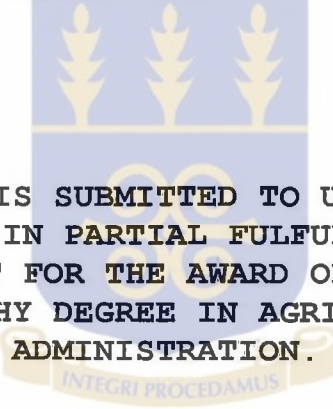


**WILLINGNESS TO PAY FOR COMPOST FROM
URBAN WASTE BY FARMERS OF DIFFERENT
URBAN AND PERI-URBAN FARMING SYSTEMS
IN THE GREATER ACCRA REGION.**

BY

HENRIETTA OPOKUA AMPADU

The crest of the University of Ghana is centered behind the text. It features a shield with three golden stalks of grain at the top, a central emblem, and a banner at the bottom with the motto 'INTEGRI PROCEDAMUS'.

**THIS THESIS IS SUBMITTED TO UNIVERSITY OF
GHANA, LEGON IN PARTIAL FULFILLMENT OF THE
REQUIREMENT FOR THE AWARD OF MASTER OF
PHILOSOPHY DEGREE IN AGRICULTURAL
ADMINISTRATION.**

**DEPARTMENT OF AGRICULTURAL ECONOMY
AND FARM MANAGEMENT
FACULTY OF AGRICULTURE
UNIVERSITY OF GHANA
LEGON**

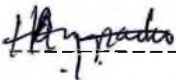
JULY, 2001



DECLARATION

I, HENRIETTA OPOKUA AMPADU, author of this thesis titled "Willingness to pay for compost from urban waste by farmers of different urban and peri-urban farming systems in the Greater Accra Region", do hereby declare that apart from references of other people's work which has been duly acknowledged, the research work presented in this thesis was done entirely by me in the Department of Agricultural Economy and Farm Management, University of Ghana, Legon from September 2000 to July 2001.

This work has never been presented in whole or in part for any other degree in this University or elsewhere.



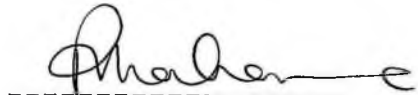
Henrietta Opokua Ampadu

(STUDENT)

This dissertation has been presented for examination with the approval of my supervisors.



Rev. Dr S. Asuming-Brempong
(MAJOR SUPERVISOR)



Dr. Ramatu Al-hassan
(Co-SUPERVISOR)

DEDICATION

This work is dedicated to my family and all mothers, especially to my mother Abena Serwaa Ampadu, who have made great sacrifices for their children's education, that these children might be the best they can be and attain their highest potential. Thank you mother!!



ACKNOWLEDGEMENT

I wish to express my sincere thanks and appreciation to God for bringing me this far.

I wish to also express my sincere appreciation to my supervisors; Rev. Dr. Asuming Brempong and Dr. (Mrs.) Ramatu Al-hassan, for taking time off their busy schedules to make immense contributions and suggestions to this study.

I am very grateful to International Water and Management Institute, IWMI (formerly IBSRAM) for the financial and literature support they provided for this study. My sincere thanks also go to Mr. Allotey, the Coordinator of IWMI (IBSRAM) project, at University of Ghana for all the contribution he made to my work.

Dr. Dagmar Kunze of Food and Agricultural Organization of the United Nations (RAFA UNIT) also provided fruitful guidance for which I am very grateful. I am most grateful to Mr. Edward Banson formerly of Food and Agricultural Organization of the United Nations (RAFA UNIT) for all the technical assistance he offered me whilst serving as an intern with FAO, and also for lending me his Gateway laptop computer to use for

this work. Eddy you're the best, it really did help!

Special thanks also go to Miss Benedicta Adjoa Yeboah, Miss Ernestina Arhine (my room mate), K.Y.fosu, Mr. Eric Osei Asare and my dear Mr.Kojo Mensa Amissah, for all their support.

I would also like to say thank you to Mr. Jatoo J.B. Donsaanang, my colleagues especially member of the IWMI team, for all the contributions they made to this work.

ABSTRACT

This study identified the types of soil ameliorant that exist in the Greater Accra Region of Ghana. It also determined farmer's willingness to pay for composted urban waste as well as the amounts they were willing to pay for a 50kg bag of compost should it result in a 25% and 50% increments in output, respectively. The study further investigated the socio-economic factors that affect farmer's willingness to pay for compost.

The results obtained further revealed that different types of soil ameliorants existed in the study area and these include compost, chemical fertiliser, black soil, poultry manure, cow dung, night soil, household refuse, sheep and goat droppings and industrial waste.

The average amount of money farmers were willing to pay for compost varied with the different farming systems. However, when the farming systems were combined, the average amounts that farmers were willing to pay at 25% and 50% increments in output were ₵13,955.70 and ₵18,978.21 respectively per 50kg bag of compost.

Empirical evidence from the estimation of the logit model indicated that the level of farmer's education and gender

positively affected farmers' willingness to pay for compost, whereas their profit levels had a negative relationship with their willingness to pay

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LIST OF ABBREVIATIONS

COG	Canadian Organic Growers
CVM	Contingent Valuation Method
FAO	Food and agricultural Organisation the United Nations
FAO-COAG	Food and Agriculture organisation Committee on Agriculture
GAEC	Ghana Atomic Energy Commission
IBSRAM	International Board for Soil Research and Management
IDRC	International Development Research Centre
IWMI	International Water and Management Institute
MOFA	Ministry of Food and Agriculture
UNDP	United Nations Development Programme
UPA	Urban and Peri-urban Agriculture
SPSS	Statistical Package for Social Sciences
VRA	Volta River Authority
WLS	Weighted Least Squares
WTP	Willingness to Pay

CHAPTER ONE

INTRODUCTION

1.1 Background

According to United Nations projections (Economist 1998 a,b), Africa's population will almost triple by 2050, even under a medium fertility scenario. This boom will happen in urban and peri-urban areas where the population of 1985 will have doubled already by the year 2000. Especially affected will be West Africa where the urban population growth rate of 6.3% is more than twice the rate of the total population growth. In its humid forest zone in the late 1990, more people live in cities than in rural areas, and in 20 years time two out of every three West Africans will live in urban centres (Snrech 1994; Economist 1998 a,b, cited in Drechsel et al 1999).

The challenges arising from the rapid urban growth concern first of all the production of sufficient food on a sustainable basis, starting with the need for inputs (nutrients, water, biocides, and labour) in the production areas and ending with the need for adequate and safe waste management in the consumption areas. Unlike waste in rural areas, urban household and market refuse are not returned into the soil and contributes to urban pollution and health risks, or are used as

landfills. Hence, there is little or no return of biomass to city-related production areas. However, urban waste can be a rich source of organic fertiliser for farmers in the urban and peri-urban areas due to preference of consumers in importing countries for organic foods (i.e. food grown without or with minimum application of chemicals). In the USA for example, agricultural policies have attempted to maintain low food prices, and high-income levels, and encouraged farmers to use fertilisers and pesticides to increase short-run production levels and profits.

However, excessive use of these chemicals tends to weaken the soil structure and can easily result in soil erosion and degradation. It can also create problems for producers and possibly consumers, for example, through contamination of water supply and chemical residues in food products (William 1990 cited in FAO 1994). Others have further argued that the excessive use of fertiliser, particularly super phosphate, may damage the structure and the overall quality of soils (Costin and Coombs, 1981) Hence, it is important that other appropriate soil enrichment nutrients, which are environmentally friendly, be found.

Sustainability of the environment has therefore become a very important issue more than ever at the beginning of the twenty-first century. Countries, the world over, are researching into new ways to maintain their environments for many more years to come. Carlson (1962) gave rise to environmental consciousness and a renewed focus on organic agriculture. The organic movement broadened its scope in the 1960s and 1970s to include the relationship between agriculture and resource conservation by emphasising the limited use of non-renewable resources (Youngberry, Schaller, and Merrigan, 1993).

A consumer survey conducted in the United States of America for example, indicated that consumers prefer organically produced food because of taste, appearance, and personal health reasons, and because they prefer food without pesticide residues (Krissoff, 1998) Warburton and Sarfo-Mensah (1998) indicated that although inorganic fertilisers have an advantage for short duration crops such as vegetables, they affect the quality of starchy staples such as cassava and yam. Consumers are also concerned about general health and environmental issues such as safety of the farm worker, soil and water quality, and protection of wildlife habitats.

In Ghana, the removal of subsidies on agrochemicals in the early 1990's as part of the Structural Adjustment

Programmes has led to high prices of inorganic fertiliser (Harris et al 1998). It is therefore not out of place that efforts are made to identify cheaper and more environmentally friendly soil nutrient enrichments.

1.2 Problem Statement

Rural-urban drift has increased the population of urban centres in recent times all over the world. This increase in population has far outpaced the rate of delivery of basic services, such as water supply, sanitation, and the removal of waste as the production and consumption activities of urban population generate large amounts of waste. Thus one of the most significant issues facing many cities of the world is coping with urban waste generated. It is therefore a common sight to see mountains of waste in many localities in the cities, especially in developing countries.

This waste creates public nuisance, such as bad odours, in addition to posing major threat to human health as they may aid the transmission of faecal-oral infections including diarrhoea and dysentery. They may also contribute to diseases associated with rats such as plagues, leptospirosis, endemic typhus, and rat fever (Rodrigues and Lopez-Real, 1999). The uncollected refuse can also obstruct streets and drainage channels, creating

a favourable environment for mosquitoes such as *Culex quinquefasciatus*, *Aedes aegypti* and others, which may transmit filariasis and viral infections such as dengue and yellow fever (Cairncross and Feachem, 1993).

The disposal of such large amounts of waste poses a major challenge to municipal authorities, especially in developing countries where the authorities are constrained by resources (Hoorweg, Thomas and Otten, 1999). Therefore the conversion of this waste into a useful product such as organic fertiliser which can be incorporated into the soil to improve the nutrient status of the soil is very much welcome.

Organic fertilisers have been identified as good soil enrichment agents, which have the ability to improve the soil organic matter levels and soil structure (FAO, 1994) Organic fertiliser can be produced from various organic materials such as farm manure, crop residue, and organic municipal wastes.

The city of Accra in Ghana for instance, is estimated to have a population of 2.0 million (1997) and a floating population of 200,000, generating about 990 tons of solid waste per day, of which 60% is organic in nature (Fobil, 2000). Waste generated in the urban and peri-urban areas

of the Greater Accra Region thus poses a major problem to the municipal authorities regarding its safe disposal. In addition, the dumping sites are presently facing community opposition as adjoining land and air are being polluted. Recycling of the organic component of waste into compost, therefore, holds an immeasurable potential for managing the waste generated (Fobil, 2000). This method helps reduce environmental degradation and produces organic fertiliser, which can be used by farmers in the urban and peri-urban areas where farming activities have increased in recent times due to the rural-urban population drift. Farming activities in urban areas are perceived as a solution to the problem of unemployment, food insecurity and malnutrition, urban poverty and environmental degradation (Maxwell and Armar-Klemesu, 1998).

Maung (1982) reported that municipal solid waste found in developing countries generally have high organic matter content and low heavy metal component, and is therefore safe for application to the soil. Hence, a better alternative use of urban waste is to compost it into organic fertiliser for farmers', parks and gardens operators, as well as households.

The large quantities of waste produced in many urban centres of the cities of Ghana, e.g. 900 tons of solid waste per day in Accra can supply sufficient organic waste for composting plants. Composting organic waste will enhance urban hygiene and the ecology. It also makes economic and common sense to collect, process and utilise as close to the organic waste origins as possible. Although such materials could also be used in rural farming, the economic cost attached to the transportation of the inputs to the rural areas could be prohibitive (Parr and Papendick 1982) Also the composting plants can also take advantage of the economies of scale achieved as a result of availability of large quantities of organic waste and familiarity of farmers about the use of organic fertiliser in farming.

Two fundamental issues therefore need careful consideration: What types of composted organic matter exist in Ghanaian cities? Are farmers in the urban and peri-urban areas of Ghana willing to complement chemical fertilisers with composted urban waste, and what amount are they willing to pay for such a product? What kind of situation pertains in the study area of the Greater Accra metropolitan areas?

1.3 Objectives of the Study.

The broad objective of the study is to estimate the willingness to pay for composted urban waste by farmers of different urban and peri-urban farming systems, using the Greater Accra metropolitan area as a case study.

The specific objectives include:

1. To identify the type of soil ameliorants that exists in the Greater Accra metropolitan area of Ghana;
2. To determine the socio-economic factors that affect farmers' willingness to pay for composted urban waste as fertiliser and;
3. To determine farmers' willingness to pay for composted urban waste as fertiliser, and estimate how much they are willing to pay

1.4 Relevance of the Study

Pervious soil research has answered questions regarding the technical side of compost use in Ghana (Warburton and Sarfo-Mensah, 1998; Harris and Smith, 1998) Current research is looking into farmers' perception of organic waste as plant nutrient source (Drechsel et al, 2000). Additionally, one needs to look into the economic aspects to determine if farmers will be interested in and will pay for compost from urban waste and how much they will be willing to pay for the compost.

This study is important because it seeks to identify the factors that affect farmers' willingness to pay for compost, how much they are willing to pay and in each farming systems. The information obtained from the study will enable municipal authorities and other interested organisations assess the viability of composting, along other options for managing the waste while recycling soil nutrients at the same time.

1.5 Organisation of Study

The study is organised into five chapters. Chapter two presents a detailed review of existing literature on the various types of farming systems, urban and peri-urban agriculture, the use of urban waste in composting, and the willingness to pay concept as well as the description of the study area. The methodology, which outlines the theoretical framework and relevant models, is the subject of Chapter three. Determinants of farmers' willingness to pay for compost and discussion of results are presented in Chapter four. Chapter five provides summary, conclusions and policy recommendations, limitation of the study as well as suggestions for future research.

CHAPTER TWO

REVIEW OF EXISTING LITERATURE

2.1 Introduction

Over 70% of Africa's population live in rural areas, and most of them depend directly on small farm holdings for a living. Although many people are moving to the cities mainly because they hope for a better standard of living there, it is common knowledge that even in the cities many people still try to cultivate small plots to obtain some of their food (IDRC 1993). Thus, it is clear that farming is by far the largest economic enterprise in Africa, and it is vital for the well being of most people (Ker, 1995). Depending on the environment in an area, many of them may grow the same crops, keep the same animals, and go about their farming in a similar manner. Consequently, they can be said to practice the same farming system (Ker, 1995).

Farmers have to adapt their farming to their environment. To succeed, they must work with nature and not against it. They must adapt their systems to existing infrastructure and the availability of inputs including as water, electricity, fertiliser, pesticides, labour, advice and information from extension officers, in addition to the existing land-tenure institutions in

their locality. External economic factors such as location, availability of roads, communication facilities, markets for selling produce, prices, credit, producer subsidies, and other features affect the attractiveness and profitability of different farming systems. Internal factors such as farm size, the availability of labour, resources that can be invested, and fixed improvements are other determinants.

Finally, personal choice and preferences may influence the system (MacArthur cited in Ker, 1995) Socio-economic conditions as well as physical boundaries thus define farming systems. The socio-economic conditions determine the type of people involved in the farming activity (the farm household) as well as the resources and inputs, capital, and information managed by the farm household. On the other hand, physical boundaries such as farm size and soil type determine the type of farms or farming systems (Ker, 1995).

2.2 Definition of Urban and Peri-Urban Agriculture

The United Nations Development Programme (UNDP, 1996) defines urban and peri-urban agriculture as an activity that produces, processes, and markets food and other products, on land and water in urban and peri-urban areas, applying intensive production methods and using or

re-using natural resources and urban waste, to yield a diversity of crops and livestock. FAO-COAG (1999) further defines urban and peri-urban agriculture as agricultural practices within and around the cities, which compete for resources (land, water, energy, and labour) that could also serve other purpose to satisfy the requirements of urban population. Important sectors of urban and peri-urban agriculture include horticulture, livestock, fodder and milk production, aquaculture, and forestry.

The common perception that dominates much of the literature is the important role that urban and peri-urban agriculture plays in feeding the mega cities of the world. For instance, in the United States it is estimated that 70% of fruits, vegetables, and ornamental plants are grown on urban land (Rabinovitch and Schmetzer 1997, cited in Drechsel et al 1999). The Asian experience also reveals similar trends where approximately 25% to 85% of vegetable demand can be satisfied by urban and peri-urban production (Midmore, 1996)

2.3 Typology of Farming Systems and Characteristics of Urban and Peri-Urban Agriculture (UPA)

Generally, farming systems vary from continent to continent. Armar-Klemensu and Maxwell (1999) identified the types of farming systems in the urban and peri-urban

areas of Accra (Ghana) as being food crops, backyard gardening or home gardens, vegetable farming, poultry farming, and mixed farming. These systems are similar to those found in other West African cities such as Dakar in Senegal and Cotonou in Benin where the predominant farming systems are home gardens, vegetable production, small-scale livestock and poultry (Mbaye and Moustier, 1999; Brock, 1999).

In the East African sub-region urban and peri-urban farming systems are similar. According to Jacobi, Amend & Kiango, (1999), home gardening, community gardening, small-scale livestock, vegetables, mixed crop-livestock systems and fruit productions are found in Tanzania. Also home gardens, small-scale livestock, market horticultural and vegetables crops are found in Harare, Zimbabwe (Mbiba, 1999)

In Nairobi, (Kenya), home gardens, vegetables, poultry, crop production, and market farms are also practised (Foeken and Mwangi 1999). Also in Lusaka, Zambia, home gardens, vegetable production, small-scale livestock and crop production also exist (Drescher and Muwowo, 1999)

The farming systems in Latin America are also similar, however there are particular farming systems that are

predominant in some countries (Jacobi et al 2000). For instance Cuba, Costa Rica, the Dominican Republic, Haiti, Mexico, and Peru, all have home gardens and vegetable characterising their urban and peri-urban agriculture. However, organoponics, tobacco, and hydroponics are specific to Cuba, Dominican Republic and Peru, respectively (Jacobi et al 2000).

In Asia, the farming systems are also similar but particular farming systems are peculiar to some countries. In Hubli-Dharward in India however, farming systems in the urban and peri-urban areas are made up of vegetables, small livestock and sewage based farming system (Nunan 1999). In Cagayan de Oro (Philippines) urban and peri-urban farming systems are characterised by 40% home gardens, fish production, food crops and vegetable production (Potutan et al 1999).

The predominance of home gardens (backyard gardens) across different regions agrees with the observation of Smit (1996), that home garden production are mainly for home consumption and also forms a component of a survival strategy (Smit 1996 cited in Brock 1999) Horticultural production is also common in urban and peri-urban farming systems practised in many regions of the world. This may be due to the short maturity period and the minimum

inputs required for their cultivation. For vegetables in particular, the proximities of such farms to market centres explains why they are practised throughout the world (Drechsel et al 1999).

The Food and Agriculture Organisation of the United Nation (FAO, 1999) indicated that urban agriculture takes place in small areas within the city in the form of growing crops and raising small livestock for own-consumption or sale in neighbourhood markets. According to Smit's report (1996), the number of urban farmers producing for the market is expected to double from 200 million in the early 1990's to 400 million by 2005.

Peri-urban agriculture is characterised by the fact that takes place in farm units close to town and cities. It includes intensive, semi-or fully commercial farms, which grow vegetables and other horticultural crops, raise chicken and other livestock, and produce milk and eggs. Furthermore, urban and peri-urban agriculture occurs within cities and in the surrounding boundaries of cities throughout the world. It also includes fisheries, forestry and non-wood forest products, as well as ecological services provided by agriculture, fisheries, and forestry. Often, multiple farming and gardening systems exist in and around a single city Urban and

peri-urban agriculture have proximity to large settlements of people and thereby create opportunities and risks. According to FAO 1997 the opportunities include:

- Less need for packaging, storage and transportation of food.
- Potential agricultural jobs and incomes.
- Non-market access to food for poor consumers.
- Availability of fresh, perishable food.
- Proximity to services, including waste treatment facilities.
- Waste recycling and re-use possibilities.

The risks include:

- Environmental and health risks from inappropriate agricultural and aquacultural practices;
- Increased competition for land, water, energy, and labour;
- Reduced environmental capacity for pollution absorption.

2.4 Composting and the Use of Urban Waste for Compost

Composting is the process of decomposing organic matter, whether manure, crop residue or municipal wastes, by microbial activity in a warm, moist aerobic environment (Canadian Organic Grower's (COG), 1992). The organic

matter is decomposed by successive action of bacteria, fungi, and actinomycetes. In the final stages of decomposition, red worms (or manure worms) assist in the production of stable humus, which is the final stage of the composting process. The nutritive and other benefits of the material depend largely on the source of the material, the conditions under which it was made and the maturity of the compost when it is applied (COG, 1992) Young or medium compost encourages biological activity in the soil. However mature compost makes a greater contribution to soil organic matter levels and soil structure. In general however, the process results in a net improvement to soil fertility

Research has also indicated that apart from compost acting as organic fertiliser, it plays an important role in improving soil physical properties (Polprasert, 1989 cited in Hart & Pluimers 1995). Compost maintains the humus balance in the soil, helps to bind nutrients, ensures the proper circulation of air and water, and is thus enhances for the growth of healthy crops. It also has a mulching effect, which includes moisture-holding capacity, prevention of weeds and reduction of erosion (Hart and Pluimers, 1996). With the numerous advantages of compost, it is very important to investigate whether

farmers will be willing to pay for this soil enrichment nutrient.

2.5 Willingness to Pay Concept

Placing a value on non-market goods is much more difficult than valuing market goods because no formal markets exist to obtain market information. Therefore researchers have resorted to non-market valuation techniques to measure consumers' willingness to pay (Buzby et al 1997) Whittington et al (1990) indicated that most attempts to incorporate willingness-to-pay considerations into project design have been ad hoc, partly because of the absence of validated, field-tested methodologies for assessing willingness to pay (for example water), in the context of rural communities in developing countries.

The contingent valuation method (CVM), which encompasses personal interviews, mail surveys, and telephone surveys, is one of the appropriate methods used to estimate willingness to pay, since it is based on eliciting consumers' willingness to pay for a non-market good "contingent" on a given hypothetical scenario.

The major problem with contingent valuation method is that, for a variety of reasons, respondents may not

answer willingness-to-pay questions accurately; hence, it does not reveal the 'true' willingness-to-pay. This is because they may underestimate their paying ability if they are to pay for the service, but over estimate their paying ability if the cost is to be borne by someone else.

The contingent valuation method when used to measure individual's willingness to pay for changes in the environmental quality has always proved difficult, because it is difficult for people to perceive what a change, for example, in sulphur dioxide or dissolved oxygen means in terms of air or water quality (Whittington *et al*, 1990). It is also alleged, particularly in developing countries, that individuals will not take contingent valuation questions seriously and will simply respond by giving whatever answer comes to mind first, leading to hypothetical bias. The fact that contingent valuation methods (CVM) are based on assessing stated preference as opposed to determining revealed preference is a source of controversy.

However, past research works indicate that contingent valuation methods generate results that are comparable in terms of accuracy to other approaches that value non-market goods (Anderson and Bishop 1986, Cumming *et al*

1986, Mitchell and Carson 1989) Other strengths of contingent valuation methods are that they tend to be less expensive than actual market experiments (Misra *et al* 1991) and contingent valuation does not rely on secondary data sources originally developed for other needs (Anderson and Bishop 1986, Cumming *et al* 1986). Loomis (1996), Loomis and Feldman (1995), Bishop *et al* (1989) and Barrens *et al* (1996), used the contingent valuation method to estimate willingness to pay, thus providing valuable information for policy makers to make informed decisions about preserving existing natural resources.

Willingness to pay can also be used to assess a product such as compost, which can be argued as a marketable good, unlike clean air, which cannot be marketed. This can be achieved by outlining the advantages farmers will derive from compost (i.e. improvement in soil structure and fertility), after which they are asked to state the amounts they are willing to pay for a specified quantity of compost.

2.6 Summary

Composting of municipal organic waste is a rational way of waste reduction instead of disposal in landfills, incineration, and other methods. The products of

composting can be used successfully in different farming systems to improve crop yields, and thereby lead to an increase in farmers' income. It can also lead to the sustainability of the environment as waste generated is recycled and returned into the soils in the form of compost to improve the soil's fertility. The review of the literature shows that compost can be used with success in agriculture and contingent valuation method can be used to determine farmers' willingness to pay for compost based on a given hypothetical situation.

2.7 Study Area

The study was carried out in the urban and peri-urban areas of the Greater Accra region. In the urban areas the following sub-metropolitan areas were covered: (a) Ayawaso (Dzorwulu Plant Pool area, Lapaz Motorway, Atomic Commission Energy area), (b) Okai koi (North Kaneshie), (c) Ablekuma (Korle-bu, Dansoman), (d) Osu Clottee (Castle Road, Cantoments), (e) Kpeshie (La, Trade Fair area, Teshie Nungua), as well as the urban centres of Tema. These farming areas were selected based on recommendation of technical officers of the Food and Agriculture Organisation (FAO) of the United Nations. These farming areas are also among the major areas where vegetable, ornamental and backyard farming activities normally take place, in addition to the fact that they

receive extension services and take part in farmer field schools organised by Ministry of Food and Agriculture (MOFA) and Food and Agriculture Organisation of the United Nations (FAO-UN). The peri-urban areas covered are located in the Ga District and the areas covered include Mempaem, Samsam, Samsam Odumasi, Ashaladja, Domeabra and Kosoa. These peri-urban areas were selected since they are the main pineapple producing areas in the Greater Accra Metropolitan area (See figure 1)

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the study's methodology, which includes the use of Statistical Package for Social Sciences (SPSS) to analyse data collected for the first, and second objectives. Descriptive analyses including percentages, cross-tabulations and paired t-tests are used to evaluate these objectives. The theoretical framework on which the econometric model is developed to address the third objective of the study is also outlined in this chapter. Achieving this objective requires using data obtained through the Contingent Valuation Method (CVM) A logit regression model is developed to estimate farmers' willingness to pay for compost in the different farming systems (vegetable, backyard, pineapple, and ornamental) as well as the socio-economic determinants of their willingness to pay.

3.2 Theoretical Framework for Estimating Farmers' Willingness to Pay for Compost.

The willingness to pay for compost can be determined using the Contingent Valuation Method (CVM) This method involves the use of interviews or questionnaires to solicit information from respondents about how much they

are willing to pay for the use of a specified amount of compost in their farming activities. From economic theory, consumers derive utility or satisfaction from the bundle of goods they consume, and this utility indicates the level of enjoyment or preference attached to a basket of goods by a consumers (Mansfield 1991).

Farmers are producers and therefore have a production function. Thus, it can be inferred that they gain utility from the use of several inputs, for example, compost for their farming activities to produce outputs. The farmer's utility function can therefore be written as follows:

$$u = U (b ,h, g) \quad (1)$$

where $U(.)$ is the farmers utility function, b is the vector of probabilities of obtaining higher crop yield as a result of the use of compost by each of the members of farmers in the different farming systems (i.e. vegetable, horticultural, backyard, pineapple); h is a row vector describing the farmer's consumption of other goods apart from c , which denotes an environmental good such as compost, g is a row vector of background variables (household characteristics such as age structure, education). For notational simplicity, g is suppressed from now on in this section.

The use of an environmental good, such as compost for use in farming has an influence on the output level (yield of crops). This therefore means that the probability of obtaining higher yield is a function of the use of compost, as shown in the equation (2) below:

$$b = B(c) \quad (2)$$

Where $B(c)$ could be seen as a vector $[B_1(c), B_2(c), \dots, B_m(c)]$ of production function relating level of compost consumption activities to probabilities of b . Thus, it can be assumed that for first order condition

$$\partial B_i(c) / \partial c > 0 \text{ and}$$

Second order condition

$$\partial^2 B_i(c) / \partial c^2 < 0 \text{ (Söderqvist 1995)}$$

In the special case of a single farmer, equation (1) reduces to $u = U(b, h)$ and (2) to $b = B(c)$. A farmer is assumed to maximize his utility $u(\cdot)$ over b and h subject to equation (2) and his budget constraint.

$$\text{Max}_{b, h} U(b, h)$$

s.t

$$b = B(c) \quad (3)$$

$$p_c c + p_h h = y$$

Where p_c is the price of compost, p is a row vector of prices of all goods other than c , and y is the farmer's disposable income. Among the first order condition for a maximum, we have,

$$\sum_i^m = \partial U (.)/\partial b_i. \partial B_i (.)/\partial c = \lambda p_c \quad (4)$$

Where λ is the Lagrange multiplier. The appearance of this condition is explained by the social welfare function nature of farmer's utility function. Assuming that the solution to the maximisation problem is described by well-behaved demand function, then the following Marshallian demand functions for compost c , and the other goods results:

$$C = C (p_c, p, y) \quad (5)$$

$$b = B (p_c, p, y) \quad (6)$$

$$h = H (p_c, p, y) \quad (7)$$

To obtain the indirect utility function for compost, we substitute equations (5), (6) and (7) into equation (1):

$$v = V (p_c, p, y) = U [B(C (p_c, p, y), H (p_c, p, y) (8)$$

Where v is the farmer's indirect utility; $V(.)$ is the direct utility function; $C(.)$ is the Marshallian demand function for the use of compost; and $H(.)$ is the vector of demand functions for all goods other than c .

Where the farmer can freely choose the desired vector of probabilities of obtaining higher crop yield as a result of the use of compost in his farming activities, the indirect utility function does not have b (or c) as an argument, since $b = B[C(.)]$ is a function of price and income. However, in a situation or case where the farmer is confronted with a hypothetical situation involving certain probabilities b^0 corresponding to some level of compost use c^0 , the farmer is restricted to facing b^0 in this case, and thus $U(.)$ can only be maximised over h . The resulting indirect utility function is:

$$v^0 = V(b^0, p, y - p_c c^0) \quad (9)$$

For notational simplicity p is suppressed and c^0 is set to equal to zero in the following discussion.

A change from b^0 to another hypothetical situation b^1 , corresponding to another level of compost use c^1 , which cost the farmer $p_c c^1$, implies a change in indirect utility to v^1 . Thus if a farmer is offered a choice between situation 0 and situation 1, he will only accept

situation 1 if v^1 is at least as large as v^0 . The amount of money that keeps the farmer at the utility level of situation 0 when confronted with situation 1 is the compensating variation (CV). The CV is defined implicitly as:

$$V(b^1, y - CV) = V(b^0, y) \quad (10)$$

Where $CV = p_c * c^1$ and $p_c *$ is the farmer's reservation price for the change from situation 0 to 1. The CV can be interpreted as the farmer's maximum willingness to pay (WTP) for change from situation 0 to situation 1 and is a money measure of utility. Hence with this interpretation, it follows that the farmer would accept to pay any amount $a \leq WTP$ for a change from situation 0 to 1, since $V^1(b^1, y - a) \geq V(b^0, y)$, when $a \leq WTP$. In this situation a is the amount that farmers would indicate to pay when asked how much they would be willing to pay.

This indicates that a farmer will be willing to pay for compost use if his new utility level of compost use b^1 is greater than the initial level of b^0

In dealing with several farmers (such as vegetable, ornamental, and backyard farmers) valuing a change in b differently, a measure of their average maximum

willingness to pay (WTP) such as mean WTP or the median WTP is often sought, since mean WTP is a money measure of relevance for a traditional welfare economics analysis. The mean WTP will be estimated using a Contingent Valuation Method (CVM) described by Hanemann (1984).

Hanemann (1984) followed the random utility maximisation model. He argued that only the farmer himself knows his utility function and that researchers can only observe a subset of the characteristics determining the farmer's choices. In this present study, the farmer's model can be interpreted as follows

$$V(b, y) = W(b, y) + e \quad (11)$$

where $V(.)$ is the indirect utility function of equation (11), $W(.)$ is part of $V(.)$ observable to the researcher and e is a random disturbance term with $E[e] = 0$.

It follows that the farmer will accept to pay an amount a , for a change from situation 0 to situation 1 if

$$W(b^1, y - a) + e^1 \geq W(b^0, y) + e^0 \quad (12)$$

and that WTP is the particular (amount of money) a that makes equation (12) an equality:

$$W(b^1, y - WTP) + e^1 = W(b^0, y) + e^0 \quad (13)$$

Where e^1 and e^0 are identically and independently distributed random variables. Thus in equation (13) WTP is a stochastic variable dependent on $W(\cdot)$ and the random disturbance terms e and thus has some cumulative distribution function $F_{WTP}(a)$, giving the probability that WTP is less than or equal to an amount of money, a i.e. $F_{WTP}(a) = \text{Prob}\{WTP \leq a\}$. It thus follows that $1 - F_{WTP}(a) = \text{Prob}\{WTP \geq a\}$; that is the probability that a farmer would accept to pay the amount a for a change from situation 0 to situation 1. It can thus be shown (Kristrom 1991, pp 64-66) that the mean WTP can be computed as:

$$E[WTP] = \int_0^\infty [1 - F_{WTP}(a)] da = \int_{-\infty}^0 F_{WTP}(a) da = \int_0^\infty F_{\Delta e}(\Delta W) da$$

$$\int_{-\infty}^0 [1 - F_{\Delta e}(\Delta W)] da \quad (14)$$

Where $F_{\Delta e}(\Delta W) = \text{Prob}\{WTP \geq a\} = \text{Prob}\{W(b^1, y - a) + e^1 \geq W(b^0, y) + e^0\}$

and $1 - F_{\Delta e}(\Delta W)$ is the cumulative distribution function for $\Delta e = e^0 - e^1$ and

$$\Delta W = W(b^1, y - a) - W(b^0, y)$$

Thus in practice the calculation of the WTP may require some specification of $W(\cdot)$ and the functions $F_{WTP}(a)$ and $F_{\Delta e}(\Delta W)$.

Empirically, $Prob\{WTP \geq a\} = F_{\Delta e}(\Delta W) = 1 - F_{WTP}(a)$ can be interpreted as the proportions of yes answers given by the farmer to a question if they are prepared to pay a particular bid a for a change from situation 0 to 1. This proportion, say d may be estimated with the aid of data obtained from a contingent valuation method questionnaire.

The aggregate demand for change from situation 0 to 1 is given by

$$d = D(a) = 1 - F_{WTP}(a) = Prob\{WTP \geq a\} \quad (15)$$

where $D(a)$ is the aggregate demand function and F_{WTP} is a cumulative distribution function.

Note that,

$$Prob\{WTP \geq a\} = \{V^1(b^1, y - a) - V^0(b^0, y) \geq 0\} \equiv \{\Delta v \geq 0\}$$

A linear approximation of Δv around (b^0, y) is

$$\Delta v = \left[\sum_{i=1}^m (\delta V(b^0, y) / \delta b_i) (b_i^1 - b_i^0) \right] + (\delta V(b^0, y) / \delta y) a \equiv \alpha - \beta a \quad (16)$$

Thus, $\Delta v = \alpha - \beta a$

The approximation implies that $Prob\{WTP \geq a\}$ can be written as $Prob\{\alpha - \beta a \geq 0\}$ where α and β are coefficient to be estimated.

The mean and median WTP can be estimated by employing some parametric specification. The particular parametric specification commonly employed in CVM studies is the logit model (Bishop and Heberlein, 1979) It was earlier noted that $Prob\{WTP \geq a\}$ can be expressed in terms of the sign of Δv . A linear approximation will result in $\Delta v = \alpha - \beta a$, which implies that the following specification of $D(a)$, will be called logit henceforth:

$$Prob\{WTP \geq a\} = D(a) = d = 1/[1 + \exp(-(\Delta v))] = 1/[1 + \exp(-(\alpha - \beta a))] \quad (17)$$

where d can be interpreted as the proportion of farmers accepting the bid a . This model can either be estimated by the weighted least square (WLS) or the maximum likelihood method (Greene, 1993). In this study, the estimation is done using the logit model.

Now re-introducing g in an ad-hoc manner into equation (16) gives

$$Prob\{WTP \geq a\} = Prob\{\alpha - \beta a + \gamma g \geq 0\} \quad (18)$$

The model to estimate farmers' willingness to pay for compost in different farming systems is based on equation (18).

3.3 Specification of Econometric Model for Farmers' Willingness to Pay for Compost.

If WTP_i is the probability of willing to pay for 1- WTP_i is the probability of not willing to pay, the ratio of $WTP_i/(1- WTP_i)$, known as the odds ratio, is simply the odds in favour of those willing to pay. The natural log of this ratio gives the logit. The logit model implies that the log of the odd ratio is a linear function of explanatory variables (Gujarati, 1992). The logit regression model for objective three is specified as below:

$$\ln\left(\frac{WTP_i}{1-WTP_i}\right) = \alpha - \beta a + \gamma_1 Edu + \gamma_2 Sex + \gamma_3 Age + \gamma_4 Pf + \gamma_5 ExC + \gamma_6 OCC + \gamma_7 MST + \gamma_8 NCLD + e$$

Where

α, β = Coefficient to be estimated

γ = Row vector of coefficients to be estimated

WTP = Willingness to pay

a = The amount Farmers are willing to pay

Edu = Education

Sex = Sex of farmers

Age = Age of farmers

Pf = Profit from farming activity

Exc = Experience with compost

OCC = Occupation

MST = Marital status

$NCLD$ = Number of children

e = Stochastic error term which represents all variables which are not explicitly included in the model.

The reasons for the choice of explanatory variable and their *a priori* expectations are as follows. Education enhances ones ability to receive and decode information (Schultz, 1994), hence it is expected that education will enhance one's ability to appreciate the advantages that improved technologies would bring.

Education is thus expected to positively affect farmers' willingness to pay for compost. In this study education will be measure by grouping the responses into two categories. Those with formal education from primary to tertiary level will be classified as literate and scored 1 whereas those with no formal education will be classified as illiterate and scored 0.

The youth tend to be explorative and are most likely to adopt new technologies than older people (Obeng, 1994). Again some researchers have argued that, young farmers

being more adventurous and with a longer planning horizon are more inclined to accept innovations than older ones (Polson and Spencer, 1992). Thus in this model old age is expected to have a negative relationship with farmers' willingness to pay for compost for the reasons given above. In terms of gender, male farmers normally tend to have access to more credit facilities than their female counterparts (Donkor 1989, cited in Obeng 1994). With this leverage over female farmers, it is expected that the relationship between male farmer's income (profit margin) and their willingness to pay will be positive.

According to Kebede (1990) experience brings with it new knowledge and skills, it also builds up one's confidence and dispels doubt. Experience with the use of compost is thus expected to have a positive effect on farmer's willingness to pay. From the foregoing, farmer's with previous experience with compost will be scored 1. Incomes generated from other activities apart from farming also are expected to positively influence their willingness to pay. On the other hand, the marital status and the number of children a farmer has, increases one's financial responsibility. It is therefore expected that these explanatory variables will compete with resource available for farming; and therefore have a negative relationship with farmers' willingness to pay for

compost. In this study farmers who are married and have children irrespective of the number would be scored 1 and those unmarried and have no children will be scored 0 respectively.

3.4 Data Sources

Primary data was used for this study. The data was collected from 150 farmers consisting of 30 vegetable farmers with experience with compost, 30 vegetable farmers with no experience with compost, 30 ornamental farmers, 30 pineapple farmers and 30 backyard farmers. All the farmers in the other farming systems were randomly selected except for vegetable farmers with experience with compost who were purposively selected. This was because the number of farmers who participated in the farmer field schools few and therefore every farmer who had participated was considered to make up the total sample size of thirty. Furthermore these farmers with experience with compost were of particular interest, since they had had previous experience with composted urban waste, via farmer field schools, thus it was expected that they would be more willing to pay for compost, as they knew of it's associated benefits.

3.5 Data Collection

Structured questionnaires were used to collect the data for the study and they were first pre-tested in part of the Ayawaso sub-metropolitan area (Specially opeabei house area) with 20 randomly selected vegetable farmers. Interview with farmers started in February 2001 and ended in April 2001. One type of questionnaire was designed to

gather relevant information for analysis and drawing conclusion on the objectives of the study (See appendix 1). The questions were mainly closed-ended and covered information ranging from the farmers' socio-demographic characteristics, farming activities, farmers' knowledge of compost and other soil ameliorants, farmers' preference for the different inputs known to them and amounts farmers were willing to pay for compost. The questionnaires also covered the types of crops grown as well as expenditure incurred and income generated by farmers from their farm enterprises.

Information on farmers' expression of their willingness to pay was obtained using contingent valuation method. The contingent valuation method involved giving out a hypothetical situation as done by Buzby, Skees, and Ready (1997) in their contingent valuation study to value food safety. In this study, a hypothetical situations was given to farmers that should the application of compost bring about a 25% and a 50% increase in output, what amount of money would they be willing to pay for 50kg bag of compost.

Farmers in the various farming systems were informed about the improvements compost could make on the farmers land and hence their income levels. A hypothetical

situation was then drawn from the farmer's own farm. The farmer was told for example, that if he obtained 100 pieces of green pepper from a single bed on his farm from the use of his usual soil ameliorant, and if upon application of 50kg bag municipal solid waste compost the yield increases to 125 pieces of green pepper/bed i.e. 25% increase in output how much would he be willing to pay per 50kg bag of compost. The output level was then increased to 150-pieces/bed i.e.50% increment in output. Under such a scenario, the farmer was again asked how much he would be willing to pay for a 50kg bag of municipal waste compost, assuming the compost site was located in Teshie, the near the existing Teshie compost plant and the response noted accordingly.

Focus group discussion interviews were also conducted to obtain more qualitative information.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results of the data analyses and discusses the outputs obtained. These include discussions on the different types of farming systems, the types of soil ameliorants that exist in the study area, farmers' preference for soil ameliorant as well as farmers perception of the cost of inputs being used. Finally, the socio-economic factors that affect farmers willingness to pay, the mean amount farmers of the different farming systems are willing to pay for compost and results of the Logit regression model are also discussed.

4.1.1 Vegetable Farmers

Vegetable farming in Accra is mainly carried out in open spaces along big drains and streams where the water bodies are used to irrigate the crops. Some farmers also have access to pipe borne water for irrigating their farms. Large vegetable farms located in the Ashaiman and Weija areas depend on water from nearby dams for irrigation. The land tenure arrangements prevailing in any farming area impacts positively on farmers' decision to invest in the land. This investment could be in the

form of farm inputs such as soil enrichment nutrient, to help maintain soil fertility, irrigation facility, and investment in machinery. Some of the vegetable farmers rent land for farming. In Haatso areas for example, farmers pay a monthly rent of ₵5000/plot to the Ghana Atomic Energy Commission (GAEC), whereas those who farm in the Dzorwulu areas (on land belonging to the Volta River Authority - VRA) pay nothing to this organisation. The VRA lands are under high-tension poles, and farming in the area prevents estate developers from encroaching on the land. Farmers were however mandated not to plant any permanent tree crops on the land. The on going farming activities also prevent the Volta River Authority from spending resources to hire labour to occasionally clear the land of weeds. Farmers in the Korle-Bu area were also allowed to farm freely on the available hospital land.

On the other hand, vegetable farmers at the Castle Road area, farmed on lands belonging to the Department of Parks and Garden. These farmers were also not required to pay any rent to the authorities, but only to ensure proper maintenance of the area as well as not to plant any permanent crops on the land.

The vegetable farmers in the La area farm on land, which have been mainly acquired through inheritance and about 95% of farmers in the area fall under this category. People who do not have family land and want to farm are required to enter into some kind of agreement (either pay rent or practice sharecropping) with the landowners. With the existence of inheritance form of land tenure arrangement, a piece of land could continue to remain in a particular family for a long period of time until the land is disposed off by the family.

Due to the secure nature of the land, most farmers were interested in investing in the land to improve and maintain the soil's fertility. Additionally, farming was the main occupation of majority of farmers; hence they were interested in trying out new soil ameliorants that would improve their soil's fertility and bring about the needed increase in their crop output, as well as their income levels.

The crops cultivated under this farming system range from exotic vegetables such as lettuce, raddish, cabbage, cauliflower, as well as local ones (e.g. okra, tomatoes, garden eggs)

Exotic vegetables were mostly grown by farmers in the city, where there was high demand for the produce by the elite and foreigners. Local vegetable cultivation, on the other hand, was mostly carried out in the peri-urban areas.

Two categories of farmers were identified under this farming system, those with experience with compost produced from urban waste as a result of participating in an experiment conducted by a Swedish PhD student working on compost and vegetable farmers in Accra, and those without experience with compost.

A total of 30 farmers were sought to be interviewed from each farming system. However, only 22 farmers who had had experience with compost could be located, whereas 30 farmers who had no experience with compost were located. This was because some of the farmers who had had experience with compost had stopped farming due to the unavailability of water and market for their crops. This had therefore forced some of these farmers to abandon their farming activities in search of other jobs, which could provide them with stable incomes. Of the 52 farmers who were interviewed 77% of them were engaged in farming as a full time activity whilst only 23% practised farming as a secondary activity. Farm sizes ranged from 1 to 20 acres, with 40% of farmers having average farm sizes of 2

acres. This was due to the fact that large tracts of land were not readily available for farming in urban centres. It was also observed that farmers had several fields dotted round the city. However, it was possible for farmers in the peri-urban areas to have access to continuous stretch of land from a few acres to several tens of acres.

Male farmers dominated this farming system, as they constituted 76.9% with females forming 23.1% of the population. This could be attributed to the fact that the women preferred to engage in marketing of vegetables rather than farming. The poor access to credit also deterred women from engaging in this farming activity (Observation from Survey) Many of the vegetable farmers were middle aged. Those between ages 21 and 30 years, constituted 28.8% of the sample and only 11.6% of respondents were aged between 31 and 40 years. About 59.6% of respondents were above the age of 41 years. Farmers were usually married (51.9%), with 40.4%, 5.8% and 1.9% being single, widowed and divorced respectively Farmers of Christian faith dominated this farming system representing 61.5% of the total population whereas Muslims constituted 34.6% and those with no religious persuasions representing 3.9%.

These farmers probably occupied themselves with their farming activities as shown by their low participation in leadership positions within their communities. A total of 69.2% of farmers held no social positions, with only 5.8% being chiefs, another 21.2% holding other positions such as opinion leader, chairman and secretary of farmers association, while 3.8% of farmers did not give any response to this question.

Education greatly enhances the introduction and acceptance of a new innovation by any group of people. This is supported by Donkor (1989) as cited in Obeng (1994), who indicated that illiteracy poses problems for development, as there is a strong correlation between educational levels and receptivity to innovations. This is because education gives people the ability to access information, process or analyse and use that information.

Thus the illiterate tend to be more cautious and more resistant to change while the literate tend to be more risk takers and innovative. Farmers under this farming system were mostly literate. The educational status of the respondents showed that, only 20% of the farmers were illiterate. Of the 80% literate farmers, 63% had up to secondary level education. About 15% of respondents had

tertiary education, and only 2% indicated that they had Muslim education as a form of formal education.

4.1.2 Pineapple farmers

Pineapple farming is mainly carried out in the peri-urban area of Accra on leased or rented lands. Rents were paid in the form of cash; a fixed charge for the use of the land irrespective of the yields or the total returns obtained from the farm. The hiring periods last for a season; however leases may be up to 99 years but 50 years was the average lease period.

Land is an important resource in this activity and may be held as a communal property or private property according to whether they are held by the community as a whole or by individuals. As a result of the existing tenancy arrangements 6.6% of farmers were engaged in large-scale (over 300 acres) production of pineapple. About 23.2% of the respondents had medium-scale (10-40 acres) operations, and about 70.2% of farmers were engaged in small-scale (1-9 acres) farming. The bulk (70.2%) of the pineapple grown was for export. The large-scale farmers harvested and packaged their fruits for exports whereas the medium and small-scale farmers harvested their fruits and sold them to exporters who in turn packaged them for export.

Some of these exporters supplied some of the farmers with inputs such as fertiliser and other chemicals (through their association) at prices slightly lower than what normally prevailed on the market. These farmers in turn sold their fruits at prices slightly lower to the exporters with whom they have signed this contract. This arrangement according to farmers enable them have access to a secure and reliable market for their produce.

This not withstanding, there were disadvantages associated with this kind of arrangement. Sometimes farmers were unable to take advantage of high bids from other exporters because of the existing contract they have signed.

Of the 30 respondents interviewed, about 97% were engaged in pineapple farming as their main occupation, while pineapple farming was a secondary occupation of the remaining 3% of farmers. Generally most of the people engaged in this farming activity were males (90%). The low participation of females (10%) in this activity may be due to the strenuous nature of the activities involved in pineapple farming. In addition, these women found it difficult to raise the high capital outlay involved in pineapple production.

The age distribution of farmers indicated that majority of the sampled pineapple farmers were aged between 31 and 40 years; 41 and 50 years with each representing 36.7%. About 10% of pineapple farmers were between the ages of 21 and 30, and 16.6% were aged between 51 and 60.

Education was generally high among these category of farmers, with those of middle level education dominating (43%), followed by those with basic education (up to primary six) 34.7% and those with tertiary education forming 15% of the respondents. Another 7% of farmers however did not indicate their level of education.

Pineapple farmers were mostly Christians (86.7%) with the Muslim population forming only 3.3% whereas 10% of farmers indicated that they did not have any religious inclination. Furthermore, many of the farmers did not hold any social positions (43.3%), 10 % were chiefs in some part of the Ga community, 26.7% were elders, while the other 20% held other positions such as secretary to farmers' association and opinion leaders.

4.1.3 Ornamental farmers

Ornamental farmers were mainly located in the urban areas along major roads. Ornamental farming were mostly carried out in flowerpots except for small plots of land, which

were used as nurseries. The farm sizes of these farmers varied, ranging from small plots to several square meters of land. Farmers grew both local and exotic flowers for the domestic market, which mainly consisted of the middle and high-income level Ghanaian households and the diplomatic community. Some of the ornamental farms were well established and even grew flowers for the export market (e.g. Ghana Fresh)

Men, who represented 83% of respondents of the total population, mostly undertook ornamental production.

About 60% of farmers' engaged in this activity were aged between 21 to 30 years, whilst those aged between 31-40 and 41-50 years represented 20% each of the total respondents. The involvement of young people in ornamental farming may be due to the low initial capital investment required. Furthermore, one could start on a small ornamental farm on any small piece of land by the side of the road as long as it did not obstruct traffic or pose any environmental threat.

Ornamental farmers were generally well educated. Only 10% of ornamental farmers were illiterate, another 80% had up to middle school level education or more, whilst 10% of respondents indicated that they had education up to the university level. Farmers were predominately Christians

(93%), and only 7% were Muslim. This trend may be due to the random way in which respondents were selected. About 60% of ornamental farmers were mostly youth and were not likely to be considered for leadership positions within their community. This explains why there was low participation in leadership positions. Most of the ornamental farmers (87%) were also engaged in landscaping activities and took on contracts from households, filling stations and as well as hotels.

4.1.4 Backyard Farmers

Backyard gardening was mostly carried out on compounds either at the back, in front or adjacent to the houses of households. Land for farming was basically free since they were attached to the main building. Many practitioners undertake this activity as a hobby. Occasionally, when good harvests were made, the excess was sold to their neighbours. Monies realised from the sale of excess food crops ranged from ₵300,000 to ₵1,960,000. Thus, one can conclude that backyard farming activities goes a long way to support households and contribute to ensuring food security in their homes.

The land used for backyard gardens were usually small hence as many as 80% of respondents could not indicate the size of their farms. However, some of the areas used

for backyard farming were measured and on the average the maximum land size was about 0.25 acres. Majority of backyard farmers did not apply any plant nutrient to the soil, however crop residues were left on the land after harvesting to enrich the soil as indicated by 40% of farmers. In some households where livestock were kept, the manure produced was spread in the garden. Occasionally, decomposed household refuse was also applied to the crops.

Crops grown by many households included fruits such as banana (*Musa sapientum*), pawpaw (*Carica papaya*), sugarcane (*Saccharum spp*); coconut (*Cocos nucifera*) and cashew nut (*Anacardium occidentale*) Maize (*Zea Mays*), plantain (*Musa paradisiaca*), cocoyam (*Xanthosoma*) and cassava (*Manihot Utilissima Pohl*) were also grown. Additionally, vegetables such as pepper (*Capsicum annum*), okro (*Hibiscus esculentus*) and garden eggs (*Solanum Melongena*) were cultivated.

Males mainly constituted a higher proportion of people engaged in backyard farming (73%), whilst females who engaged in backyard gardening were mostly housewives (27%). The youth constituted up to 37% of the respondents and were aged between 21 and 30 years, while those aged between 31 to 40 years old formed 13% of backyard

farmers' population. Farmers aged between 41 and 70 years made up about 50% of the sample and this further goes to confirm the notion that, backyard farming was mainly undertaken by the middle aged for recreational purposes. Farmers of Christian faith dominated this farming system, representing 93% of the respondents whereas Muslims constituted 7%.

The educational status of the respondents showed that, 90% of respondents were literate; with only 7% of the farmers being illiterate. 3.3% however did not indicate their educational background. Of the 90% literate farmers, 56.7% had up to secondary level education, and about 33.3% of respondents had tertiary level education i.e. commercial; teacher training post-secondary or polytechnic.

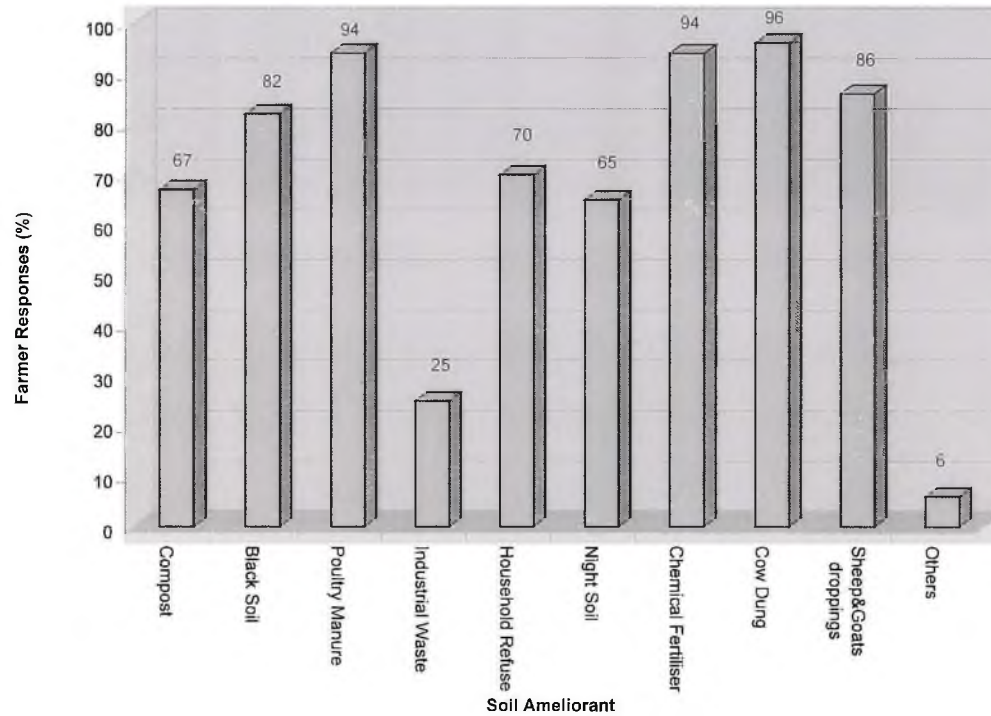
4.2 Types of Soil Ameliorants that exist in the Greater Accra Metropolitan areas of Ghana.

Different types of soil ameliorants exist in the study areas. On the basis of this, information was collected from farmers on inputs known, those in use and those previously used by them.

The survey data revealed that generally farmers had knowledge of all the following compost, black soil,

poultry manure, household refuse, night soil, industrial waste, chemical fertiliser, cow dung, sheep and goat droppings as well as others such as pig manure. The inputs well known to farmers were cow dung (96%), chemical fertiliser (94%) and poultry manure (94%) respectively. Sheep and goats droppings were also known to another 86% of farmers whilst 82% had knowledge of black soil as a soil ameliorant. Another 70% of farmers further indicated that they were aware of the use of decomposed household refuse as soil improver. The use of compost in improving soil fertility was also known to 67% of farmers, whilst 65% had knowledge of night soil as a good soil enrichment nutrient. Industrial waste as a soil improver, was not well known to many of the farmers as only 25% indicated knowledge of it's use in farming. This trend is indicated in figure 2.

Figure 2: Soil Ameliorants Known to Farmers



4.2.1 Soil ameliorants in use.

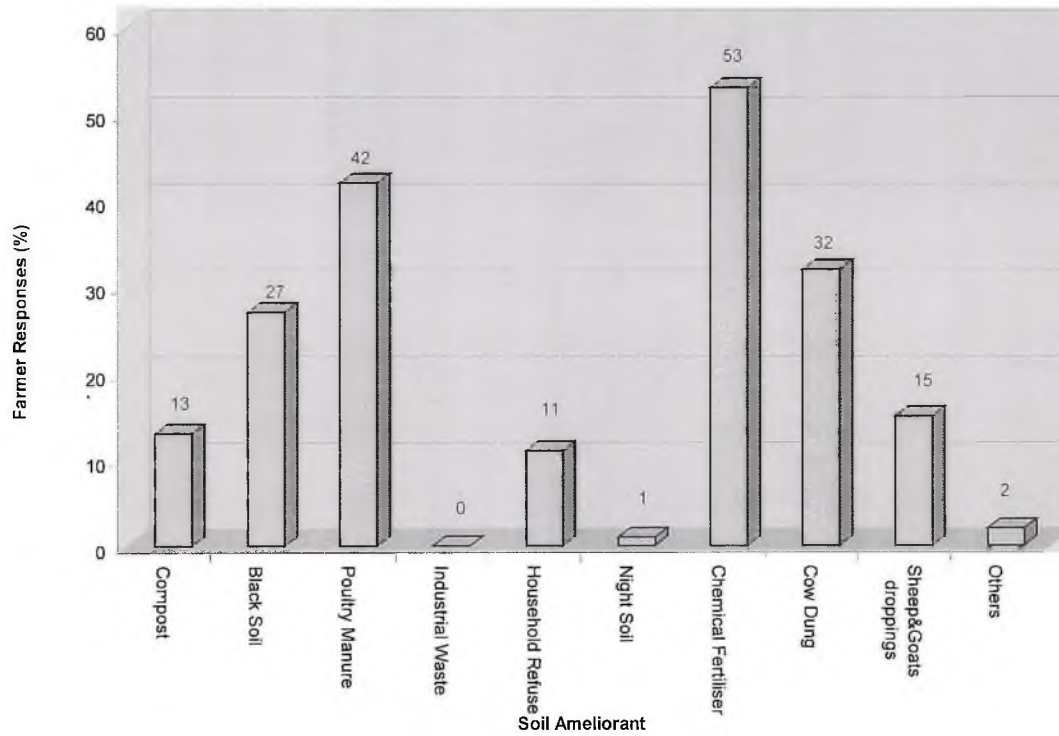
Figure 3 below shows a graphical presentation of inputs in use by farmers. The predominant input used by farmers was chemical fertilisers as indicated by 53% of farmers interviewed. This was because all pineapple farmers and a sizeable number of farmers engaged in the other farming systems depended on chemical fertilisers to maintain the soil's fertility. The high use of chemical fertiliser (50kg/acre) despite its cost may be due to its availability, convenience of use, and its ability to improve crop yield.

Another 42% respondents indicated that they use poultry manure on their crops, whilst 32% use cow dung to manure their soils. Farmers indicated the following as reasons for the above trend. First crops could immediately be grown on the land once the poultry manure applied to the soil was completely dried.

Cow dung on the other hand, was readily available and less expensive. When applied to the soil, it enabled crops to fruit well and also gave rise to bigger sized fruits. It further strengthened the stalks of the crops, which were then able to survive for longer periods as compared to chemical fertiliser. This enabled the harvesting of vegetables such as tomatoes and okro to be

done at more than two times week during the harvesting seasons.

Figure 3: Soil Ameliorants in Use by Farmers



Ornamental farmers mostly use black soil and they represented 27% of respondents. Compost was being used by 13% of farmers and this included compost produced from urban waste and those from decomposed farm residues.

A small proportion of farmers indicated that they were using household refuse (11%) and sheep and goats droppings (15%) on their lands. This was because access to large quantities of these soil improvers was not available.

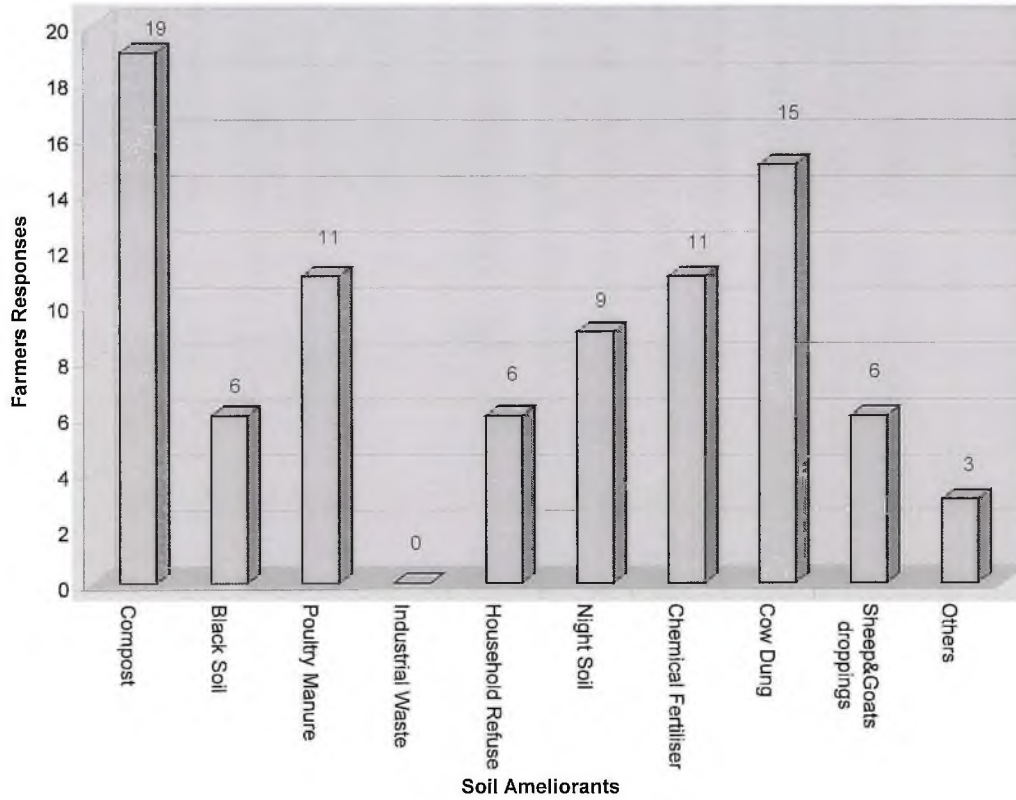
Soil ameliorant such as industrial waste, which includes waste generated from the breweries and fruit juice making industries were not being used at all by any of the farmers, whilst only 1% and 2% used night soil and other soil inputs such as pigs manure respectively. This trend may be due to the low awareness level of the use of industrial waste as soil enrichment nutrient. The use of night soil in farming was not acceptable to many consumers as well. Furthermore, farmers poorly used pig manure because some of the people who came to buy food crops (vegetables) from them were Muslims and therefore would not buy any vegetable that had been grown with pig's manure. Additionally, Muslim farmers themselves, would not buy any soil improver whose components consisted of pig manure for their farming activities.

4.2.2 Soil ameliorants previously used by farmers.

Farmers' knowledge of inputs previously used revealed the following sequence. Compost (19%), cow dung (15%), poultry manure and chemical fertiliser (11%) respectively. Another 9% of farmers indicated that they had previously using night soil (i.e. human waste that has been allowed to decompose over a long period of time). Another 6% of farmers had previously used black soil, household refuse, and sheep and goats droppings respectively. Compost ranked highest among the inputs previously used basically because, some farmers in Accra had previously used composted urban waste during a field trial experiment and had reverted to the use of their original soil ameliorants after the experiment. Reasons given for the reversion included inadequate resources to buy compost, compost sites being located far from their farms, the availability of the manure they were originally using, which some farmers indicated that they obtained for free and therefore did not see the need to buy compost. Although they acknowledged compost was a good soil ameliorant.

Farmers indicated that the drop in the use of cow dung was also due to its associated disadvantage of encouraging the rapid growth of weeds.

Figure 4: Soil Ameliorants Previously Used by Farmers



This therefore called for the application of weedicides or the need to employ more farm hands to pick out the weeds, thereby eroding the already low profits made from their farming activities.

The 11% of respondents who had previously used chemical fertiliser also noted they had stopped using this input because even though chemical fertiliser was quick acting and therefore resulted in increased crop yields, its continual application tended to weaken the soil structure and eventually resulted in the reduction of crop yields. This assertion of the farmers' is consistent with the findings of Costin and Coombs (1981) who, argued that the excessive use of chemical fertiliser, particularly super phosphate, might damage the structure and the overall quality of soils.

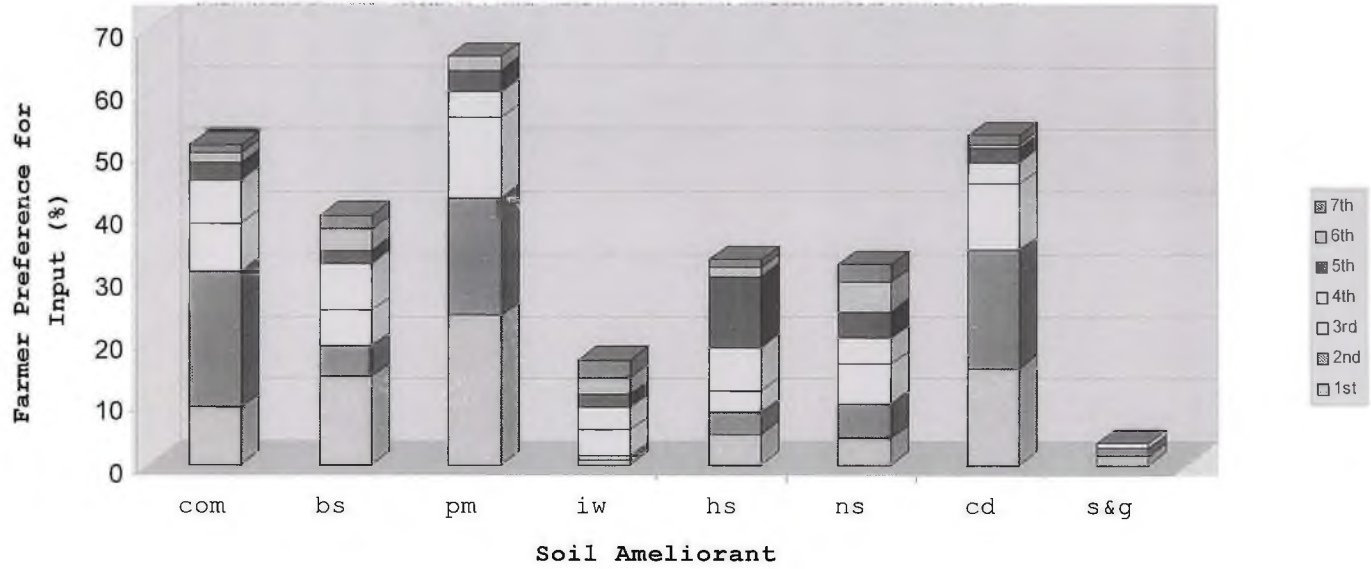
Reasons given for the application of night soil to crops was due to the availability of free sewage sludge from Achimota sewage plant. However, when the public expressed concern about the health hazard associated with such vegetables farmers stopped its application. This is because inadequate treatment of waste or organic solid waste are generally perceived to pose health risk to the urban consuming population (Urban Agriculture Magazine, 2001),

Furthermore, some pineapple farmers in the Samsam-Odumasi area in the Ga district also contributed to this figure (9% of farmers who had previously used night soil) as they also indicated that, they had previously used night soil obtained from an old place of convenience in the town. Therefore on the basis of the information gathered from the survey, the inputs which exist in the Accra Tema Metropolitan areas of Ghana are compost produced from urban waste and farm residues, black soil, poultry manure, industrial waste, household refuse, night soil, chemical fertiliser, cow dung, and sheep and goat dropping.

4.3 Farmers Preference for Organic Soil Ameliorant.

Although various types of soil ameliorants exist for use by farmers to improve the soil's fertility, the preferences for these inputs vary. Whereas a particular soil ameliorant could be preferred as first, second, third choice etc, at one time by a section of farmers, other sections of farmers on the other hand did not share the same view and stated otherwise when their opinions were sought. In the light of this, farmers' preferences regarding the different soil ameliorants they knew about, were using, or had previously used have been discussed below. Cumulatively poultry manure was preferred by 24% of farmers (see figure 5) This was because the input was less expensive ranging between ₵500 to ₵1000 per fertiliser bag weighing between 30-35kg. Poultry manure was also considered as an effective input, which gave rise to good crop yield when applied to the soil. It's application did not require as much watering of the crops in a day as compared to compost. Thus it was suitable for use even in the dry season when most of the main drains farmers relied on for irrigating their crops were dried up. Despite these advantages, the farmers noted that it was becoming increasingly expensive to use poultry manure due to the high transportation cost involved in conveying the input to their farms.

Figure 4.4: Farmers Preference for Input



Variable Definition

Com-Compost, BS-black soil, PM-poultry manure, IW-industrial waste, HR-household refuse, NS-night soil, CD-cow dung, S&G-sheep & goat dropping.

Compost ranked second, as the most preferred organic manure among the different types of inputs as indicated by 22% of respondents. This may be due to the ability of compost to gradually release nutrients to the soil, and as a result maintains the soil's fertility for a longer period of time. Some farmers further attested to this, by emphasising that upon the application of compost, crops could be planted continuously on the same piece of land for three seasons, before compost could be applied again. However, an associated disadvantage with compost was the fact that one needed to keep the soil moist through regular watering, failure of this may result in the death of cultivated crops. Additionally when the compost was not well decomposed it could also lead to the death of the crops due to the heat generated during the decomposing process. Again farmers complained about the presence of objects such as metals, broken glasses and other harmful objects, which injure them during the process of application.

Poultry manure once again was preferred by another 13% of farmers as a third choice input, whilst black soil, household refuse, night soil, and industrial waste ranked fourth, fifth, sixth and seventh (least) according to the percentage of farmers who expressed preference for these inputs. The other positions that these inputs occupy on

the scale of preference are indicated in figure 5. The fourth position occupied by black soil was because all ornamental farmers perceive black soil as a prerequisite for their farming activities, whereas farmers in the other farming systems had different perceptions about black soil.

Firstly, the other crop farmers perceived black soil as not being too effective to be used solely to manure the soil. Secondly, it gave rise to so much vegetative growth. Reasons for households refuse occupying the fifth position, as the most preferred input among the lot included the inability of household refuse to be produced quickly and in larger quantities to meet farmers demand.

Night soil and industrial waste were the least preferred inputs because, crops produced from night soil were not patronised by consumers on health grounds, whilst industrial waste as an input was completely unknown to many farmers. Therefore in the absence of all the other inputs, it would then be considered as a last option to be used on farmers' fields.

4.4 Farmers Perception of the Cost of Soil Ameliorant.

Information was also collected regarding farmers' perception of the cost of the different types of soil ameliorants. The results obtained are indicated in the table below.

Table 1: Expensive Soil Ameliorants

Inputs	No. Of Respondents	Percentage
Compost	42	30.0
Chemical fertiliser	30	21.0
Industrial waste	13	9.0
Cow dung	13	9.0
Poultry manure	10	7.0
Black soil	2	1.0
Non responses	32	23
Total	142	100.0

Source: Data survey 2001

Out of 110 farmers who responded to this question, 30% of farmers perceived compost as being the most expensive input, followed by chemical fertiliser (21%) and cow dung (9%) as shown in Table 1 above. The cost components include cost of the input, cost of transport and as well as cost of application of the input. Farmers perceived compost as the most expensive input even though majority

of them had not used it before and those who had experience with it did not pay for it as it was given to them for free during an experimental trial. Two main reasons were given for the above decision. Firstly, they noted that since the existing compost sites were far away from their farms, the cost of transporting this bulky input would be very high. Secondly, the application of compost to the soil required more hands hence the need to employ more farm hands and thereby paying more farm wages. This could thus contribute to make the input expensive to use in their farming.

The removal of subsidies on agricultural inputs in the 1990's was also given as the reason for the high cost of chemical fertiliser since farmers now had to bear the full cost for the input. Cow dung was also ranked as the 3rd expensive input by a section of the farmers, because some of the farmers had to travel as far as to Aveyimen in the Volta region

(76.8km from Accra) to buy cow dung. Thus the cost of transporting the manure tended to be high.

4.5 Socio-economic Factors that Affect Willingness to Pay for Composted Urban Waste.

In this section, paired t-test were used to evaluate the level of significance of socio-economic factors such as

education, age, sex, religion, profit level and social status that were assumed to influence willingness to pay for compost.

Table 2: Comparison of Socio-economic factors of farmers willing to pay and those not willing to pay for compost.

Socio-economic Factors	Mean levels for farmers		t-values
	WTP	NWTP	
Age	39.0	43.0	-1.369
Profit level	2,362,833.3	5,925,000.0	-1.2720

*** Significant at 1 percent, ** significant at 5 percent, *Significant at 10 percent.

WTP denotes willing to pay, NWTP denotes not willing to pay. The variables are in the raw form.

Sample size: 15

Source: Author's own computation

Table 2 summarises the results of a paired t-test carried out on age, and profit levels of farmers. Sex, Religion, and Social Status were excluded because the SPSS software could not generate their outputs since the sample size of those willing to pay were small. The mean age and profit levels of farmers who were not willing to pay for compost were higher than those willing to pay for compost. However the t-values of these variables were not significant at the 10 percent level.

Education was also excluded from this analysis because in the questionnaire respondents were only asked to indicate their highest form of education and not the number of years that had spent in formal education.

4.6 Mean Willingness to Pay for Composted Urban Waste.

The mean willingness to pay for compost was derived as follows. All the amounts stated by farmers regarding how much they would be willing to pay for a 50kg bag of compost, should its application result in a 25% and 50% increment in their crop output respectively was summed up and then divided by the total number of farmers who responded to this question.

The results of farmers' willingness to pay for compost are thus summarised in Table 4. The survey data revealed that 80% (113) of respondents expressed their willingness to pay for composted urban waste, but only 67% (99) of these respondents actually indicated the amounts they were willing to pay at the 25% and 50% increments in output levels. This suggests that conservation of the soil was very important to the respondents. These farmers also took into consideration the cost of transporting compost from the existing compost site in Teshie (a suburb of Accra) to their respective farms, the cost of its application, the cost of watering etc before

indicating the various amounts they were willing to pay at the different levels of output.

The reasons given by farmers' who were not willing to pay included income constraint and lack of previous experience with compost to ascertain its effectiveness in order to pay for its use. Some further indicated that the soil ameliorants they were presenting using gave them very good results and therefore did not see the need to replace it or try a new product.

Table 3: Minimum, Maximum and Mean amounts Farmers are willing to pay per 50kg of compost.

	N	Min (¢)	Max (¢)	Mean (¢)	Std. Dev
Vegetable					
(NoExcom) *					
25%	18	500	2500	1255.56	706.46
50%	18	600	10000	2316.67	2266.96
(Excom) *					
25%	15	500	4000	1333.33	975.90
50%	15	800	5000	2086.67	1390.72
Pineapple					
25%	16	15000	85000	39375.00	17969.88
50%	16	20000	90000	54687.50	20774.08
Ornamental					
25%	23	1000	10000	4565.22	2638.46
50%	23	1500	15000	6391.30	3561.01
Backyard					
25%	14	2000	15000	6857.14	4417.75
50%	14	2000	20000	9214.29	6277.90
Combined FS*					
25%	79	500	85000	13955.70	18719.62
50%	79	600	90000	18978.21	23720.49

Source: Author's own computation

N - No of respondents

Min - Minimum amount

Max - Maximum amount

Std. Dev. - Standard deviation

NoExcom*- Farmers with no experience with compost

Excom* - Farmers with experience with compost

Combined FS*- Combined farming systems.

Those who were willing to pay but did not indicate the amount they were willing to pay suggested that, producers of compost know the cost they would incur in the production process and hence should come out with their

own price. If the price at which it would be sold falls within their purchasing ability, they would then buy and use the input on their farms otherwise they would continue to use their original soil ameliorants, some of which they now obtained for free.

Generally, the mean willingness to pay for compost varies from one farming system to another. Vegetable farmers with no experience with compost had the least mean willingness to pay amount of ₵1,255.56/50kg bag of compost at 25% increments in output, while those with experience with compost had the least mean willingness to pay amount of ₵2,086.67/50kg bag of compost at 50% increments in output respectively. This is attributable to the fact that, these farmers pay between ₵500 and ₵1000 per fertiliser bag of poultry manure weighing between 30-35kg. They were therefore willing to pay an amount slightly higher for urban compost, since urban waste needed to be processed first in order to obtain the compost. However a paired t-test conducted between the amounts farmers with experience and those without experience with compost were willing to pay at 25% and 50% increments in output levels were not significant at the 10% level (see Appendix 3).

Pineapple farmers on the other hand, had the maximum mean willingness to pay amount of ₵39,375.00 and ₵54,687.50 per 50kg bag of compost respectively at 25% and 50% increment in output, as indicated in Table 4. About 70% of pineapple farmers grew the fruit for the export market and the returns made from the sales of these fruits were very high. Again, the emphasis on organic based food crops especially pineapple in European countries may also have influenced the farmers' preference for compost. This may therefore explain the high amount expressed by this category of farmers. Additionally, pineapple farmers use chemical fertilisers, whose prices were high, and when given the opportunity to indicate the amount they were willing to pay for another soil improver, they would quote amounts that are below those of chemical fertiliser. The combined farming systems mean willingness to pay for compost at incremental output levels of 25% and 50% were also ₵13,955.70 and ₵18,978.21, respectively. However, compost being manufactured by the compost plant in Teshie Nungua were sold for ₵20,000/50kg, though the manufacturers indicated that this price was highly subsidized. This was because farmers could not pay the actual cost price of ₵87,500/50kg.

The observed standard deviations ranged from 706.46 (vegetable farmers) to 18,719.62 (combined farming

systems) at 25% increases in output and from 1,390.72 (vegetable farmers) to 23,720.49 (combined farming systems) at 50% increase in output. By subtracting and adding the standard deviations of each farming system to their respective mean willingness to pay amounts, the range of prices that farmers are willing to pay at the respective incremental output levels indicated earlier on in the text can be obtained. The standard deviation obtained for the combined farming systems at 25% and 50% increases in output level were higher than the respective means. This may be due to the small sample size used.

Table 4: Paired t-test between the different farming systems at 25% increases of output.

FS	Mean	t	df	sign
BYF-PF	-34,214.3	-6.77	13	0.000
BYF-ORN	2,250.0	1.47	13	0.165
BYF-VNXC	5,635.7	4.47	13	0.001
BYF-VEXCOM	5,571.4	4.49	13	0.003
PF-ORN	34,406.3	7.34	15	0.000
PF-VNXC	38,118.8	8.39	15	0.000
PF-VEXCOM	39,333.3	8.6	14	0.000
ORN-VNXC	3,827.9	5.4	17	0.000
ORN-VEXCOM	3,300.0	5.00	14	0.000
VNXC-VEXCOM	-60.0	-0.20	14	0.842

Definition of Variables

FS-Farming System, BYF-Backyard farming, PF-Pineapple farming, ORN-Ornamental farming, VNXC-Vegetable farming (with no experience in compost, VEXCOM-Vegetable farming (those with experience in compost)

Results from the paired t-test analysis indicates that there is no significant difference between the means of farmers practising backyard and ornamental farming (BYF-ORN) as well as vegetable farmers who had not had any experience with compost and those who had experience with compost (VNXC-VEXCOM) at 10% level. This implies that even though their means differ (see Table 3), the amount these farmers were willing to pay should the application of compost result in a 25% increase in their crop output are not significantly different. Thus one could infer that the amounts these farmers want to pay are the same. There was however a statistical significance (at 10% level) between the remaining farming systems as indicated in Table 4 above. This further suggests that the mean/average amounts farmers in these farming systems are willing to pay at 25% increase in output are significant at 10% level.

Table 5: Paired t-test between the different farming systems at 50% increases of output.

FS	mean	t	df	sign
BYF-PF	-47,214.3	-7.72	13	0.000
BYF-ORN	2,250.0	1.19	13	0.257
BYF-VNXC	5,635.7	3.58	13	0.003
BYF-VEXCOM	5,571.4	3.91	13	0.002
PF-ORN	34,406.3	8.69	15	0.000
PF-VNXC	38,118.8	9.81	15	0.000
PF-VEXCOM	39,333.3	10.74	14	0.000
ORN-VNXC	3,827.9	4.51	17	0.000
ORN-VEXCOM	3,300.0	4.76	14	0.000
VNXC-VEXCOM	-60.0	0.65	14	0.524

Definition of variables

FS-Farming System, BYF-Backyard farming, PF-Pineapple farming, ORN-Ornamental farming, VNXC-Vegetable farming (with no experience in compost), VEXCOM-Vegetable farming (with experience in compost)

The results of the analysis in Table 5 also follow a similar trend to that of Table 4. There were no statistical difference between the means of farmers practising backyard and ornamental farming (BYF-ORN) at 10% level. Thus the mean amounts farmers in above farming systems were willing to pay should compost bring about a 50% increase in their crop output level was not different even though quantitatively their means differ (See Table

3). A similar trend as also observe between vegetable farmers with experience with no experience with compost and those with experience with compost (VNXC-VEXCOM) However, statistical significance was observed at 10% between the remaining farming systems should the application of compost result in a 50% increase in output.

4.7 Regression Results

The logit model was used to estimate the willingness to pay responses (A statistical package called Econometric Views (Eviews) was used to run the logit model). The dependant variable is willingness to pay. A value of 1 was assigned to respondents who were willing to pay for compost and a value of 0 for those not willing to pay for compost. The explanatory variables used in the model were socio-economic variables, which included sex, age, educational status, occupation, marital status, number of children and variables such as profits (which was used as proxy for income since data could not be obtained on farmers income) and experience with compost.

The logit model was estimated to determine the probabilities associated with willingness to pay. The results from the model are presented in Table 7.

Table 7 Logit regression model

Variable	coefficient	std. error	t-stat.	Prob.
AGE	-0.0593	0.0624	-0.9493	0.3425
EDU	4.6071	1.6975	2.7141	0.0081*
EXCOM	-3.2720	2.0135	-1.6250	0.1080*
MST	-3.9846	2.5200	-1.5812	0.1176
OCC	3.1524	2.3149	1.3618	0.1769
PROFIT	-2.46E-07	1.38E-07	-1.7831	0.0782*
SEX	6.0338	2.9703	2.0314	0.0454*
CONSTANT	3.1435	4.0870	0.7691	0.4440

Log likelihood = -8.628088

***Significant at the 1 percent level, ** significance at the 5 percent level, * significance at the 10 percent level.

The values are in the raw form.

Edu education, MST - marital status, OCC - occupation

EXCOM - experience with compost.

Sample size- 15

Source: Author's Computation.

The result from Table 7 indicates that the education, sex and profits variables are significant at the 1 percent, 5 percent and 10 percent, respectively. This suggests that farmer's willingness to pay for compost depends very much on these variables. However, age, experience with compost, marital status, and occupation were not statistically significant. Age, education, marital status, occupation, and sex had the correct expected signs, while experience with compost did not. This negative coefficient of farmers' profit may suggest that as farmers' profit margin increases they tend to have access to more resources, and as a result are able to buy other soil ameliorants other than compost. Also farmers'

experience with compost was found to be negatively related to their willingness to pay. This may also suggest that their experience enabled them discover some shortcomings associated with compost. This include the high water requirement of compost and the poor sorting of urban waste which left certain harmful objects such as broken glasses and sharp metals in the compost.

If farmer's level of education increases by 1 unit, *ceteris paribus*, the logit or log of the odds in favour of willingness to pay for compost increases by 4.6 units. Similarly, a unit decline in profit leads to a 2.4 increase in favour of (log of the) odds of willingness to pay for compost *ceteris paribus*. This was however contrary to the work of Akpalu (2000) who found that willingness to pay for fish was very much related to disposable income.

Additionally, compared to farmers, the log of the odds ratio in favour of males who were willing to pay goes up by 6.033 units. This is because it was hypothesised that male gender would be more willing to pay than their female counterparts, since males tend to have access to more credit than the female gender and this is consistent with the findings of Donkor (1989) cited in Obeng (1994)

CHAPTER FIVE

SUMMARY, CONCLUSION AND POLICY

RECOMMENDATION

This study has identified the different types of soil ameliorants that exist in the Greater Accra Metropolitan area of Ghana. It has also estimated the mean amounts farmers in the different farming systems in the study area are willing to pay for composted urban waste as well as the factors which affects farmers' willingness to pay for compost using descriptive statistics and econometric techniques.

5.1 Summary

The study found that the soil ameliorants that exist in the Greater Accra Metropolitan areas of Ghana include compost from agricultural residue and urban waste, black soil, poultry manure, chemical fertilisers, household refuse, industrial waste, night soil, cow dung, and sheep and goat droppings. Although all these ameliorant exist, it is worth noting that, farmers were not utilising all these inputs at the same time. The predominant inputs being used among farmers included chemical fertiliser, poultry manure, cow dung and black soil.

The results of the study also revealed that on the whole about 80% of farmers were willing to pay for the use of composted urban waste. The amount per farming system varied. However when all the farming systems were combined, the mean amounts that farmers were willing to pay at 25% and 50% increases in output were ₵13,955.70 and ₵18,978.21 respectively, when the actual cost of being compost was ₵87,500/50kg bag of compost.

Again, when separate analysis were conducted between the different combination of the farming system at 25% and 50%, statistical significance of 10% were obtained between all the different combination of farming systems, except for those practising backyard and ornamental farming as well as vegetable farmers without any experience in compost and those with experience with compost.

The empirical evidence from the logit model indicates that the farmer's willingness to pay for composted urban waste were significantly affected by farmer's level of education, sex, profit levels. A positive relationship however was observed between farmer's education level and sex, whilst that between farmer's profit levels was negative.

Compost has the ability to maintain the fertility of the soil for a long period of time. However, an associated constraint in using compost was its high water requirement and therefore the need to keep the soil moist through regular watering. Poor sorting of urban waste lead to the presence of harmful objects such as metals and broken bottles, which sometimes cause injury to farmers during the application process.

5.2 Conclusion and Policy Recommendations

Based on the results of the study the following recommendations have been made.

First, pineapple farmers exhibited a stronger willingness to pay for compost and thus private entrepreneurs and other interested organisations (NGO's) interested in composting of urban waste must target these particular farmers as they serve as a large potential market for compost.

Second, proper sorting of urban waste should be done to exclude the waste of all-harmful objects and substances, which can cause injury of both farmers and consumers respectively.

Third, Ghanaian farmers need to be educated on the need to employ compost in their farming activities especially due to the high demand for organically produced foods on the European market, by the extension services department of Ministry of Food and Agriculture (MOFA) and other environmentally conscious NGOs.

Finally, both males and females showed a positive attitude to use compost in their farming activities as the logit regression model results indicated a level of significance at 10% level.

5.3 Limitations of the Study

The sample size used in the logit analysis was small, due to the fact that backyard farmer's did not keep records on the expenditures incurred in their farming activity. This is because these farmers mainly grew crops for home consumption. As a result, a lot of their responses were not included in the analysis and this may have affected the results of the Logit analysis, regarding the *apriori* expectations that were not met.

Additionally, the type of crops grown depends on the rainfall pattern. The responses of farmers who grow large acreage of maize could not be captured because this study was carried out in the dry season.

5.4 Suggestions for Future Research

Composting of urban waste to compost can go a long way to help manage waste, which poses severe environmental threats in our cities. Future research should look at the willingness to pay of cereal farmers in regions well noted for the mass cultivation of cereals as well as those of non-traditional crops, which are catching up on the export markets.

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Appendix 1

PRIMARY DATA COLLECTION QUESTIONNAIRE

TOPIC: WILLINGNESS TO PAY FOR COMPOST FROM URBAN WASTE BY
FARMERS OF DIFFERENT URBAN AND PERI-URBAN
FARMING SYSTEMS.

Name of Enumerator

Date of interview

Locality/Town/Village

District

Region

SECTION A. (Do not read the options out loud)

1. Do you have experience with compost?

	Yes	No
a. Made from own residue/refuse	<input type="checkbox"/>	<input type="checkbox"/>
b. Made from urban waste	<input type="checkbox"/>	<input type="checkbox"/>

2. How do you obtain your compost?

a. Produce it myself

b. Buy it , if (b), specify the
source: _____

3. Which inputs do you know/use or have used? Tick as many as you can.

	Know	Use	Used
a. Compost	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b. Black soil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c. Poultry manure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d. Industrial waste	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e. Household refuse	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f. Night soil	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g. Chemical fertilizer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h. Cow dung	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i. Goat and sheep droppings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
j. Other livestock dropping	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

4. What is the performance of crop with the different types of input used?

Type of input	Type of crop	Yield		Performance
		Yield/acre	Value/yr. (₵)	

1=very good

2=average

3=low

5. Do you always get the quantity of input needed?
(Specify the input)

- a. Yes
- b. No

6. If yes, where do you get it from and how much do you pay for it?

Input	Source	Cost/measure (bag, tin, etc)
Chemical fertiliser		
Compost		
Black soil		
Poultry manure		
Industrial waste products		
Household refuse		
Night soil		
Other livestock manure		

7 Which one of the above does you think is expensive:

8. Taking into account the money you actually have per year, for which input would you pay more for?

9. If you could afford the input in 8 above, which other organic waste would you pay for?

Rank according to preference

(Rank: 1-most preferred; 2,3,4,5, and 6- least preferred)

Soil Enrichment	Rank
Compost	
Black soil	
Poultry	
Industrial waste products	
Household waste/refuse	
Night Soil	
Other livestock manure	

10. If you use compost in your farming activity how long have you been using _____?

11. If no why

- a. _____
- b. _____
- c. _____

12. Where did you learn about it?

- a. Farmer field school
- b. Extension officer
- c. Other farmers/friends
- d. Specify others: _____

13. How often do you apply the inputs and on what crops?

Type of input	Type of crop	Size of farm	Unit of measurement	No of applications

14. Would you use compost produced from urban waste in your farming activity if one was made available to you?

- a. Yes
- b. No

15. What factors will motivate you to use this compost?

- a. Price of compost
- b. Price of substitute
- c. Labour cost
- d. Transportation cost
- e. Experience with compost
- f. On-farm income
- h. Environmental awareness
- i. Mkt. for organic produce
- j. Education
- k. Knowledge of compost
- l. Farm size
- k. Location of site

- g. Off-farm income _____ f. Specify any other reasons:

SECTION B

To help you understand the ensuing questions, I am going to read some facts about compost to you.

Compost maintains the humus balance in the soil, helps to bind nutrients, ensures the proper circulation of air and water, and is thus important for the growth of crops. It also has a mulching effect, which includes moisture-holding capacity, prevention of weeds and reduction of erosion.

Statement of reference

Compost from urban waste also has the above properties.

16. Based on the above advantages of compost would you be willing to pay for its use?

- a. Yes
b. No

If No, give reasons:

- i. _____
ii. _____
iii. _____



17. If compost application to your crops can increase your outputs from the present yield level by 25%, how much are you willing to pay for a fertiliser bag (50kg) of compost.

- a. ₵2000
b. ₵5000
c. ₵10000
d. ₵15000
e. Specify any other: _____

18. If compost application can increase your present yield level by 50% how much are you willing to pay for a fertiliser bag (50kg) of compost.

- a. ₵2000
b. ₵5000
c. ₵10000
d. ₵15000
e. Specify any other: _____

19. If compost can increase your yield would you use more of it?

- a. Yes
- b. No

20. Since you have indicated that you will use more compost, will you use less?

- | | Yes | No |
|---------------------------|--------------------------|--------------------------|
| a. Chemical fertiliser | <input type="checkbox"/> | <input type="checkbox"/> |
| b. Poultry manure | <input type="checkbox"/> | <input type="checkbox"/> |
| c. Other livestock manure | <input type="checkbox"/> | <input type="checkbox"/> |
| d. Black soil | <input type="checkbox"/> | <input type="checkbox"/> |
| e. Industrial waste | <input type="checkbox"/> | <input type="checkbox"/> |

21. How many seasons do you have in a year for each of the crops you grow?

Type of crops	No of planting/yr (seasons)

22. How much compost would like to buy per year?

23. What is your main occupation? _____

24. What other secondary occupational activities are you engaged in? _____

25. How much do you obtain from your farming activity per year?

Crop type	Expenditure	Revenue

26. How much do you obtain from your off-farm activity per year? _____

27 Are you?

- a. Urban
- b. Peri-urban farmer?

28. What type of farming activity do you undertake?

- a. Backyard farming
- b. Vegetable farming
- c. Ornamental farming
- d. Food crops farming
- e. Specify any others

29. Sex of farmer

- a. Male
- b. Female

30. What is your highest level of education?

- a. Illiterate
- b. Primary
- c. Middle
- d. Secondary
- e. Commercial
- f. Teacher training
- g. Middle School
- h. Post sec./Polytechnic
- i. University
- k. Muslim School

31. How old are you? _____

32. Please indicate your marital status.

- a. Single
- b. Married
- c. Widowed
- d. Separated
- e. Divorced

33. What is your religion?

- a. Muslim
- b. Traditional
- c. Christianity
- d. No religion
- e. Specify any other

34. What is your social status?

- a. Chief
- b. Elder
- c. Assemblyman/woman
- d. No position
- e. Specify other leadership position

SPECIFIC QUESTIONS FOR ORNANMENTAL FARMER

35. Do you landscaping?

- i. Yes
- ii. No

36. What do you use?

- i. Compost
- ii. Black soil
- iii. Cow dung
- iv. Poultry manure
- v. Sheep & Goats dropping

37. What quantity do you use?

- i. Per house
- ii. Per filling station
- iii. Per hotel

Appendix 2**FOCUS GROUP DISCUSSION**

**Topic: Willingness-to-Pay for Compost from Urban Waste
by Farmers of different Urban and Peri-urban Farming
Systems.**

What kinds of land tenure arrangement exist in this farming area?

What type of soil enrichment nutrients do you apply to your soil?

What is good or bad about these? (List and discuss each of them).

What is your understanding of compost (what is it all about, what does it involve, what steps are necessary if one intends to prepare it)?

What is good or bad about compost?

Would you rather pay for compost or would you prefer to prepare it yourselves.

If paying, how much would you be prepared to pay for compost/unit? (Specify the units of measurement) e.g.:
Per fertiliser bag

What are the constraints that prevent you from using compost?

What are the major problems you face in your farming activity?

Appendix 3

Paired t-test of vegetables (EXCOM & NOEXCOM) farmers willing to pay for compost at increments output level of 25% and 50%.

		T	Sig (2 tail)
Pair 1	Excom-Noexcom at 25% increase in output	0.203	0.842
Pair 2	Excom-Noexcom at 50% increase in output	-0.653	0.524