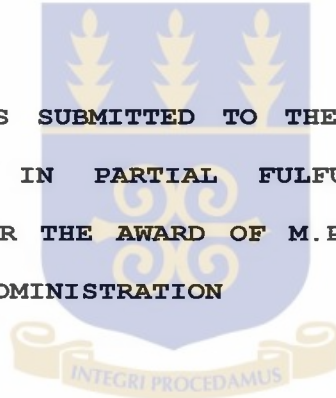


**A QUANTITATIVE ANALYSIS OF THE POTENTIAL
FERTILIZER VALUE OF POULTRY MANURE
GENERATED IN THE ACCRA-TEMA METROPOLITAN
AREA**

BY

JACOB KOJO ANSONG BENSON

**THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF
GHANA, LEGON IN PARTIAL FULFULMENT OF THE
REQUIREMENT FOR THE AWARD OF M.PHIL. DEGREE IN
AGRICULTURAL ADMINISTRATION**



**DEPARTMENT OF AGRICULTURAL ECONOMICS
AND AGRIBUSINESS
FACULTY OF AGRICULTURE
UNIVERSITY OF GHANA
LEGON**

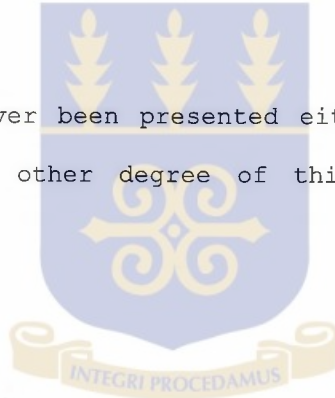
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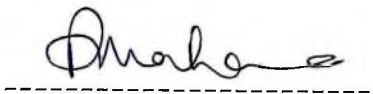
DECLARATION

I Jacob Kojo Ansong Benson, author of this thesis titled 'A Quantitative Analysis of the Potential Fertilizer Value of Poultry Manure Generated in the Accra-Tema Metropolitan Area' do hereby declare that apart from references of other peoples' work which have been duly acknowledged, the research work presented in this thesis was done entirely by me in the Department of Agricultural Economics and Agribusiness, University of Ghana, Legon.

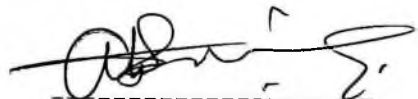
This work has never been presented either in whole or in part for any other degree of this University or elsewhere.



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(Co-Supervisor)

DEDICATION

To my Darling Wife Mrs. Vida Ameyaw-Benson and sons,
Ainslie and Ian.



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, Dr. (Mrs.) Ramatu Al- Hassan and Mr. K. Owusu Baah for their patience and taking time off their busy schedules to give immense contributions and suggestions for this study.

My sincere thanks also go to Rev. Dr. Asuming Brempong for making it possible for me to be a part of the IBSRAM project. Special thanks go to Prof. S.K. Danso, the Director of the Ecological Laboratory, University of Ghana, for allowing me to use the facilities of the laboratory for chemical analysis.



Great thanks go to my wife, Mrs. Vida K. Benson, my parents Mr. and Mrs. Ameyaw -Benson, and my colleagues, Andrews, Henry, and Richard for their contributions to this work.

ABSTRACT

The rapid population growth and urbanization has brought about the challenge of organising food on a sustainable basis with the use of inputs such as fertilizers. The present study was conducted to investigate the potential fertilizer value of poultry manure produced in the Accra-Tema metropolitan area.

Structured questionnaires were used to interview 30 commercial farms. Also, three farms were chosen for case studies. The results indicate that poultry manure contains high levels of Nitrogen (3.3%), Potassium (1.5%), and Phosphorus (3.03%), a ton of which was valued at ₵353,850.00. A broiler bird produces 113.4g litter per day whilst a layer bird produces 47.8g manure per day. The study also revealed that manure produced is largely unused by farmers.

It was recommended that farmers keep proper records on litter production for its proper management. The setting up of micro compost plants on large poultry farms particularly those using the battery cage system with links to other poultry farms was recommended for further study.

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CHAPTER ONE

INTRODUCTION

1.1 Background

Plant and animal species including man face the possibility of extinction. This possibility is high when the rate of growth of the population exceeds the ability of the environment to support such a growth given the prevailing level of technology.

It is expected that the population of the world would increase from 5.7 billion in 1995 to 8.9 billion in 2050 (United Nations, 1998). Within the same period, Africa's population is expected to triple. This rapid rise in population will primarily occur in the urban and peri-urban areas (Snrech, 1994). Migration of people from the rural areas in search of a better life would contribute to this increase according to (Snrech, 1994).

The results of the 2000 population and housing of Ghana show the total head count of the population as 18,412,247 persons. The population results indicate an increase of 49.7% over the 1984 population, compared

with a 43.7% increase recorded by the 1984 census over that of 1970. Also the number of persons per square kilometre increased from 36 in 1970 to 52 in 1984 to 77 in the year 2000.

It can be seen that not only is the population increasing but also the rate of growth of the population is also increasing. The population density figures indicate that the land area of Ghana in 2000, was inhabited by one and half times the number of people present in 1984. This increasing trend in population poses a great challenge for the government of Ghana, the metropolitan authorities and agencies concerned with ensuring food security as well as a safe environment.

To satisfy the food needs of the increasing population requires the shifting of more resources into food production and imports. Associated with the increasing population is the increased production of garbage, the need for adequate waste management and the need employment and shelter. Also competition for land use other than for agriculture occurs.

Apart from the direct effects of increased demand for food, employment and adequate waste management, population pressures in cities indirectly reduces the capacity to supply food because of non agricultural building development and environmental degradation (Drechsel et al., 1999). This is so because the demand for social amenities and infrastructure like schools, hospitals and roads increase. To provide these amenities, more and more fertile lands in and around cities would have to be given up. Fallow periods get shortened and pollution from increased human activities further limits the availability and suitability of the land for agriculture. In the face of the ever-diminishing land resource, food production in the cities must become more and more efficient. This calls for a shift from extensive system of farming to a more intensive system.

Urban agriculture has been found to be essential to the livelihood of millions of families (Mougeot, 1994) and the number of urban farmers is expected to rise. According to Smit (1994), the number of urban farmers all over the world is expected to double from 200 million in early 1990 to 400 million by 2005. It is

expected that this would bring an increase in food production and incomes of urban farmers. Usually perishable crops such as fruit and vegetables, which need quick access to markets, are cultivated.

In Accra and Tema, these urban farming activities is seen to occur on land unsuitable for building purposes and on public lands. Vegetables are intensively cultivated along watercourses. Also seasonal crops such as maize and cassava are cultivated. Intensive and semi-intensive livestock production systems for milk, meat and poultry are operational within the city limits with a trend towards zero grazing (Drechsel et al., 1999).

With the rapid urbanization and population explosion, farming whether crop or livestock, is becoming more and more intensive in and around cities. In the case of crop farming inputs such as fertilizers are required in order to maintain the productivity of the soil. Therefore in the absence of a conscious effort to fertilize the soil, large amounts of nutrients are removed at every cycle of planting and harvesting without being replaced- a phenomenon known as nutrient

mining- and this would eventually affect yields. All the chemical fertilizer needs of Ghana are obtained from imports however this important ingredient in intensive farming attracted attention in the Ghana Government's Structural Adjustment Program (SAP).

The introduction of Structural Adjustment Program (SAP) in 1983 saw a phased removal of fertilizer subsidies from about 45% in the mid 1980's to none by 1992 and transferred the importation and distribution of fertilizer by the State to the Private Sector. After the removal of subsidies the impact of persistent devaluation of the cedi meant that farmers fully bore the cost of fertilizers even though they were hardly compensated for the extra risk and work associated with the use of fertilizer. This risk stems from the fact that agriculture is basically rain fed in Ghana and the erratic nature of which could lead to crop failure and hence investments in the form of chemical fertilizers could be lost.

As a result of the removal of subsidies, a significant reduction in the demand for chemical fertilizers occurred according to studies conducted by Gerner *et*

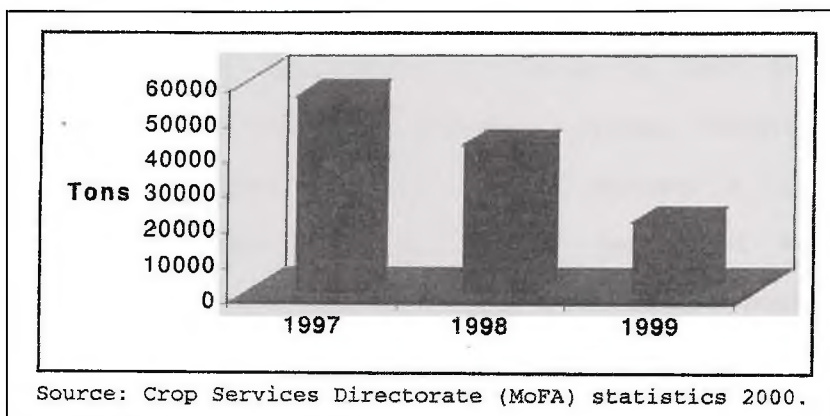
al. (1995). Data available from the crop services Directorate of the ministry of food and Agriculture (MOFA) indicate that a total of 20,439 metric tons of inorganic fertilizers were imported in 1999 compared to 42315 metric tons in 1998. The 1997 imports of 56163 metric tons was 51.7% and 63.6% higher than the quantities imported in 1998 and 1997 respectively as shown in the figure 1.1 below. The declining trend in the total quantity of fertilizer imported annually since 1997 is therefore a major concern. This is because yield per unit area of crops grown in the country would remain low compared to their potential levels without the application of fertilizer.

The high cost of inorganic fertilizer coupled with the increased need for soil fertility improvers, calls for the identification of alternative but cheaper means of enriching the soil.

Prudent recycling of organic waste materials found in and around cities could be an important resource to replace or complement the use of inorganic fertilizers. It is important to note that the success or otherwise of such an option depends very much on the quantities

and availability of such a resource. The livestock sector, can offer a potential source of waste material to be recycled.

Figure 1.1: Trends in Importation of Chemical Fertilizers (1997-1999)



Since 1989, the annual growth rate of cattle, sheep and goats populations has been 1.22%, 2.0%, and 4.5% respectively with poultry recording the greatest growth of 9.0%. Pig production has however declined steadily at a simple average rate of approximately 3 % per annum within the same decade (Institute of social, scientific and Economic Research, 2000).

Cattle, sheep, goats and poultry can be kept under extensive, intensive or semi-intensive system of production. The extensive system of production

involves very little or no provision of shelter and the animals are allowed to roam about freely. With this system, animals are predisposed to adverse weather conditions and predators. In terms of serving as a source of manure this system cannot be relied upon since most of the manure generated is lost in the field. With the semi-intensive system, housing is provided at night and livestock is allowed a limited amount of space to roam. Some amount of manure generated can be collected from the kraals, pens and houses. The part of the manure that is spread by the animals while grazing on the field is again lost and this reduces the amount available for intentional recycling.

The intensive system of production offers the greatest source of manure. Here livestock is completely housed and movement is greatly restricted. A system of manure collection can be devised to collect almost all the litter or manure produced. In the urban and peri-urban centres, it can be observed that commercial poultry production is basically intensive. This intensive nature combined with the large numbers involved makes urban and peri-urban poultry production a potentially

good source of manure, which can be generated in a relatively small space.

Poultry manure is an excellent source of plant nutrients that can either be applied directly in its raw state or composted. In addition to being an excellent source of plant nutrients, manure when applied to the soil, can increase the water infiltration rates by improving the structure of the soil. Also on a short-term basis, poultry manure can increase the soil organic matter content (Vest and Merka, 1998).

Though poultry manure is an excellent source of plant nutrients and can improve the qualities of soils, it may contain pathogens. It is also bulky and has odour and fly problems. Some form of processing is therefore desirable. Properly treated or composted manure is a value added, marketable organic residue which when applied at the correct rate will generally out perform a similar level of nutrients supplied by chemical fertilizers (Holden, 1990). Hence to satisfy the fertilizer needs of urban and peri-urban farming systems, there is a need for some value addition to

manure to take advantage of its good attributes whilst minimizing its adverse effects like the introduction of pathogens, flies and bad odour.

1.2 Problem Statement

The rapid population growth and urbanization has brought about the need to provide food on a sustainable basis, to meet the nutritional needs of people. Due to the intensive nature of urban and peri-urban farming systems and the need to replace nutrients that are taken up by crops, some form of fertilization needs to be carried out if the objective of higher productivity is to be achieved. However, with the removal of subsidies on chemical fertilizers, farmers can hardly pay for it and hence alternatives need to be found.

Poultry manure, as has earlier been stated, is a potential resource that can be used to improve the fertility of soils. Whether it is used in its raw state or processed into compost, the amount produced needs to be determined and the present uses and management need to be identified. It is also necessary to determine its potential chemical fertilizer value so as to know the extent to which it can be used to

supplement the use of inorganic fertilizers. These pieces of information about poultry manure are necessary elements in assessing the viability or otherwise of a program designed to make use of manure or add value to the manure generated. Therefore the relevant research questions are:

1. Where is commercial poultry farming being carried out?
2. How much manure is generated
3. What is the potential chemical fertilizer value of the manure generated
4. What are the present management systems and uses of the manure generated?

1.3 Study Objectives

The broad objective of this present study is to carry out a quantitative analysis of the potential chemical fertilizer value of the poultry manure generated, and also to find out about its present uses and management in Accra-Tema metropolitan area. The specific objectives are:

1. To locate where commercial poultry farming is being carried out.
2. To estimate the weight of manure produced.

3. To determine the potential chemical fertilizer value of the manure and
4. To find out about the present management and uses of the manure generated by farmers.

1.4 Relevance of Study

Little data exist on the amount, uses and current management of poultry manure in Accra and Tema and this study address this information gap.

Answers to the research questions would first of all help us to know how much manure is produced and where this resource is located. It will also inform us about the current uses and management practices associated with poultry manure. These would be beneficial to investors and municipal authorities concerned with food security, income generation and waste management.

1.5 Study Area

The present study covered the areas of Accra and Tema, which form part of the Greater Accra region. The Accra-Tema metropolitan area is located between longitudes $0^{\circ}05'E$ and $0^{\circ}25'W$ of the Greenwich Meridian and latitudes $5^{\circ}30'N$ and $5^{\circ}52'N$ of the equator. In

terms of climate and ecology, the area is in the coastal savannah. Rainfall in this area is bimodal. The major rainy season starts in April and lasts till mid July. This is followed by a dry spell lasting until the end of August. The minor rainy season starts from early September and ends in mid November. The mean annual rainfall ranges from about 800mm to 1150mm (Gerner *et al.*, 1995).

Agricultural production forms part of the local economy of the area. The above climatic characteristics have implications on the timing of demand and use of manure in the area. The high temperatures combine with high rainfall amount encourages the evaporation and leaching of soil nutrients. Also the demand for manure for soil preparation would be high during the rainy season. Major crops grown are annual food crops such as maize and cassava as well as vegetables. Production of vegetable in the study area is mainly carried out along the banks of streams and waste channels.

The study area, which has 74.6 per cent of the population of greater Accra is situated in a region that has been experiencing great increases in

population. The region experienced the highest growth rate from 3.3 per cent in 1984 to 4.4 per cent in the year 2000. The study area has also seen the development of large-scale intensive poultry farms. Some of these include Sydals farms, Macba farms, and Letap farms. These poultry farms have automated feeding and drinking systems. There is also the existence of automatic manure collection system.

1.6 Limitations of Study

The estimation process for litter production per bird did not include the amount of caked litter removed from poultry houses, as this could not be estimated. Also the valuation process for the value of manure considered manure only as a nutrient source, similar to commercial fertilizers regardless of its other positive attributes such as the improvement of the soil physical attributes. It does not also consider its negative attributes such as hauling, handling or application cost.

1.7 Organization of study

The present study is organized into five (5) chapters. Chapter one introduces the present study and lays out

both its broad and specific objectives. The chapter also states the limitations of the study. Chapter 2 is the Literature Review, which discusses aspects that are pertinent to the study such as manure production and methods of estimating the amount and value of manure or litter produced. Chapter 3 is the Methodology. The chapter outlines the various methods employed, the data required, and its sources. The results are presented and discussed in Chapter 4. Chapter 5 is the Summary, Conclusions and Recommendations of the study

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The literature review examines urban and peri-urban agriculture and the urban farmer. It discusses the factors that affect the productivity of urban agriculture. The use of manure as an alternative source of fertilizer is also discussed as well as the composting process and benefits from the use of compost. Methods of determining the value and amount of poultry manure produced from a farming are also discussed.

2.2 Urban Agriculture

2.2.1 Definition

Urban agriculture is an activity that is difficult to define. First of all urban agriculture is differentiated from home gardening by Hoogebrugge and Fresco (1993). These authors defined home gardening as a small-scale supplementary food production system by and for household members that mimic the natural, multi-layered ecosystem. Mimicking the natural multi-layered ecosystem involves the planting of different

sorts of trees and plants and the practicing of mixed farming. They further add that home gardening never provides the main source of income or food to the household. This distinguishes it from commercial horticulture or arable cropping as well as commercial livestock production. From this, it could be inferred that home gardening is only meant for supplementing on household food and income and can be considered as one kind of all the different forms of agriculture that is found in cities. Hoogebrugge and Fresco (1993) on the other hand see urban agriculture as a commercial activity.

The term 'urban agriculture' has been defined in different ways by different authors. Smit and Nasr (1992) defined urban agriculture as the production of food and fuel, within the daily rhythm of the city or town, directly for the market and frequently processed and marketed by farmers or their close associates. It was defined to include aquaculture, livestock or orchards, vegetables and other crops. This definition is broad in the type of activities it covers. However, it is vague on the definition of the boundaries of the city. A more precise definition as far as location is

concerned, was given by Mougeot (1993) who describes urban farming as the growing of food and non-food crops and the raising of animals such as cattle, fowls and fish both within and on the edge of built-up areas. From the ongoing discussion it can be inferred that urban agriculture is first of all commercial in nature and is carried out within or around built-up areas. The discussion on what can be considered as urban or peri-urban agriculture in terms of location can be settled when urban agriculture is described as an activity that is carried out within the city or within a distance of the city. There should also be direct commercial links with the city, either because the farmers live in the city or a major part of the marketing is done within the city.

The following definition of urban agriculture is therefore used in this thesis: Urban and peri-urban agriculture is the growing of food and non-food crops as well as the raising of livestock within built-up areas and in the area around it, where direct commercial links exist with the built-up area. Direct commercial links exist either because the farmers live

in the built-up area or a major part of the marketing is done there.

In the light of the rapidly increasing population in urban centres, urban agriculture is expected to become more and more important in the lives of city dwellers. This is because urban agriculture could serve as a source of readily available food especially those that are highly perishable like fruits and vegetables, which could gain easy access to markets due to their proximity to urban market.

2.2.2 Urban Farming

All over the world, the number of urban farmers is expected to double from 200 million in the early 1990's to 400 million by 2005 (Smit, 1996). Work done by Mougeot (1994) in Tanzania indicates that the number of households involved in urban agriculture is increasing. In 1980, it was estimated that 446 of low-income earners in Dar es Salam, Tanzania had farms in and around the city. By 1987, 70% of heads of households were engaged in some farming or husbandry in and around the city.

A study on livelihoods, food and nutrition security in the Greater Accra region of Ghana in 1997 by Armaklemensu and Maxwell (1998) found that food crop farming was the major agricultural activity in Accra. The quantitative part of the study involved a survey of 559 households from 16 randomly selected enumeration areas in Greater Accra. The study identified seven categories of farming systems. These were:

1. *Seasonal crop farming*: Rain-fed, seasonal agriculture, relying mostly on informal land access and mostly produced for home consumption.
2. *Customary land rights system*: Rain-fed agriculture with some dry season irrigation on La 'stool land' between La and Teshie for both home consumption and marketing.
3. *Vegetable growing system*: Irrigated market oriented production of vegetables, mostly relying on informal land access and usually carried along main drains and streams.
4. *Small ruminants and poultry*: Raising small ruminants in densely populated areas and sometimes market oriented but more frequently as an investment or asset strategy.

5. *Backyard gardening*: small-scale gardening on own land or rented compound, usually for home consumption.

6. *Commercial livestock*: usually poultry, pigs goats, sheep and cattle raised at medium to large scale for sale to urban markets.

7. *Miscellaneous*: export crop production, micro livestock, snail farming bee keeping and large ruminants.

Also Urban and peri-urban farmers do not form a homogeneous group of people. They can be found among every socio-economic group of the city. Mougeot (1994) classifies urban farmers into three categories based on the reasons for practicing agriculture.

1. *Low-income survival farmers*: These practice urban agriculture mainly to survive and achieve a combination of nutritional and socio-economic benefits.
2. *Middle-income home-gardeners*: These practice urban agriculture mainly to provide supplemental food and income.
3. *Agribusiness farmers*: These practice urban agriculture to obtain income.

These agricultural activities in cities produce waste, which could serve as a potential resource to further enhance the production of food in cities. On the other hand the waste being generated could be harmful to the environment if not properly managed. As cities keep on expanding in terms of inhabitants, resulting in a growing scarcity of land, the need for greater intensification of agricultural production could translate into an expanded demand for soil improvers such as organic and inorganic fertilizers.

2.2.3 Land Availability and Quality in Urban Agriculture

Urban agriculture may be found in different locations in the city. It is practiced in backyards, on communal land and on all kinds of public vacant lands suitable for growing crops. These public and vacant lands include spaces next to roads, near rivers, streams or dumpsites and vacant places to be built on. Large fields at the edge of or outside a city are also used for urban agriculture. One of the major constraints mentioned by farmers in the survey by Armar-Klemensu and Maxwell (1998) was access to land in terms of both physical access and tenure security. In contrast to

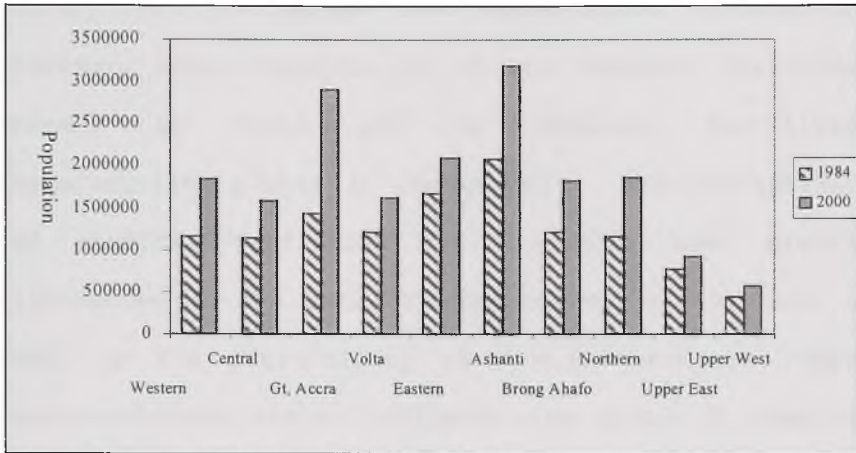
the situation pertaining in rural areas where people can often choose the right soils for agriculture, the choice of land and thus soils is often limited in urban areas, and farmers have to do with what is available. The implication is that farmers have to use soil fertility enhancers to sustain farming on these lands.

2.3 Population Growth in Ghana

The results of the 2000 population and housing census released by the Ghana Statistical Service indicate that the current total population of Ghana stands at 18,412,247. Figure 2.1 shows the population by region for 1984 and 2000. The results also indicate that half of the regions recorded a decline in their proportionate share of the population in 2000. The decline was experienced in Eastern (-2.3%), Upper East (-1.3%), Volta (-1.1%), Central (-0.7%) and Upper West (-0.5%). The loss in proportionate share of the population may reflect out-migration from the affected regions (Ghana Statistical Service, 2000). Ashanti region emerged as the most populous region followed closely by the Greater Accra region while the Upper West was the least populated region. Though Ashanti region is the most populous region, Greater Accra more

than doubled its population density from 441.0 per sq. km. in 1984 to 870.0 per sq. km. in 2000, reflecting an increase of 103.3 per cent in its population.

Figure 2.1: Population by Region for 1984 and 2000



Source: Ghana Statistical Service 2000

This increased the share of its population by 4.2 percent compared to an increase of only 0.3 per cent recorded for the Ashanti region. The increase in proportion of people living in Greater Accra may be a reflection of a trend in migration pull to the big cities especially Accra and Tema (Ghana Statistical Service, 2000). The significant increase in the population of Greater Accra particularly Accra and Tema has great implications for urban food production,

availability and access to lands in the cities, sanitation and the quality of the environment.

2.4 Fertilizer Use in Ghana

Ghana, just like the rest of the world uses chemical fertilizers to boost its agricultural production. However, Ghana imports all of its chemical fertilizer needs, as there are no chemical fertilizers manufacturing plants in the country. The availability of chemical fertilizer has therefore been greatly influenced by the rate of depreciation of the cedi as well as the availability of foreign exchange. These macro-economic forces influence the price of chemical fertilizers in Ghana.

Analysis of the trends in imports of fertilizers by Gerner *et al.* (1995) suggests that the chemical fertilizer market shrank considerably in the 1980s and even more in the 1990's. A look at the chemical fertilizer market prices in Ghana reveals that in late 1980's and early 1990's chemical fertilizer prices in Ghana increased dramatically as shown in Figure 2.2. Also Table 2.1 shows the 2002 February ending fertilizer prices from Wienco. The increases in prices

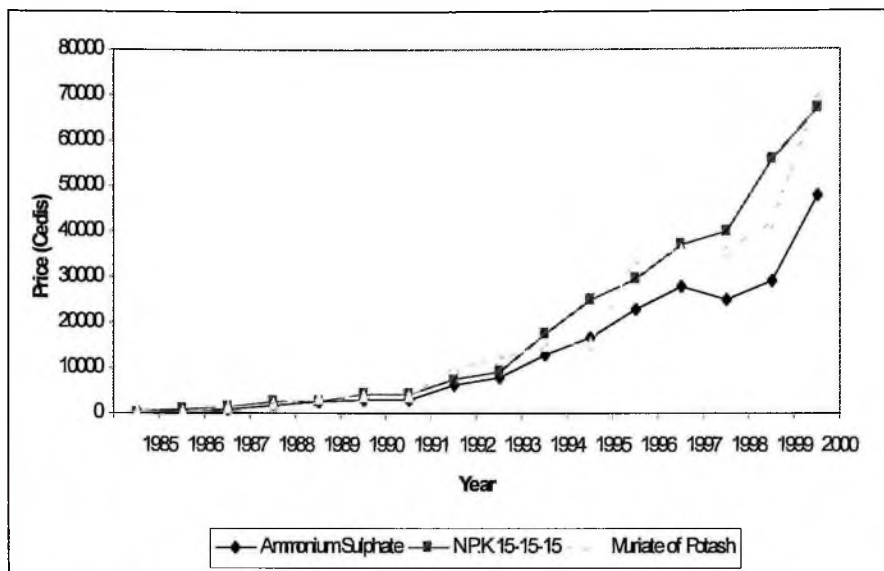
were the result of persistent devaluation of the cedi and the removal of subsidies.

With the introduction of Structural Adjustment Programme (SAP), the value of the cedi was allowed to depreciate and attain a market-determined rate. Consequently, the value of a United States dollar changed from ₵2.75 in 1980 to ₵350 in 1990 to ₵570 in 1993 and to ₵1024 in November 1994. The depreciation of the cedi contributed to increases in the cost of all imported products including chemical fertilizers. To reflect these increased import costs, fertilizer prices were adjusted rapidly, which led to the observed several fold price increases (Bumb *et al.*, 1994). By the end of December 2000, one United States dollar was exchanging for ₵7,000.00, making the cost of fertilizer even more expensive.

Under the SAP, fertilizer subsidies were systematically phased out. In 1987, about 45% of the cost of chemical fertilizer to the farmer was subsidized. From 1988 to 1991 subsidy levels ranged between 30.0 and 15.0%. There were no longer subsidies from 1992 onwards.

Farmers could hardly be compensated due to the high cost, which made its use less profitable.

Fig.2.2: Retail Prices of Chemical Fertilizers (1985-2000)



Source: Crop Services Department (MoFA), Wienco, FASCOM. 2001

These rapid increases in the price of chemical fertilizer led to the considerable shrinking of the fertilizer market in Ghana (Bumb, et al., 1994). Alternative but cheaper means of soil fertilization needs to be found if efforts towards the attainment of food security are to be successful.

Urban and Peri urban areas are centres for intensive poultry and livestock production which produces large amounts of manure and litter that can be used to improve the fertility of the soil.

Table 2.1: Fertilizer Price (February 2002)

Type Of Fertilizer	Price (¢) per Bag Of:	
	25kg	50kg
Urea	56,000.00	99,000.00
15.15.15 (NPK)	56,000.00	106,000.00
Single Super Phosphate	-	82,000.00
Triple Super Phosphate (46% P ₂ O ₅)	-	106,000.00

Source: Wienco 2002

2.5 Poultry Manure Production And Estimation

Knowledge of the amount of manure or litter produced on a poultry farm is important for the design and proper operation of a manure handling and utilization system. Both liquid and solid handling systems are used for poultry and the system chosen also has an effect on the amount of litter or manure to be removed from a poultry house.

Several methods exist for the estimation or determination of the amount of manure or litter

produced. One of the ways of doing this is to use estimates of manure output that has been determined for several types of poultry. Daily fresh manure output per 100 birds estimated for laying chicken, growing broiler at 6 weeks and growing large Tom turkey at 16 weeks are 20-34lb (9.1-15.4kg), 30-35lb (13.6-15.9kg), and 108-132lb (48.99-59.87kg) respectively (Naber and Bermudez, 1990).

Another way to estimate manure output is by using feed intake. Work done by Bird and Munroe (1999) in Canada gives the amount of fresh manure produced as 114 percent of total dry feed intake. Also Naber and Bermudez (1990) give the weight of fresh manure output as 115 percent of dry feed intake.

The live body weight, standardized as animal units, (AU), (1AU= 1000lb (453.59kg)) is also used to estimate the amount of manure produced. Finding the product of the average bird live weight and the total number of birds gives the total animal unit. This is then multiplied by a factor of 5.0 for manure production from a high-rise, deep pit system or a factor of 7.1 for manure production produced under cage scraped alley

manure system removed every 2 days. The product of the animal units and the factor give the tones of manure produced per year (Chastain *et al.*, 1999). The quantity of litter or manure can vary greatly from farm to farm due to different management practices and species. Hence one of the best methods is to measure the rate of production from the operation in question (Bird and Munroe, 1999). If standard sized equipment is used to remove manure, the weight per load can be measured and the total derived by finding the product of weight per load and the total number of loads removed (Vest and Merka, 1998).

According to the Accra Metropolitan Authority, the total quantity of waste generated in Accra from households can be estimated at approximately 840,000 m³ per year. This however does not include the amount of manure produced from poultry houses. Data on the quantities of manure produced in Accra and Tema from poultry production is not available. Similar story is true for Kumasi. However, estimates for Kumasi indicate an annual (dry matter) production of about 34,000 tons based on poultry data from 1996 (Kindness, 1999).

2.6 Poultry Nutrient Analysis

Estimates of manure nutrient content are available from a number of published sources (Mitchell and Donald, 1995; NRAES, 1999; Schmitt *et al.*, 2000). These authors report the nitrogen (N), phosphorus (P) and potassium (K) levels in manure ranging from 2.1-6.0%, 1.4-8.9% and 0.8-6.2% respectively. The estimates for the plant nutrient content of manure vary widely between farms due to differences in animal species, management and manure storage and handling. The only method available for determining the actual nutrient content for a particular operation is a laboratory analysis (Schmitt *et al.*, 2000). Manure is analysed to determine its total nitrogen (N), (sometimes called Kjeldahl nitrogen (TKN)), phosphate (P_2O_5) and potash (K_2O). In taking manure samples care is taken to ensure that a representative sample is obtained for analysis.

2.7 Plant Nutrient Concentration and Its Availability in Poultry Manure

Poultry manure consists primarily of droppings and bedding. Feathers and waste feed make up the remainder except in dirt floor houses where soil may be mixed with it. Hen manure may or may not contain bedding

materials. The nutrient content of manure and its availability to plants is determined to a large extent by the composition of ration fed, the method used to collect and store the manure, the amount of bedding and time of application to the soil. For example, changing the levels of inorganic salts and feed additives in a ration will change the concentration of these elements and possibly the rate of decomposition of organic matter in the manure (Mitchell and Donald, 1995). It is reported by the same authors that a considerable amount of nitrogen is lost when manure is sun dried or exposed to air movement or to run-off by rain, as would be the case in an open-lot livestock or deep pit poultry system. The addition of bedding and water to manure dilutes its nutrient concentration thereby lessening its value per unit volume.

Chemical analysis of both broiler and layer manure have shown varied results. Mitchell and Donald (1995) attribute these differences to different moisture levels, temperature, amount and kind of bedding, amount of soil picked up while a house is cleaned, number of batches consecutively reared, and conditions under which the manure was stored. Nutrient content in

broiler litter and layer manure from different sources and surveys is reported in Tables 2.2 and 2.3. Comparing the average plant nutrient concentrations of broiler and layer manure and litter it could be seen from Table 2.2 and Table 2.3 that, at the same moisture content broiler litter contained higher levels of nitrogen, phosphorus and potassium.

Table 2.2: Average Nutrient Composition of Alabama Broiler Litter on Fresh Weight Basis

	Weighted Mean ^a
Number of Samples	207.0
Moister (percentage)	19.7
<i>Primary Plant Nutrients</i>	
Total Nitrogen (percentage)	3.10
P ₂ O ₅ (percentage)	2.77
K ₂ O (percentage)	2.04
^a Weighted mean is calculated from four separate surveys conducted in Alabama from the mid-1980s through 1993. The surveys included a total of 207 samples.	

Source: Mitchell, C.C., and Donald, J.O (1995)

Caged layer manure generally contains between 1 and 2 per cent nitrogen on a fresh weight basis if collected at 1-3 weeks intervals. However under high-rise houses where layer manure sometimes accumulates for long periods of time, some nitrogen is lost into the air as ammonia gas. At the same time, manure dries, which increases the concentration of all nutrients (Mitchell and Donald, 1995).

Table 2.3: Nutrient Composition of Fresh, Caged Layer Manure

%	Pennsylvania caged Layers ^a	Alabama caged layers	North Carolina ^b		
			Fresh	Scraped	High rise
Moisture	50	70	-	-	-
Total N	2.0	1.5	1.3	1.4	1.9
P ₂ O ₅	2.0	1.3	1.1	1.6	2.8
K ₂ O	1.0	0.5	0.5	1.0	1.5

^aShipp et al., 1981
^bZublena et al., 1993

Source: Mitchell, C.C., and Donald, J.O (1995)

The mode of application of manure to the soil for crop production varies. Methods of applying animal manure to the soil include, broadcast followed by ploughing, broadcast without incorporation, and injection under the soil surface or by irrigation (Mitchell and Donald, 1995). Again according to Mitchell and Donald (1995), some plant nutrients are lost during application of manure thereby lowering the amount of nutrients that would be available for plant uptake. According to them about 50% of nitrogen in fresh manure is in the organic form and appears as partially digested feed and/or micro-organism. The amount of nitrogen available for plant uptake is that portion of organic nitrogen that mineralises during the growing season and the ammonium nitrogen fraction of manure. The other 50% is

inorganic, usually as ammonium ($\text{NH}_4\text{-N}$). When manure has a strong ammonia odour, or it is spread on the surface of the soil and not incorporated, significant nitrogen is lost to the air. The organic nitrogen fraction gradually becomes available for crop uptake as the manure decomposes. Mitchell and Donald, (1995) estimate that around 70% of the total nitrogen in broiler litter is made available to crops in the first year after application. Phosphorus and potassium fractions are considered to be about 75% as effective as commercial fertilizers during the first year of application.

2.8 Management and Use of Poultry Manure

The management of poultry manure is closely associated with the type of production system chosen. Manure management is very important as the way it is handled affects its nutrient content. If a production system is designed to use water to remove manure, the manure that is collected becomes diluted hence affecting the concentration of all nutrients in the manure.

On the production side, commercial birds are kept either on a deep litter system or are housed in a cage

system and these affect the collection of manure. In the deep litter system, birds are kept on litter material such as straw or wood shavings and this could be changed frequently or after one or more production cycles. The longer the bedding material has been in use, the more concentrated it would be in terms of plant nutrients.

With the cage system, birds are kept in cages and manure collects beneath the cage. Manure is collected more frequently when the shallow pit or the 'no pit' system is used. In the case of the deep pit system, manure is collected at the end of the production cycle. Work done by Drechsel (1996) showed that a large portion of the manure produced in and around Kumasi is lost. This is a significant loss of valuable resources as poultry litter analysed around Kumasi shows high nitrogen content of 2.0-3.8% (Amoah, 2000). It was also observed in the Kumasi urban natural resources studies that there was little interest in manure marketing. Many poultry farmers considered the litter as waste and gave it away to crop farmers who however paid for the transport or litter replacement (Kindness, 1999).

Poultry manure, when properly handled, is the most valuable of all manure produced by livestock according to Mitchell and Donald (1995). It has historically been used as a source of plant nutrients and as a soil amendment. It is a slow-release fertilizer (Mitchell and Donald, 1995). It is so because mineralization of the organic matter contained in manure is a gradual process and makes the nutrients less liable to be lost within a short period of time. Also when applied to the soil, poultry manure can add organic material, which improves the physical characteristics of the soil. It can also be used as feed for ruminants and for manuring fishponds.

However unprocessed poultry manure has some undesirable characteristics associated with it. It is seen as a source of weed seeds, pathogens, that may be harmful to humans, it is bulky and is associated with flies and odours (Brake, 1992). One of the ways to reduce these disadvantages is to compost the fresh manure.

2.9 Compost

Composting is a biological process in which organic waste is stabilized and converted into a product, which

can be used as a soil conditioner and organic fertilizer. This process depends on the activity of micro-organisms. These micro-organisms require a carbon nitrogen ratio (C:N) of between 15 and 25, a moisture content of 40 to 60%, a pH of between 5.0 and 11.0 and a greater than 30% free air space (Wilson, 1989).

Soon after composting has begun, the organic material is assembled into a self-insulating mass and temperatures begin to increase as metabolic heat accumulates. At first the rising temperature of the decomposing organic material stimulates the growth of mesophilic bacteria but as high inhibitive temperature levels are reached, mesophilic activity is limited. The elevated temperature induces the thermophilic bacterial growth. The pattern is then repeated in a second hotter stage. The process is self-limiting because of excessive accumulation of heat. The temperature of the final product eventually falls (Finstein and Morris, 1975).

Poultry manure has a low C:N ratio and any attempt to compost it without raising the C: N ratio will result in several undesirable events. These may include:

- a) The litter emitting great quantities of ammonia during composting.
- b) The high temperature required for composting not being achieved.
- c) The mass may become sticky and revert to anaerobic digestion, which is much less efficient.
- d) The end product may cake very readily (Brake, 1992).

2.10 Benefits of Compost

There are several benefits of compost, which make composted manure much more preferred. The handling properties of manure are improved through compost and make it easier to spread evenly on soils (Holden, 1990). Furthermore, compost does not possess the odour and fly problems generally associated with raw litter. Also, there is no risk of nitrogen immobilization with the application of compost as compost is already a stabilized product. During composting, the high biocidal temperatures achieved have been demonstrated

to be lethal to pathogenic bacteria and viruses (Anthony and Nix, 1962; Brake, 1992).

2.11 Conclusions

Urban and peri-urban agriculture has been defined as the growing of food and non-food crops as well as the raising of livestock within built-up areas and in the areas around it, where direct commercial links exist with the built-up area. It is an activity, which will continue to play an important role in the lives of city dwellers, and its progress needs to be enhanced in efforts towards achieving food security. The by-product of such activities such as manure could be recycled to further enhance production as it has been shown to be an excellent source of plant nutrients. This is even more important as urban lands are becoming more and more scarce and its quality for agricultural production cannot be assured.

Recycling of poultry waste has become important also because with the removal of subsidies and the deregulation of the foreign exchange market, chemical fertilizer use has become less profitable due to its high cost to farmers. Recycling of poultry manure

whilst supplying essential plant nutrients, could also serve as a way of keeping the cities clean.

It is true that Accra and Tema has seen the establishment of large-scale poultry farms with the potential of producing large quantities of manure in a relatively small space, which could be collected and utilized. However little data exist on the characteristics of the manure produced and more importantly whether it is available for use. Also as management practices and the environment affect the nutrient content of the manure produced, it is possible for its nutrient content to vary from farm to farm as well as on a particular farm. Farmers can be sampled and interviewed to capture the management and use of manure. Also case study experiments can be set up to determine manure production per bird and its plant nutrient content.



CHAPTER THREE

METHODOLOGY

3.1 Introduction

The specific objectives of the current study are: to locate where commercial poultry farming is being carried out; to estimate how much manure is produced; to determine the potential chemical fertilizer value of the manure generated and to find out what the current management and uses of the manure are. This chapter sets out the data required, sources and the methods employed in data collection and analysis in order to achieve the set objectives.

3.2 Methods of Analysis

To achieve the objective of locating commercial poultry farms, the Accra Metropolitan Authority, the Tema Metropolitan Authority as well as private enterprises engaged in the supply of feed, feed additives and veterinary products to farmers were contacted. Other organizations contacted were The Ghana Poultry Farmers Association and The Greater Accra Poultry farmers Association. The output of this exercise was a map of

the study area showing the various poultry production centres.

The second objective of the study is to estimate the amount of manure or litter produced. The amount of litter produced in the brooder house at the University of Ghana research farm was determined by weighing all the bags of litter collected and summing up the weights to get the total amount of litter produced. This amount was divided by the average number of broilers at the start and end of brooding. The result was an estimate of the average amount of litter produced per brooder broiler for the period of four weeks (i.e. the duration of brooding). At the finisher house, the total mass of litter produced was determined by finding the product of the average density of litter in the house and the volume of litter at the end of the finisher stage. The weight of a dug out area of litter divided by the product of the length, breath and average depth of the dug out litter in the house gave the density of litter in the poultry house. The process was repeated for several spots and an average was calculated. Total volume was also determined by finding the product of the length, breath and average

depth of litter in the finisher house. Weight of litter produced per bird for the period was then calculated as the total weight of litter produced divided by the average number of birds. Weight of litter produced per broiler at both stages was added up to give the total amount of litter produced per broiler for the whole period of 8 weeks (i.e. total time taken to reach market weight).

Mathematically:

$$D = M / V \quad (1)$$

$$M_1 = D_1 * V_1 \quad (2)$$

$$M_b = M_1 / A_s \quad (3)$$

Where:

D = Density

M = Mass

V = Volume

V_1 = Volume of litter

M_1 = Total mass of litter produced

M_b = Mass of litter produced per bird

A_s = Average stock

On Mackba farms, litter production per layer for the growing period covering 18 weeks was estimated by

dividing the total weight of litter produced by the average number of layers at the beginning and end of the period.

Mathematically:

$$M_1 = M_{as} * N_s \quad (4)$$

Where:

M_{as} = Average mass of a sack of litter

N_s = Total number of sacks

M_1 = As defined above

The third experiment involved the estimation of manure production by birds in lay in a battery cage system at Sydals farm. The manure produced is loaded into the trailer of a tractor and disposed off. Manure samples of known volume were taken from the trailer and density determined using equation (1). The density of manure was then multiplied by the volume of manure in the trailer to arrive at the mass of manure in the trailer. The amount of manure produced per bird per day was then estimated as follows:

$$M_m = D_m * V_m \quad (5)$$

$$T_m = \sum M_m \quad (6)$$

$$A_d = T_m / (A_b * dy) \quad (7)$$

Where:

- M_t = Mass of a manure in trailer
- V_m = Volume of manure in trailer
- A_d = Average manure produced per bird per day
- T_m = Total mass of manure collected
- A_b = Average number of birds
- dy = Total number of days

In determining the potential nutrient content of the manure of laying birds at Sydals, a work sheet by Lory and Massey (1997) was adapted for use. The input form and worksheet are shown in Table 3.1 and Table 3.2 respectively. The input form is basically a form for the input of the results of the chemical analysis on manure sample, which has been done to estimate the percentage composition of nitrogen, phosphorus and potassium. It also has a column for the input of fertilizer price per kilogram of nutrient. Data from the input form is then inputted in the worksheet (Table 3.2) where the calculation of the fertilizer value of manure is done.

The value of manure was estimated as the sum of the product of the weight of nitrogen, phosphorus and

Potassium content of manure and their respective prices.

Table 3.1: Input Form: Information Needed to Complete the Worksheet

<i>Step 1: Total Nutrients In Manure (kg/ ton)</i>	
1. Total Nitrogen	TN
2. Phosphorus	P
3. Potassium	K
<i>Step 2: Fertilizer Costs</i>	
1. Fertilizer Nitrogen (¢/kg)	CN
2. Fertilizer Phosphorus (¢/kg)	CP
3. Fertilizer Potassium (¢/kg)	CK

Source: Adapted from Lory J., and Massey R., 1997

Table 3.2: Worksheet

	Total N	P ₂ O ₅	K ₂ O ₂
1. Manure Nutrient Content (kg/ton)	TN	P	K
2. Fertilizer Cost of nutrient (¢/kg)	CN	CP	CK
3. Manure value (¢/ton) [multiply line 1 by line 2]	TN*CN= A	P*CP= B	K*CK= C
Value/ ton	A+B+C		

Source: Adapted from Lory J., and Massey R., 1997

The estimated value per kilogram of nutrient was based upon retail cost of chemical fertilizer. The valuation process considered manure only as a nutrient source, similar to commercial fertilizers regardless of its other positive attributes such as the improvement of the soil physical attributes. It does not also consider its negative attributes such as hauling, handling or application cost.

Analysis of data was carried out using SPSS. Descriptive statistics using frequency distributions were employed to describe the present management and uses of manure and litter produced.

3.3 Data Collection

To be able to locate where commercial poultry production is being practised and to interview them to find out about the management and use of manure, a list of poultry farmers was collated from several sources. The sources were: The Accra Metropolitan Authority (AMA), the Tema Metropolitan Authority (TMA), Maridav, (a private firm involved in the supply and distribution of feed additives and veterinary products to farmers), The Greater Accra and The Ghana National Poultry

farmers Association were contacted. In all 241 poultry farms were identified in the Greater Accra region out of which 30 were chosen for the study. The 30 farms chosen were those situated in Accra and Tema (the study area) and were still in business at the time of conducting the experiment.

Both primary and secondary data were used for the study. The methods employed for the collection of data comprised of in-depth interviews with farm managers using structured questionnaires and personal observation. The questions asked sought to obtain information on manure production and management as well as its use. The questions were mainly closed-ended questions.

The first part of the field data collection involved a reconnaissance survey, which aimed at identifying the commercial poultry farms in the study area. The second part of the study involved the use of structured questionnaire to interview 30 commercial poultry farms, which were identified in the reconnaissance survey.

An accurate method of determining the amount of waste removed from a poultry farm during the year would be to weigh all loads. However, in most cases this is not practical. If standard size loads are used to haul the waste from the farm, an average weight per load can be established and the total amount removed can be estimated by counting the number of loads.

Another means of estimating waste production is to establish the volume capacity of all equipment used to remove the waste and use waste density estimates to calculate the estimated weight per load. Various authors, (Naber and Bermudez (1990); Vaest and Merka, (1998)) have provided average waste production values for various animal types and production practices. Although these averages are a relatively simple means of estimating waste production, the actual amount of waste can be highly variable among poultry operations due to the different management systems found on such farms.

Three case studies were conducted to determine the amount of manure produced from three different production systems. These production systems were:

1. Broiler production on deep litter
2. Layers growing from day-old to 18 weeks on deep litter and
3. Layers in-lay in battery cages

The case of University of Ghana research farm was chosen to study broiler manure production on deep litter. The research farm is situated in the Tema district. It is basically a livestock research and production centre with a large stretch of land for the growing of feed for livestock. Average number of broilers and layers raised per year are 21,377 and 3,500 birds respectively.

Production of broilers on the farm involves first of all brooding for a period of 4 weeks after which they are transferred to a finisher house for another period of 4 weeks. Hence the total period from day-old to the time the birds are ready for the market is 8 weeks. The brooding and finishing stages both occur on deep litter but in different houses. The study therefore determined manure production at the brooding stage and then at the finisher stage. The bedding material used in both situations was wood shavings.

At the brooding stage not much litter is being generated per batch so the strategy for the determination of total litter produced involved bagging all the used litter and weighing of the bags.

The determination of total litter produced at the finisher house involved a different strategy. The strategy made use of the average density and volume of litter in the finisher house to estimate the total amount of litter produced. Data on depth of litter for 20 different points in the finisher house were taken and an average figure found. The length and breath of the finisher house were also measured. The density of manure was then determined for 20 areas in the finisher house and an average calculated. The determination of density involved finding the length, breath and average depth of a dug out litter in the house. Twenty different points and areas were chosen to increase the precision of estimation.

The second case study involved the determination of litter production by layers on deep litter from day-old to 18 weeks of age. This was carried out on Mackba farms. Mackba farm is a poultry farm solely into the

production of table eggs. It is situated in the Tema district of the Greater Accra region near Ashaiman. Mackba farms is a layer farm with an average bird population of 14,199 birds per annum. The keeping of layers on Mackba farms involves brooding and growing of layers on deep litter for a total period of 18 weeks after which the birds are transferred into battery cages for the laying period. The practice on the farm is to bag all the litter left after transfer of birds into sacks of equal volume. The study considered only the amount of litter produced by the growing birds on deep litter. To estimate the total amount of litter produced, an average weight per sack was calculated from the weight of 10 bags of used litter, which were randomly selected. Finding the product of the average weight per sack and the number of sacks of litter then gave the total weight of litter produced. Also data on bird population at day-old and at the time of transfer to battery cages were taken.

The third case study was carried out on Sydals farm. The farm is situated in Adjei Kojo, a suburb of Ashaiman in the Tema district of Greater Accra region. It is solely into the production of table eggs. The

farm is also one of the biggest poultry farms in Ghana with an average layer bird population of 84,945 about layers per annum. There are two production sections on the farm. These are the old and the new sections. At the old section all production activities are manually carried out. However, in the new system, all the production activities from feeding and watering to temperature control, egg and manure collection are automated. The system also allows for regular removal of manure. The practice at the new site is to remove manure every other day. Manure collects in shallow pits under the battery cages and it is removed by an electric powered scraper system. The scraper deposits the manure into a trailer, which sends the manure to a dumping site. However manure at the old site piles up and is removed only at the end of the production cycle of the birds.

Production of layers on the farm involves, first of all, brooding and growing on deep litter for a total period of 18 weeks and then transfer to battery cages for the laying period. Only battery cages are used for the laying period hence no bedding material is used.



Before commencement of the experiment at Sydals farms and also on the last day of the experiment it was ensured that all the manure pits in the layer house being used for the experiment were cleared completely of manure. On every other day manure generated by the birds was loaded unto a trailer and the volume of manure in was leveled the trailer was estimated. This was continued for two weeks. The total number of trailer loads of manure was recorded as well as the bird population for each day of manure collection. The density of samples of manure from the trailer was determined by finding the mass per unit volume of the manure sample from which an average value was calculated. Assuming the same level of compactness for the samples of manure taken from the trailer and the manure in trailer, the mass of manure in the trailer was determined by the product of the average density of the manure samples and the volume of manure in the trailer at each collection time.

Manure samples from laying birds at the experiment house were sent to the ecological laboratory of the University of Ghana, Legon for analysis. Chemical

analysis was carried out to determine the nitrogen, phosphorus, and potassium content of the manure.

Closed-ended questionnaires were employed to collect data from the selected 30 poultry farms. The questions were framed to solicit for information on manure production, its management and use as well as the demand for manure. The information gathered was used to describe the manure management and use in Accra-Tema area.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussion of the various experiments that were carried out. It covers the presentation of results and discussion on the location of the poultry farms, the amounts of manure produced by layers and broilers, their plant nutrient content and the management and use of the manure generated.

4.2 Location of Farms

The farms involved in the experiment together with their locations are shown in Table 4.1. Appendix B also shows a map of the study area and the location of farms involved in the survey. It was observed that most of the large farms such as Mackba, Sydals, Letap and Chris farms were found in areas that are far from residential areas and also have large tracks of unoccupied lands around them that are unoccupied. On the other hand, farms such as Farm Vivian, Alliance Three and a few others were found to be located within residential areas.

Table 4.1:Farms and Their Locations

Name of Farm	Location	Poultry Type	No. of Birds/yr
89 Mariland farm	Oyarifa	Layer	5,345
		Broiler	3,500
Afoakwa farms	Oyarifa	Layer	5,272
Alliance Three	Lashibi	Layer	11,060
Asiedu farms	Oyarifa	Layer	5,014
Barima Y. Farm	Oyarifa	Layer	5,813
Benelat farm	Ashaiman	Layer	5,697
Central farm	Oyarifa	Layer	7,680
Chris farm	Kpone	Layer	8,500
David K. Opoku	Oyarifa	Layer	4,726
Delawin farm	Tema	Layer	17,649
Dufie farms	Kpone	Layer	8,141
Eddievyn farm	Tema	Layer	6,718
Farm Vivian	Lashibi	Layer	14,887
		Broiler	22,557
Korankye farm	Tema	Layer	4,623
Letap farm	Near Accra Abattoir	Layer	14,199
Mackba farm	Ashaiman	Layer	45,875
Meilong Farm	Ashaiman	Broiler	45,000
Mr. Danso	Oyarifa	Layer	6,030
O-P farm	Tema	Layer	5,467
Osei farm	Ashaiman	Layer	3,417
Paragon farm	Ashaiman	Layer	5,533
Ratson farm	Ashaiman	Layer	4,163
Sydals farm	Ashaiman	Layer	84,945
Sylcat farm	Tema	Layer	4,839
Takmal farm	Oyarifa	Layer	3,166
U.G Research farm	Nungua	Layer	3,500
		Broiler	21,377
Vidas farm	Oyarifa	Layer	17,104
Villa farm	Oyarifa	Layer	3,593
Yiadow farm	Adenta Barrier	Layer	9,347
Zuba Farm	Kpone Barrier	Layer	4,254

Source: Fieldwork 2001

From a history of farms, which are now found in residential areas, it was established that these farms were established at a time when there were little or no human settlements in their immediate vicinity. As the

population kept growing and the pressure on the land increased, more and more residential facilities sprang up in close proximity to the farms. Disposal of manure and litter generated by the farms became a problem as residents kept complaining about flies and odour from the litter and manure. Considering the rate of population growth in Greater Accra and the increasing pressure on land, it is expected that increasing numbers of poultry farms would eventually be located within residential areas.

Hence a good manure and litter management program could go a long way to reduce the bad environmental effects of poultry farming. This would enhance the co-existence of poultry farms and residential set-ups.

4.3 Manure Production

A summary of the estimates of the amount of manure produced by broiler birds, growing layers and birds in-lay is presented in Table 4.2. Litter and manure production of 113.4g per broiler per day and 47.8g per laying bird per day determined for the case study farms were lower than the estimates reported by Naber and Bermudez, (1990) for broiler (136.1-158.8g/b/d) and

layer bird. The differences could be due to variation in species, management practices and possibly difference in measuring technique used.

A broiler bird from day-old to 8 weeks produces 6.3 kg of manure (i.e. 113.4g/d), whilst a layer bird from day-old to 18 weeks on deep litter produces 3.4 kg (26.98g/d) of litter. The estimates of amount of litter produced for a broiler bird and a growing layer were based on the amounts of litter present at the end of a production phase, which lasted for 8 weeks and 18 weeks respectively and do not include the amount of caked litter removed from the poultry house.

Table 4.2: Manure and Litter Production per Bird from Case Study Farms

Type of Bird	Production System	Estimation Period	Manure produced	Manure produced /day
Broiler	Deep litter	56 days (8wks)	6.35 kg	113.9
Layer grower	Deep litter	126 days (18wks)	3.4 kg	26.98
Birds in-lay	Battery cage	Per day	47.8 g	47.80

Source: Fieldwork 2001

The amount of litter produced could therefore be higher than estimated. Removal of caked litter is a regular

litter management strategy to prevent wet litter from serving as an environment for the growth of pathogens that could be harmful to the birds. Caked litter results from spillage of drinking water on the litter.

A laying bird in a battery cage produces 47.8g of manure per day without any bedding material added. From this estimate a laying bird in a battery cage would produce a total of 17.45 kg (i.e. $47.8\text{g} \times 365$ days) of manure for one year of laying.

Also tracing litter and manure production of a layer bird from day-old to one year, a layer produces 3.4 kg of litter in the first 18 weeks on deep litter and then 11.4 kg ($239 \text{ days} \times 47.8\text{g}$) of manure for the rest of the year (239 days) spent in a battery cage. This gives a total of 14.8 kg of litter per layer for the first year of its life assuming that laying is done in a battery cage.

The estimated litter productions at the farm level for the sample farms are presented in Table 4.3. These estimates were derived by finding the product of litter

production per bird and the average number of birds raised per year for each of the sample farms.

Table 4.3:Farms and Their Estimated Litter Production

Name of Farm	Poultry Type	No. of Birds/yr	Estimated Litter Production (tons/yr)
89 Mariland farm	Layer	5,345	79.1
	Broiler	3,500	22.1
Afoakwa farms	Layer	5,272	78.0
Alliance Three	Layer	11,060	163.7
Asiedu farms	Layer	5,014	74.2
Barima Y. Farm	Layer	5,813	86.0
Benelat farm	Layer	5,697	84.3
Central farm	Layer	7,680	113.7
Chris farm	Layer	8,500	125.8
David K. Opoku	Layer	4,726	69.9
Dufie farms	Layer	8,141	120.5
Eddievyn farm	Layer	6,718	99.4
Farm Vivian	Layer	14,887	220.3
	Broiler	22,557	142.1
Korankye farm	Layer	4,623	68.4
Letap farm	Layer	14,199	210.1
Mackba farm	Layer	45,875	679.0
Meilong Farm	Broiler	45,000	283.5
Mr. Danso	Layer	6,030	89.2
O-P farm	Layer	5,467	80.9
Osei farm	Layer	3,417	50.6
Paragon farm	Layer	5,533	81.9
Ratson farm	Layer	4,163	61.6
Sydals farm	Layer	84,945	1,257.2
Sylcat farm	Layer	4,839	71.6
Takmal farm	Layer	3,166	46.9
U.G Research farm	Layer	3,500	51.8
	Broiler	21,377	134.7
Vidas farm	Layer	17,104	253.1
Villa farm	Layer	3,593	53.2
Yiadam farm	Layer	9,347	138.3
Zuba Farm	Layer	4,254	63.0
TOTAL			5,415.4

Source: Fieldwork 2001

It can be seen that a total of 5,415.4 tons of litter is produced with Sydals farm producing the largest

amount of 1,257.2 tons followed by Mackba farm producing 679 tons of litter. This amount of resource in the form of litter could be harnessed and made use of in plant production or else it could pose an environmental problem.

4.4 Plant Nutrient Content and Value of Layer Manure

The results of chemical analysis conducted on scraped cage layer manure from Sydals Farm are shown in Table 4.4. The results indicate that layer manure contains high percentages of nitrogen (3.30%), potassium (3.03%) and phosphorus (1.50%) with moisture content of 68%. The nitrogen and potassium contents were higher than those reported in Table 2.2, which had nitrogen content ranging between 1.3 to 2.0% and potassium content ranging between 0.5 to 1.5%. This implies that manure in our system could also serve as an important source of plant nutrients if properly preserved and packaged. Proper preservation and storage is necessary if manure is to keep its nutrient content.

Table 4.4: Plant Nutrient Content of Scraped Layer Manure

Nutrient	Percentage Content
Moisture	68
Nitrogen	3.30
Phosphorus	1.5
Potassium	3.03

Source: Fieldwork 2001

The process for the determination of the value of manure is shown in Table 4.5.

Table 4.5: Fertilizer Value of Layer Manure at 2002 Chemical Fertilizer Prices

	Total N	P ₂ O ₅	K ₂ O
1. Manure Nutrient Content (kg /ton)	33.0	15.0	30.3
2. Fertilizer Cost (¢/kg) estimated from Table 2.1	4,600.00	6,400.00	3,500.00
3. Manure Value (¢/ton) multiplying line 1 by line 2	151,800.00	96,000.00	106,050.00
Value per ton	353,850.00		

Source: Fieldwork 2001

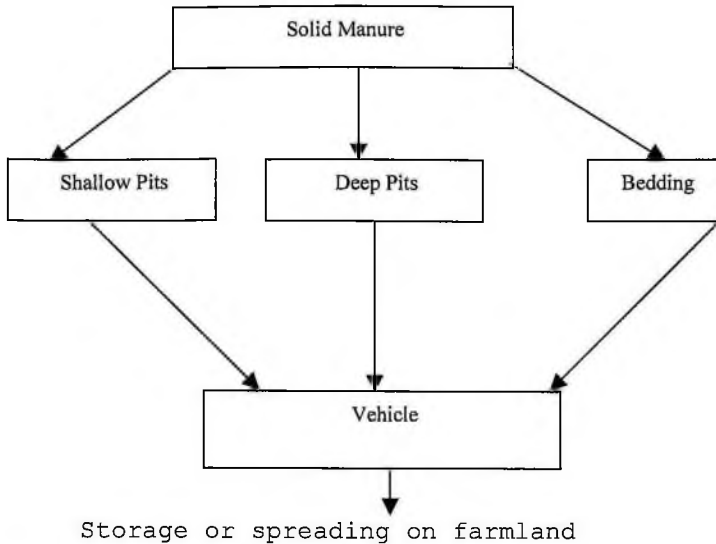
Using the concentrations of nitrogen, phosphorus and potassium in manure as well as price per kilogram of nutrient it is estimated that a ton of manure is worth ¢353,850.00. However, the quantity of manure that is used by farmers to replace chemical fertilizers would

determine its value. Processing into compost could reduce its bulkiness and further enhance its value.

4.5 Management and End Uses

Manure management in the study area was found to be closely associated with the system of production. Basically, manure produced is of two forms: one is manure without any bedding material added to it. This form of manure is associated with cage layer system. The other form of manure has bedding material mixed with it. This form is derived from the deep litter system and is referred to as litter. Figure 4.1 shows litter and manure management alternatives found in the study area. At the end of production or whenever it is convenient, manure or litter is removed and disposed off. With the exception of Mackba farm no attempt is made by farms to properly store manure or litter; rather, it is dumped in the open and left to the mercy of the weather. This would affect the nutrient concentration and hence its value. Water is not used to remove manure from poultry houses. Manure or litter in the study area is therefore handled in the solid state.



Figure 4.1: Litter and Manure Management Alternatives

Source: Fieldwork 2001

Manure from the cage layer system collects into two types of pits, namely the shallow pit and the deep pit. The shallow pits are designed to use a scraper, which scrapes the manure into a vehicle for disposal. The scraper is operated manually or electrically. Manure is collected regularly and can be done conveniently. With the deep pit system, manure is allowed to accumulate and is removed at the end of productive life, when the birds have been sold off or taken out of the poultry house. With the deep litter system manure accumulates on a bedding material such as wood shavings

and it is removed, usually at the end of production or after the birds have been sold off. The only bedding material in use was wood shavings. After manure has been removed from the poultry house it is disposed off in the open and usually on the farm premises. However, with litter it is sometimes bagged and sold to farmers. Compared with manure, litter is easier to spread when fertilizing the soil.

The frequency of changing of bedding material as a litter management strategy varies within the study area. Analysis of data revealed that three out of four broiler farms change litter seven to eight times in a year with the remaining one doing so five to six times in a year. Of the layer farms interviewed, 34.5% of the farms change litter 5-6 times, whilst 10.3% change litter 9-10 times in the year. Also 17.3% of layer farms change litter 1-2 times a year and another 17.2% change litter 3-4 times in a year. These are presented in Table 4.6. The more frequent the change of litter, the less concentrated its plant nutrient content and hence the lower its value per ton. It also came out that the demand for litter increases the frequency of its change.

Manure or litter is used for several purposes in Accra and Tema. Landscapers and real estate developers use it for horticultural purposes, by residents for backyard gardens and by urban farmers for growing crops and vegetables.

Table 4.6: Frequency For Change of Broiler and Layer Litter

Frequency of Change (no. of times/yr)	Occurrence of Litter Change (%)	
	Broiler	Layer
1-2	0	17.3
3-4	0	17.2
5-6	25	34.5
7-8	75	20.7
9-10	0	10.3
TOTAL	100	100.0

Source: Fieldwork 2001

From Table 4.7, 40% of poultry farms reported a higher demand for manure or litter than they are currently producing, and 3.3 % indicated that demand was equal to production. Also 56.7% said production of manure and litter was more than demanded.

These figures do not conclusively indicate a higher level of production than demand as the farms interviewed are of different sizes and hence produce

different amounts of manure and litter (i.e. manure mixed with bedding) per year. However, it was found that most of the manure produced is wasted, as it is not demanded as much as litter.

Table 4.7: Production and Demand for Manure and Litter

Relation	Percentage of Respondents
Production = Demand	3.3
Production > Demand	56.7
Production < Demand	40.0
TOTAL	100.0

Source: Fieldwork 2001

Manure and litter produced is either sold, used on the poultry farm for crop production or it is dumped and goes wasted. Only 13.3% of the farms interviewed reported sale of manure or litter as the highest activity whilst 36.7% gave it for free. Also 26.7% of farmers and another 23.3% indicated dumping and use on farm respectively. This information is presented in Table 4.8. None of the farms interviewed practised composting. The problems encountered with manure and litter management included demand for labour for removal, flies and odour.

Table 4.8: What Farmers Mostly Do with Manure

Activity	Percentage
Sale	13.3
Giving Out For Free	36.7
Dumping	26.7
Use on Farm	23.3
TOTAL	100.0

Source: Fieldwork 2001

Also timing of demand and production of manure and litter was reported to be a problem. Periods prior to and during the rainy season were reported by farmers to be associated with a high demand for manure. This demand falls in the dry season and farmers experience the problem of storage. The manure is mostly left in the open where it is exposed to the weather. Prolonged exposure to weather results in the lowering of the value of manure.

Despite the manure and litter management problems, only 10% of sample farmers make use of the waste departments of their respective Metropolitan Authorities in managing their waste.

It was also found that farms with more manure and litter production than demand were most willing (16 farms) to enter into an agreement with an organization that will help with the management of the waste they produce. In all 76.7% of farmers were willing to enter into a litter management agreement. This is presented in Table 4.9.

Table 4.9: Manure and Litter Management Willingness by Manure Production against Demand Cross tabulation

Willingness to Enter into a Management Agreement	Manure and Litter Production against Demand			TOTAL (%)	
	Production =Demand	Production >Demand	Production <Demand		
	Yes	1	16	6	76.7
	No	0	1	6	23.3
TOTAL	1	17	12	100.0	

Source: Fieldwork 2001

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

Poultry production in Ghana has been increasing since 1989. It is an agricultural activity that is important in the lives of urban dwellers. It serves as a source of employment as well as an important source of protein. This agricultural activity produces a by-product in the form of manure, which is a nuisance to residents living in close proximity to poultry farms therefore posing a problem. This problem is not yet wide spread as many of the big poultry farms are situated in places which are not close to residential areas. The situation is however expected to change with the rapid urbanization and population increases resulting in pressure on land for other non-agricultural purposes. There is therefore the need for a good manure and litter management plan that would make use of the manure generated to prevent it from being a nuisance to residents living around poultry farms.

From the study it was estimated that a broiler bird within 8 weeks from day-old produces 6.3 kg of litter whilst a growing layer bird produces 3.4 kg of litter within the first 18 weeks. On the other hand, a laying bird in a battery cage produces 47.8 g of manure per day. Hence within one year from day-old, a layer would have produced 14.4 kg of litter by the time it is a year old. For a whole period of one year of laying, 17.45 kg of manure would be produced. Total amount of litter production per year for the sample farms was estimated as 5,415.4 tons with Sydals farms producing the largest portion of 1,257.2 tons of litter.

Considering the varying rate of change of layer litter from farm to farm it is expected that manure and litter will vary in its plant nutrient concentration. Chemical analysis on scraped layer manure revealed that it contains a high amount of nitrogen (3.3%), phosphorus (1.5%) and potassium (3.03%). Compared to the price of nitrogen, phosphorus and potassium in chemical fertilizer a ton of manure was found to be worth ₵353,850.00.



Though poultry litter or manure is an excellent source of plant nutrients, not all of this resource is put to use. It came out that only 40.0% of the cases reported a greater demand than production of manure or litter and 56.7% reported a higher production than demanded. It also came out that virtually all the manure produced is not made use of. Unused manure is left in the open at the mercy of the weather resulting in the lowering of its mineral content.

Some of the problems identified with manure and litter management included labour for removal, timing of demand and production of manure and litter as well as problems of flies and odour associated with manure. To solve these problems, about 76.7% of farms (23 farms) are willing to enter into partnership with an organization that will help them manage their waste.

5.2 Conclusions

The potential for using poultry manure as a soil nutrient enhancer really exists. Considering the high plant nutrient content of manure and the amount produced, it is concluded that litter produced in the Accra-Tema Metropolitan area, particularly from farms

using the cage layer system, can be used to complement the use of chemical fertilizer. This will require that the litter produced is collected and processed into compost.

5.3 Recommendations

Poultry farmers should be encouraged to keep records of their actual manure and litter production as the manure produced can be a very important source of plant nutrient. The proper management of which would require good record keeping. This was absent on all the farms surveyed. This will help in the proper management of the waste produced.

Though manure and litter are important plant nutrient sources, they are bulky and transporting them over long distances would be costly. Therefore processing into compost should be considered. It is suggested that the metropolitan authorities should encourage the private sector into setting up micro-composting plants on selected poultry farms. Selection criteria should consider the size of the poultry enterprise, availability of space for plant establishment, and acceptability of the concept of composting. Near by

farms could be linked through a manure collection system. It is also recommended that consideration should be given to setting these micro-compost plants on farms that use the battery cage system since most of the manure they produce is not presently being used.

The compost produced can be properly stored and used at the time it is needed, hence solving the problem of timing of demand and production of manure or litter. Again, compost is less bulky compared with manure; hence it could be transported at a relatively cheaper price. The issue of flies and odour will be reduced and farmers could obtain extra revenue from the sale of compost.

Since the battery cage system of production can stock large amounts of birds in a relatively smaller space it should be encouraged. Its pits should be designed in such a way to allow regular collection of manure. These measures when put in place would ensure the acceptability of poultry farms in residential areas.

5.4 Suggestions for Future Research

It is evident that taking full advantage of the benefits of manure and litter requires that the waste be composted. Future research should look at the feasibility of establishing several micro compost plants on poultry farms and how other farms could be linked to these plants

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APPENDIX A

QUESTIONNAIRE

Topic: A Quantitative Analysis Of The Potential Fertilizer Value Of Poultry Manure Generated In The Accra-Tema Metropolitan Area

Author: *Jacob Benson*

Preamble: This is a thesis research that is being undertaken by the student author in partial fulfillment of a Master of Philosophy Degree in Agricultural Administration at the University of Ghana, Legon.

It is the aim of the project to determine the amount of waste being generated on poultry farms with the view to exploring the opportunities of processing the wastes into compost/ organic fertilizer

Respondents are therefore to perceive this exercise as purely academic. It is not for the purpose of taxation, or for any other reason. All information given in this regard would be treated with optimum confidentiality

A. General Background

1. Name of farm.....
2. Location of farm.....

3. Condition of access road to farm

- 1. Tarred and good
- 2. Tarred but bad
- 3. untarred

B. Waste Generation

4. What types of poultry do you raise?

- 1. Broilers
- 2. Layers
- 3. Broilers and layers

5. What system of housing best describes the production of broilers on your farm?

- 1. Brooding and finishing in one house
- 2. Brooding and finishing in different houses

6. What system of housing best describes the production of layers on deep litter system on your farm?

- 1. Brooder, Pullet and Layer stages in one house
- 2. Only the Brooder and Pullet stages in one house
- 3. Only the Pullet and Layer stages in one house

7. What type of bedding material are you using?

Category	Bedding Material
Broiler brooder	
Broiler finisher	
Layer brooder	
Pullet	
Layer	

1= wood shavings 2= saw dust 3= other

8. What is the average No. of birds raised per year for:

- A. Broiler.....
- B. Layer.....

9. How many times in a year do you change the bedding material?

Category	Wood shavings No. of times/yr	Saw dust No. of times/yr	Other No. of times/yr
Broiler			
Layer			

10. What is the average duration of a batch of on the deep litter system?

Category	Duration
Broiler	
Layer grower	

11. In how many years do you plan to expand your operations?

- 1. Next 2 years
- 2. Next 4 years
- 3. After 6 years
- 4. Do not intend to expand in the nearest future

C. End Uses of Waste Generated

12. Do you have any problems with the removal of litter from the poultry houses?

- 1. Yes
- 2. No

13. If yes kindly list the three most important ones

- 1.....
- 2.....
- 3.....

14. Do you employ the services of the metropolitan authorities in handling your waste?

- 1. Yes
- 2. No

15. If yes list the three most important services

- 1.....
- 2.....
- 3.....

16. If no why?
1.....
2.....
17. List some of the problems you encounter with waste management
1.....
2.....
3.....
18. Will you be willing to enter into some form of agreement with an agency to remove the litter for you?
1.Yes
2.No
19. What do you do with the waste generated?
1.Sold
2.Given out for free
3.Dumped and abandoned
4.Used on the farm
20. If sold how much does it sell per kilogram?.....
21. If abandoned what is the distance of the dumping site from the farm?.....
22. If used on the farm, for what purposes is the waste used for?
1.Spreading on cropped land
2.Use as ruminant feed
3.Composted
4.Used in other recycling activity
23. If sold or given out freely, how is the waste generation meeting the demand for it?
1.Produces roughly the amount being demanded
2.Produces more waste than being demanded
3.Produces less waste than demanded

Greater Accra Metropolitan Area - Showing the Farms Surveyed

