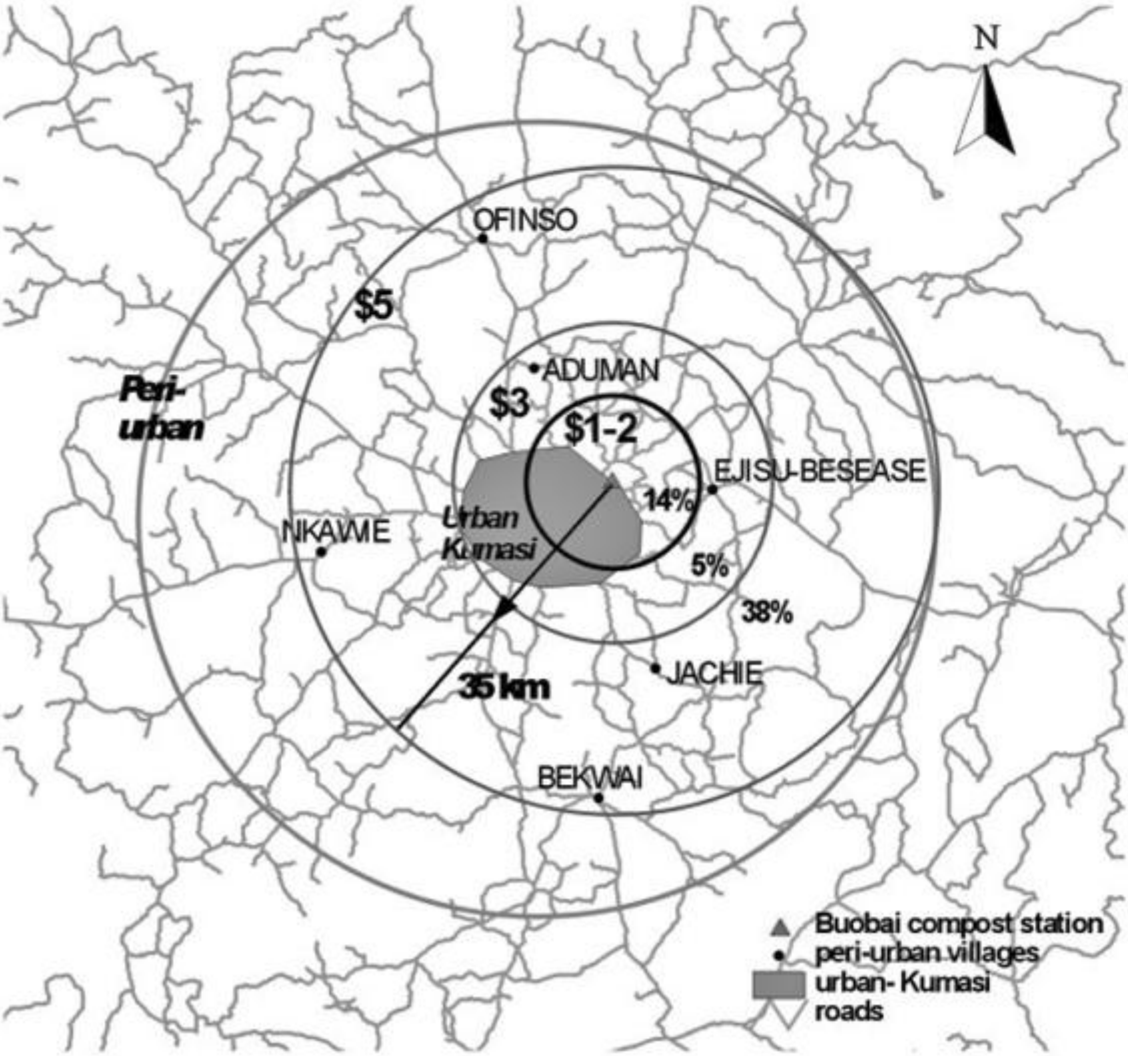

Figure 2.1 *WTP for compost at different distances from the compost station*

Germination experiment

The germination percentage was consistent for all vegetables and ranged from 70 to 100 percent except for okra and garden eggplant, whose seeds were infested by red ants. The germination of most vegetables was unaffected by the compost application, with the exception of carrot and onion. Germination of carrot (P = 0:050, R^2 = 0:55) and onion (P = 0:050, R^2 = 0:61) decreased as the rates of compost application increased. Seedling survival of most vegetables was similarly unaffected by compost rates, with the exception of carrot (P = 0:048, R^2 = 0:78) and onion (P = 0:060, R^2 = 0.74). The average time of germination increased with increasing compost rates for tomato (P = 0:031, R^2 = 0:83), carrot (P = 0:013, R^2 = 0:86), lettuce (P = 0:012, R^2 = 0:91) and okra (P = 0:001, R^2 = 0:98). For these vegetables, the average time for germination was 1–2 days longer at high compost rates (>50 percent) than low rates (<6.25 percent). Differences in shoot weight were not apparent after 21 days except for okra, which had the greatest shoot biomass at 6.25 percent compost.

With the exception of carrot and onion plants, seed germination and seedling growth of most vegetables were unaffected by the phytotoxic compounds in the compost. Compost applications to carrot and onion nursery beds should be limited to low amounts or entirely avoided. The delay in germination of some plants is most likely due to low levels of salinity in the compost, which interfered with the imbibition phase of the seeds.

Nematode suppression experiment

Root galls were observed for the majority of plants inoculated with root knot nematodes. Tomato and lettuce plants without compost and those infected with nematodes were either dead or highly infected at the time of harvest. Root galling in tomato (P = 0:001, R^2 = 0:70) and lettuce plants (P = 0:002, R^2 = 0:97) decreased with increasing compost rates. A significant reduction in root galling from the 0 percent compost treatment was observed in tomato plants at 6.25 percent compost and in lettuce plants at 50 percent compost. Phytotoxic effects of compost significantly reduced plant weight when compost rates exceeded 50 percent in tomato and 25 percent in lettuce. The optimum compost rate for greatest yield was between 6.5 percent and 12 percent for tomatoes and 12 percent for lettuce. This research supports other findings which have shown that composted biowaste reduces the incidence of many diseases in a wide range of vegetables (Tuitert et al, 1998; Blok et al, 2002).

Field fertilizer experiments

Three farmers volunteered a limited number of lettuce beds to be used in the experiment. The resulting experimental design had each farmer managing a single replicate of each treatment on their lettuce beds. This design introduced the farmers as a new factor along with fertilizer type and application rate. To discount the effects of the farmers, we attempted to control the management of the lettuce beds. The date of planting and harvesting, quantities and method of fertilizing, watering and hand-weeding were the same for all of them. Nonetheless, differences between them were confirmed through statistical analysis (P = 0:01) and these were caused by differences in management history, location of lettuce beds and pest incidence among the three farmers' plots. Contrast analysis showed that poultry manure treatments had greater yield (P = 0:004) than compost treatments. The compost and poultry manure treatments with the same application rates were paired on the same bed to allow for direct visual comparisons. Although the only significant differences between paired treatments were at the lowest application rate (1 kg m^{-2}) in the third crop (Table 2.4), all farmers agreed that lettuce plants were larger and greener in poultry manure treatments compared with compost treatments. Furthermore, the farmers' perceptions agreed with the statistical analysis, which showed that 4 kg m^{-2} compost had greater lettuce yield (P < 0:05) compared with the control but only in the first crop. Marketable yields of 1.5 kg m^{-2} were obtained from all poultry manure treatments and from the highest compost application (4 kg m−2) (Table 2.4). Lettuce yields increased linearly with increasing compost application in the first crop and marketable yields (about 1.5 kg m^{-2}) were achieved for the 50 and 100 kg N m^2 treatments. In the second crop, marketable lettuce yields were attained only with addition of the 100 kg N m^2 treatment.

Table 2.4 *Yield of lettuce following application of the compost and poultry manure*

Treatment	*Rate*	*Time of application*	*Crop*[1]			*Mean of all crops (kg m^{-2})*
			1st (kg m^{-2})	*2nd (kg m^{-2})*	*3rd (kg m^{-2})*	
Control	0 kg	n.a.	0.9 b	1.0 b	0.8	0.9 d

	m^{-2}				cd	
Compost	1 kg m^{-2}	Every crop	1.4 ab	1.2 ab	1.3 bcd	1.3 cd
Compost	2 kg m^{-2}	Every crop	1.2 ab	0.9 b	1.4 abcd	1.2 d
Compost	4 kg m^{-2}	Every crop	2.4 a	1.7 ab	1.6 abc	1.9 abc
Poultry manure	1 kg m^{-2}	Every crop	2.0 ab	1.7 ab	2.2 a	2.0 ab
Poultry manure	2 kg m^{-2}	Every crop	1.8 ab	1.3 ab	1.8 ab	1.6 abc
Poultry manure	4 kg m^{-2}	Every crop	2.4 a	2.3 a	2.0 ab	2.2 a
Compost	2.5 kg m^{-2}	First crop	1.4 ab	1.0 b	0.7 d	1.1 d
Compost	5 kg m^{-2}	First crop	1.7 ab	1.2 ab	0.7 d	1.2 d
Compost	10 kg m^{-2}	First crop	2.2 ab	1.6 ab	0.7 d	1.5 bcd

[1]Values in each column for each crop and the mean of crops followed by similar letters are not significantly different than Tukey's HSD test (*P* < 0:05). Letters indicate treatment groupings that are statistically different from one another. Grouping rank decreases with alphabetical order (e.g. group 'a' is greater than group 'b').

Lettuce yields in treatments that only had a compost application on the first crop were not different from the control in each crop nor for the mean of all crops. Yields obtained from the control treatment remained the same for the crops in the three cropping seasons. Since no soil nutrients were added, it would have been expected that the continued extraction of nutrients in harvested lettuce would deplete the nutrients in the control plot to a level where no crop would have grown. This is because nitrogen mineralized from the organic matter in the sandy soil was unlikely to provide sufficient nutrients to explain these yields. However, irrigation water used in this study supplied about 50 kg N ha−1 per month and acted as fertilizer to the control treatment.

CONCLUSIONS AND RECOMMENDATIONS

Farmers were aware of the potential benefits compost could give to improving soil quality, increasing yields and controlling the incidence of pests and diseases. However, there were many concerns regarding the potential costs of producing compost, the difficulty in using the bulky compost and the health risks associated with handling compost made from night soil.

WTP for compost was lowest for urban vegetable farmers (US$0.10 per 50 kg), who rely on readily accessible and cheap poultry manure, whereas peri-urban vegetable farmers were ready to pay US$3 per 50 kg.

Demand for compost in Kumasi was estimated at about 11,000 tonnes per year based on the assumption that subsidies were provided. But without subsidies actual demand was only 940 tonnes per year.

Adding compost increased growth and did not delay germination of a wide range of vegetables when applied at concentrations between 6.25 and 12.5 percent, with the exception of carrot and onion. Nematode damage in lettuce and tomato plants was also suppressed, and poultry manure was the organic fertilizer of choice for the urban farmers in Kumasi.

In conclusion, we can infer from this study that large-scale compost production from urban organic waste and night soil in Kumasi is not an economically viable project without some kind of subsidy. Sorting and transportation costs for compost at this scale outweigh the economic benefits associated with the use of compost. There is a need to explore also the viability of community-based composting initiatives at the farm level, where sorting and transportation costs are minimal.

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NOTE

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