A COMPARATIVE STUDY OF FORMAL AND INFORMAL IRRIGATED URBAN VEGETABLE PRODUCTION IN THE GREATER ACCRA REGION

BY

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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN AGRICULTURAL ADMINISTRATION

DEPARTMENT OF AGRICULTURAL ECONOMICS AND AGRIBUSINESS, FACULTY OF AGRICULTURE

JANUARY, 2003

DECLARATION

I, Charles Bonsu Abban, author of this project report do hereby declare that the work presented in this thesis: "A COMPARATIVE STUDY OF FORMAL AND INFORMAL IRRIGATED URBAN VEGETABLE PRODUCTION IN THE GREATER ACCRA REGION" was done entirely by me in the Department of Agricultural Economics and Agribusiness, University of Ghana from September 1999 to January 2003. This work has never been presented in whole or part for any other degree of the University or elsewhere.

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ACKNOWLEDGEMENTS

Glory be to God in the highest and on earth for seeing me through this work to the very end. My greatest gratitude goes to Mr. D.P.K. Amegashie and Dr. (Mrs.) Ramatu Alhassan, all lecturers of the Department of Agricultural Economics and Agribusiness, University of Ghana for their guidance, constructive criticisms and fullest supervision of this work.

My indebtedness also extends to the executive members of the Ghana Vegetable Producers Association and the farmers at Weija, Ashaiman, Dwahenya and those farming along drains and streams in the city centers in Accra for their invaluable assistance.

Mention must also be made of Rev. (Dr.) Asuming-Brempong, the Head of Department of Agricultural Economics and Agribusiness and the entire teaching staff whose invaluable suggestions and constructive criticisms during seminar presentations helped to improve the quality of work.

DEDICATION

I dedicate this work to my wonderful parents: Mr. and Mrs. Abban, my siblings Kofi, Esi and Ekua, two wonderful uncles; Mr. F .A. Abban and Mr. K. Dadzie and, especially, to my fiancée Rosemond Owusu Bimpomaa, whose efforts in diverse ways have brought me this far.

ABSTRACT

In the urban centres the demand for vegetable is not seasonal, necessitating a year-round production heavily dependent on irrigation. This study was designed to conduct a comparative economic analysis of formal and informal irrigated vegetable farms in the Greater Accra Region. The analysis was based on farm management data obtained from 60 respondents of the two vegetable irrigation systems respectively in 2001.

A budget analysis revealed that formal irrigated urban vegetable farming employed larger quantities of all variable inputs than informal irrigated urban vegetable farming. In addition, output per acre and profit was much higher on formal farms than on informal farms, because formal farms obtained larger output by using larger quantities of inputs at relatively lower unit costs.

Production function analysis showed that the technical efficiencies associated with both farm types is factor-biased or neutral, and that technical efficiency is higher on formal than on informal farm types. Both farm types were found to be allocatively inefficient in the use of all the production resources considered in the study. In relative terms, however, formal farms were more allocatively efficient in the use of agrochemicals. The study also showed that farmers in the formal system underutilized land, labour and agrochemicals, and overutilized irrigation service inputs. Informal farm types underutilized fertilizer and agrochemical but overutilized miscellaneous inputs (seeds and planting materials).

The higher technical efficiency and profit margins associated with formal irrigated farms tend to support investments in irrigation infrastructure as a means of increasing agricultural productivity and income to small-scale farmers. To exploit the

full potential of irrigation, farmers need a complete package of production inputs, improved access to land as well as training on the operation, maintenance and repair of irrigation equipment. To attain optimal resource allocation, formal irrigation farm types need to increase their employment of labour, land and agrochemicals and reduce irrigation services inputs. Informal farm types similarly need to increase the use of fertilizer and agrochemicals while reducing their employment of high expenses on seeds and planting materials and other miscellaneous inputs.

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CHAPTER ONE

INTRODUCTION

1.0 Background

The world's population is increasing at about 85 million every year (Drenchsel et al, 1999). Globally, the U.N expects population in urban areas to increase from 2.8 billion to 5.3 billion between 1995-2025 with 90% of growth occurring in developing countries, mostly in Asia and Africa. During the past 40 years, the greater part of the global urban population growth has been occurring in developing countries (Burgess et al, 1997) where the urban population growth rate is about 3.5% per year compared to 1% in the more developed regions (World Resource Institute, 1996). It is also estimated that at the beginning of this century, only 13% of the world's population lived in towns and cities; by 1975, an estimated 33% of the world's population lived in urban areas. This figure is expected to be over 50% by the year 2010. Furthermore the United Nations projects that the world's population will grow from roughly 6 billion to more than 9.5 billion by 2050 with the developing countries experiencing the increase.

Sub-Sahara Africa has the fastest rate of urbanization in the world. In Africa, more than one-third of the population already lives in urban cities, and over the next 25 years, the rapid urbanization of Africa could lead to increasing food insecurity in the cities (Sonou, 2000)

According to Mokwunge et al (1996), the population of West Africa has more than doubled from 85 million in the 1960's to 215 million in 1993. It has been estimated that about two out of every three West Africans will live in urban centers in twenty year's time (Snrect, 1994; Economist 1998, cited in Drenchsel et al 1999).

In Ghana, the urban population is growing at an estimated annual rate of 4.1% compared with the overall population growth of 3% Sonou, (2000). The population of Accra has also increased likewise from 2 million in 1994 to 2.5 million in 2000 (Ghana statistical Service 1999, 2000).

The growth in the rate of urbanization in most countries, especially the developing countries has precipitated the supplementation of rural farming with urban agriculture to improve agricultural production to sustain the growing urban population. There is therefore a growing recognition of the importance of urban agriculture in a strategy to cope with new urban challenges.

Maxwell (1997) defines urban agriculture as food production occurring within the confines of cities. He however, stressed that this production takes place in backyards, rooftops, community vegetable and fruit gardens, and unused or public spaces. It includes commercial operations producing food in greenhouses and other spaces, but is more often small-scale and scattered around the city. This narrow definition includes specific circumstances of urban agriculture, which is frequently a more intensive variety of rural agriculture, but deliberately excludes important aspects of urban agriculture, such as forestry and fisheries. According to the United Nations Development Program (UNDP, 1996) urban agriculture is an activity that produces, processes and markets food and other products on land and water in urban and peri-urban areas. It also uses intensive production methods and re-uses natural resources and urban waste to yield a diversity of crops and livestock. The FAO committee on Agriculture (FAO-COAG, 1999) adds that an important sector of urban agriculture includes horticulture, livestock, fodder, milk production, aquaculture and forestry and that agricultural practices in the urban areas can be distinguished from rural agricultural systems by parameters such as the inputs used, the size of the farm, the nature of tenure, the technology used, high labour cost and crops grown. Also included are practices such as shifting cultivation and bush fallowing, due to the shortage of land and the legal and regulatory framework of the city. It is practiced wherever land is available in the cities, whether private or public lands, regardless of its legal or illegal acquisition.

Anku et al (1998) have reiterated the fact that, urban agriculture in Africa has a relatively long tradition and is widely practiced; yet in most African countries it has been undervalued and resisted by generations of public officials. This attitude has only recently begun to change as a result of growing hunger and economic and environmental crisis in the Africa metropolis. A survey conducted by the UNDP identified over 40 distinct farming systems with produce ranging from medicinal herbs to aquaculture (Mougeot, 1993). In Accra metropolitan area, however, a study conducted by Zakariah et al (1998) came up with seven systems of farming namely, vegetable gardening, commercial livestock, seasonal crop farming and finally a miscellaneous group, which entails the raising of export crops, micro livestock, snail farming and bee keeping.

The fast rate of increase in urbanization in a developing country such as Ghana has caused the rural food supply to the urban areas to drastically reduce because of loss of farm hands to rural-urban migration. At the same time, migration has led to a corresponding increase in the urban food demand. This therefore poses serious challenges both in crop production and specialized urban and peri-urban farming systems to avert the situation of food insecurity in the urban centers.

Urban agriculture is a dynamic sector characterized by proximity of production and consumption sites. Its performance is ultimately limited by the difficulty of accessing water. The concept of formal irrigated urban vegetable farming is used to imply farming under a well organized system being manned by set up institution with technical men to assist farmers receive required levels of water from a dam and extension services for their farming activities. Water for irrigation is tapped from a well-constructed canal onto the farming plots. Large or formal irrigated urban vegetable farms with sizes ranging between 0.8 to 2.5 acres are located in Ashaiman and Weija depend on the water from near by dams for irrigation. It has some level of government control. Under this study the form of irrigation practice in Ashaiman, and Weija are regarded as formal irrigated farming. Informal irrigated urban vegetable farming is quite different from the formal system because it has no governmental control whatsoever. Small or informal irrigated urban vegetable farms of sizes ranging from 0.5 to 1.0 acre are, however, located along big drains (gutters) and streams located in many urban centres in Accra namely: Haatso, La, Korle Bu, Castle road, Cantonments, Malam, Dzorwulo, Teshie and the Atomic Energy Commission and the South industrial areas. The source of water for irrigation is not regulated and it is sourced from near-by streams, rivers, pipe-borne water and sometimes water from drainages or gutters. The water is not treated and, therefore, has a lot of germs. It is characterized by the use of simple equipment such as watering cans, buckets and water holes in the case of pipe-borne water. The crops cultivated under both systems of irrigation practices ranges from exotic vegetables such as lettuce, radish, cabbage, cauliflower, as well as local ones (okra, tomatoes, garden eggs). Exotic vegetables occupy more acreage and are mostly grown in the city where there is high demand for the produce by elite and foreigners. Local vegetable cultivation is also cultivated but not in large acreages.

According to Sonou (2000), among major urban problems are those related to unemployment and under-employment, as well as high food prices especially due to the high costs of marketing food products. The growing demand for fresh and perishable agricultural produce in the major cities is driving the development of urban agriculture. This demand is not seasonal, necessitating year-round production, heavily dependent on irrigation. He further re-iterated that, development of irrigated agriculture has a high priority in the present world where production of foodstuffs must keep with a rapidly increasing population, and that a well-planned and efficiently utilized irrigation (formal and informal) system must at the same time significantly contribute to raising the farmer's standard of living. There is the need for an efficient form of formal and informal irrigation vegetable farm types that will improve the lives of the marginalized urban-poor so as to enhance urban vegetable production all-year round.

1.1 Problem Statement

According to Dittoh (1991) African agriculture is in crisis and the abundant natural resources of the continent must be harnessed to increase food and fibre production. He noted that one limiting factor in crop and livestock production in Africa is rainfall. There is, therefore, the need to apply an all year round crop production strategy through the use of some kind of irrigation. The distribution of rainfall over time and space and the undependability of rainfall patterns are major nonhuman constraints in African agricultural production. The Greater Accra region is no exception since it is noted as one of the hottest parts of the country, with the least annual rainfall. Rainy season falls between March and September with an average annual rainfall of about 750 millimetres. The state of affairs looks different in the dry season; rainfall could be as low as zero millimetres. This condition has made vast areas of land in the Greater Accra region semi-arid and can only support crop production for 2 to 4 months a year under rain-fed conditions and, therefore, is partly responsible for the overall low production of food and fibre in the area. The rainfall pattern prevents efficient use of land, labour, and other resources and makes adoption of improved technology difficult. Vegetable production, however, could be expanded in the urban areas of the Greater Accra region if irrigation were used more widely and efficiently.

The frequent drought and associated famine in Sub-Saharan Africa has given rise to the establishment of several formal and informal irrigation schemes in the sub-region. Studies have shown that many governments in the sub-Sahara African countries, supported by developed countries invested in irrigation schemes for increased and sustained food production to meet the ever-increasing demand due to population growth. In Ghana the development of modern (formal) irrigation schemes began in the early 1960's and continued over the years. Between 1960 and 1970, the Ashaiman, Vea, Asutuare, Komenda, Afife, and Adidome irrigation projects were established. Several others including Dawhenya, Tano, Weija and Kpong projects were initiated later. According to the World Bank (1986) generally, it was presumed that the construction of dams and the provision of canal structures were themselves sufficient to result in bounteous agricultural output. Contrary to this view, a large number of formal irrigation schemes around the world including Ghana, perform below expectations. They have been plagued by many problems such as excessive water loss, mismanagement of water, poor maintenance and water theft. In a further study Amegashie (1994) noted that the Weija and Ashaiman irrigation schemes are some of the few formal irrigation schemes that have not been spared of these problems since their initiation in the 1960s. The problems led to a drastic reduction in the number of participating farmers and the area under cultivation.

Urban vegetable production requires irrigation yet the record on the performance of modern (formal) irrigation systems is not a positive one. Although informal irrigation systems have grown in recent times (Dittoh, 1991), there is little information on the advantages of this system relative to the existing formal systems.

Formal irrigated urban vegetable production is the application of irrigation (watering the crops from a portable water source-dams or river with the aid of a sprinkler) in small areas within cities, such as vacant plots, gardens, and containers for growing crops, mainly vegetables for own-consumption or sale in neighbourhood markets. Informal irrigated urban vegetable production, on the other hand, is the use of watering cans and buckets as a means of collecting water from main source of water. This means of production is relatively less capital and labour intensive unlike the formal irrigated urban production.

The sustainability of either system depends on the economic efficiency of resource use by farmers, which in turn determines profitability of the systems. This raises the following research questions:

1. What are the relative costs, returns and profitability associated with formal and informal irrigation in urban vegetable production?
2. What is the relative economic efficiency of resource use in vegetable production in formal and informal irrigation systems?
3. What is the contribution of formal and informal irrigation to the income of urban vegetable farmers?
4. What are some characteristic features of the Irrigated Urban Vegetable Farming?

1.2 Objectives of the Study

The general objective of the study is to compare the economics of formal and informal irrigation systems of vegetable production in the Greater Accra region.

The specific objectives are:

1. to estimate and compare the costs, returns and profitability of the two groups of farmers;
2. to determine the relative economic efficiency of resource use (technical and allocative) of vegetable production in formal and informal irrigation systems;
3. to estimate and compare the contribution of formal and informal urban irrigated farming to the household income; and
4. to identify some characteristic features in both formal and informal irrigated urban vegetable producers

1.4 Relevance of the Study

This work is an attempt by the author to give a broader knowledge of urban agriculture to increase the prestige of the practice especially to vegetable farming under formal or informal irrigation. Another significance of this work is to create the awareness of the dynamics of urban agriculture, and the characteristic features of improving the socio-economic status of the people involved in the practice as well as offering a means of overcoming the limitations imposed on agricultural production by unreliable, erratic, and unpredictable rainfall.

In most urban centres in Ghana such as in the Greater Accra Region, the cultivation of vegetables such as tomatoes, garden eggs, lettuce, okra, sweet pepper, cabbage and cucumber is a common practice and is on the increase. In spite of this not much attention has been given to urban vegetable farmers in the Greater Accra region, This study therefore seeks to unearth the economics of irrigation (formal and informal) systems in agricultural production in the urban centres of Accra with the ultimate aim of enhancing a year round agricultural production to supplement rural produce. It is also expected that the findings will help to suggest ways of improving the economic contribution of irrigation (formal and informal) in urban vegetable production to households in the Greater Accra Region.

1.5 Organization of the Study

The study is organized into five chapters. Chapter Two presents a review of existing relevant literature on urban agriculture, food security and nutrition, the role of urban vegetable production, population growths and urbanization, retrospective look at economic efficiency and role of irrigation around Accra

The methodology, which outlines the theoretical framework and relevant model, is the subject of Chapter Three. The results of the study and discussion of results are presented in Chapter Four. Chapter Five provides conclusions and policy recommendations, as well as limitations of the study.

CHAPTER TWO

LITERATURE REVIEW

This chapter looks at relevant scientific literature relating to the current study and how some researchers have applied them in achieving similar academic and industrial goals. It is intended to place the current study in its proper perspective.

2.1 Urban Agriculture

2.1.1 The Role of Urban Agriculture: The Debate

Urban agriculture refers to small areas within cities, such as vacant plots, gardens, verges, balconies and containers, that are used for growing crops and raising small livestock or milk cows for own-consumption or sale in neighbourhood markets. However, peri-urban agriculture refers to farm units close to town that operate intensive semi- or fully commercial farms to grow vegetables and other horticulture, raise livestock, and produce milk and eggs also for own-consumption or sale in neighbourhood markets.

A FAO-COAG (1999) definition of urban agriculture refers to it as an agricultural practice within and around the cities, which compete for resources (land, water, energy and labour) that could also serve other purposes 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 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 (Rabinoritch and Schmetzer, 1997 in Drenchsel 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 respectively (Midmore, 1996).

Urban agriculture is practised by an estimated 800 million people of the world, but until now was most prevalent in Asia (Smith et al 1996). Usually, vegetables and fruits are grown on land unsuited for building purposes and on undeveloped public and private lands (IDRC, 1993). In addition, intensive and livestock production systems for milk, meat and poultry or egg production are operational around and within city limits, with a trend to zero grazing. At DSE/ATSAF workshop in 1994, three major types of urban vegetable production systems were identified and described, all of which play distinctly different roles with regards to urban market or urban subsistence food supply (Gura, 1996). Urban shifting cultivators farm wherever they can find empty spaces and they normally grow vegetables mainly for the informal market in order to meet their basic household needs. However, their rights to use the land are very limited; they do not appear to be the most recent migrants to town, but rather belong to the group, which has been residing there for some time, and who have turned to farming as a source of income. Traditional leafy vegetables, which grow fast and absorb few inputs, are some of their most important products, because they contribute to the inexpensive vegetable supply of the urban lower classes.

Household gardeners reside in towns and farm around their homes or elsewhere in (or nearby) the city. Their land rights are more secure and their investments seem accordingly higher and of a longer-term nature. They raise small livestock and grow trees aiming at both subsistence and market production. Women in particular grow crops to supplement household food supply, while men concentrate on cash-crop production or off-farm activities. Urban market producers are often specialized farmers on usually secure land around cities who tend to produce vegetables of higher values (tomatoes, onions, cabbages, eggplants, and peppers)

Urban agriculture has become a permanent part of the landscape in many cities in Asia, Africa, Latin America and other parts of the world (Bardach, 1982; Nazario, 1984). This is surprising and often embarrassing to many who had envisioned the evolution of modern, industrial cities as symbols of economic development and technological progress in the developing world (Bardach, 1982). Much to the dismay of these proponents of modernization, who range from city officials to international donors, many cities in the developing world currently show growing trends towards squatters' housing, street hawking and informal cultivation, none of which contribute to modernity, well-being or technological progress. Except for some attractive government building, a few office towers and at most one or two shopping centers, cities in the developing world, even the colonial capitals, seem to many to have regressed from earlier beautiful and orderly appearance (Sanyal, 1985).

The authorities in the developing world initially responded to these trends with harsh, authoritarian measures. State repression was unleashed in various forms; squatters' houses were demolished, street vendors were jailed and in the case of urban cultivation, crops were destroyed even at times of food scarcity in the cities (Hake, 1977). The flexibility with which the people responded to the state repression was truly remarkable:

they rebuilt demolished houses within days, reformulated strategies for petty trading and replanted seedlings away from the view of the city officials. Hart (1970), for example, cited the case of squatters in Ghana, whose sheds were pulled more than thirteen times, to be rebuilt on each occasion.

Most authorities assume that urban cultivation is practised by a small section of low income families, predominantly recent migrants from rural areas who have not been assimilated socially, culturally, or economically into the sophisticated social fabric of the monetized urban economy (Sanyal, 1985). Thus, urban cultivation is considered the manifestation of rural habits. Contrary to the official view that rejects urban cultivation as irrational activity by a small group of recent migrants who have yet to be integrated into the urban environment, urban agriculture is an innovative response by a majority of the urban poor, who are fully entrenched in an urban economy that currently lacks the capacity to provide them with sufficient real income. Despite the space limitations, the urban poor still put whatever land they can find to use in limited agriculture, producing a much smaller proportion of food they consume than do rural inhabitants (Yeung, 1987).

Urban agriculture is one of many techniques that can be employed to reduce the vulnerability of waste and other problems facing cities. It includes diverse activities that use nature for the benefit of people, such as sylviarlture (to produce wood for fuel, timber or other uses), gardening, livestock raising, fruit growing and thus urban agriculture and can even improve the supply of drinking water (Deelstra, 1987). Deelstra continued to describe urban agriculture as offering, many advantages to cities from both ecological and technical perspectives, especially if the green spaces that result are an integral part of the urban fabric. Apart from improving the functioning of the city, it has social advantage in that it enables vulnerable groups in the urban community to improve their conditions. A well-developed city whose fertile soils have been conserved is healthier. Green spaces also have a favourable effect on air circulation, temperature and humidity levels in the city. In tropical regions, alternating areas of cultivated land help to refresh the atmosphere. Air quality is also improved by the production of oxygen through photosynthesis. Urban farming has been demonstrated to be significantly associated with improved food security and child nutritional status, particularly among lower–income groups (Maxwell, 1995).

Urban agriculture can reduce the costly and problematic transportation of food from the rural areas because it provides food locally. This means saving on roadways, truck, fuel, trains, boats and warehouse, as well as storage and refrigeration installations. Another positive element is that urban agriculture can optimize human resources and this is not just a question of physical labour. Persons who moved into town from farming often have social knowledge about land use that can be taken advantage of, for the proper management of green spaces in the cities. In addition, rapid urbanization frequently makes it difficult for immigrants to adjust to the life in the large cities. Urban agriculture enables them to use their traditional attachment to the land to help them in the transition. Without resorting to highly artificial and expensive food production systems, the absolute output of urban agriculture is obviously limited. There is a great opportunity, however, to use urban resources to enable some inhabitants to provide themselves with substantial portion of their recommended daily allowance of calories and protein including most of the vitamins and minerals needed to maintain health (Sacha and Silk, 1987).

Finally a major advantage of urban agriculture is its potential to improve the socio-economic situation of the poor. A large number of rural residence in developing countries migrates to cities with the hope of finding a more promising future. Many of them are illiterates and as they can rely only on limited family and others for support, they often wind up in shanty towns or move from place to place. The opportunity to raise some of their own food can be a strong stimulus to improving nutrition (Deelstra, 1987). For these and other reasons, urban agricultural activities are commonly found in many cities throughout the world.

2.1.2 The Scope of Urban Agriculture

In the article, "improving urban agriculture in Africa: A social perspective," Stereiffelern (1987) indicates that urban agriculture plays an important role in any developing country and is of special significance in sub-Saharan Africa. The extent of urban agriculture varies according to time and place. For instance in Libreville in 1957, 80% of all women were reported to be engaged in urban agriculture. In a 1962 survey of Ouagadougou, 36.4% of those questioned called themselves urban cultivators; a similar percentage was found towards the end of the 1970's in Yaoundé. In 1967, a study conducted in Dar es Salaam indicated that, 18.6% of the households were engaged in urban agriculture; during the last years of the Bokassa regime in Bangui, many of the prisoners and residents of Ngaragba survived only because of the gardening efforts of local women. In Zaire and Nigeria, aerial photographs showed that 66.2% of the urban area was cultivated.

The patterns of location may change over time as cultivated land is pushed outside the city by housing demands that out price the gardens as land use alternative. This was the case in both Dakar and Brazzaville. The latter described in 1963 as a garden city, has become a city in which economic factors decide where urban agriculture develops. In the ancient cities of Yoruba in Nigeria, cultural factors have determined that agricultural activities are traditionally located on the periphery. Streiffeler (1987), reports that the development of small scale agriculture on the urban fringes of Lome, Togo, has increased in the 1980s following economic crisis which developed in the second half of the 1970s, and the introduction of government policy promoting green revolution and food self-sufficiency.

Yeung (1987) also writes on examples of urban agriculture in Asia. Urban agriculture has been evolving rapidly in response to changing demand and supplies. Despite the lack of planning and government support in some Asian cities, many have produced food effectively within their spatial confines. Others have enjoyed a great deal of policy guidelines and capital injection to promote food production within the urban areas. Profile of six cities studied by Yeung, highlight different approaches and degrees of success in urban agriculture in Asia. Shanghai in China offer an example of highly articulated rural urban relationship leading to high level of self sufficiency in essential foods. Lae, Papua New Guinea, is noted for a comprehensive citywide food and fuel self-reliance programme. In George Town on the Penang Island, Malaysia, conflicting demands are posed by rightful landowners and entrenched farmers on the land that has been used to grow food. The city-states of Hong Kong and Singapore have vigorously pursued urban food production in an intensive and scientific manner.

Kler (1987) also indicated that the history of small–scale food production in Polish towns and cities is already more than 100 years old. Generally speaking, one may identify two reasons for this phenomenon; it is a relatively cheap source of fruits and vegetables and equally important in providing recreation. Wade (1987), also says food production even in small spaces can be significant. He gives the example of surprisingly high yields obtained in model small-space home gardens developed in places like California (1976), Hawaii (1978) and Taiwan (1982) respectively.

The above examples give an indication and emphasize the fact that urban agriculture is being practiced in most urban areas and cities of the world. As the urban areas become more densely populated, it has become necessary for the vegetable gardeners who have originally supplied a fairly stable market, to increase their output in order to keep pace with the growing demand. Shortage of animal protein often causes serious illness but these may be entirely prevented by judicious mixtures of different vegetable protein equal in quality to animal protein. Also, Tindall (1978) says vegetables are sources of fat as well as protein, carbohydrates, minerals and vitamins.

2.1.3 Characteristics of Urban Agriculture

Although there is a growing amount of literature on this topic, studies of urban farming systems in West Africa are scattered and scanty. A wide spectrum of production system can be found ranging from household subsistence to large-scale commercial farming. In general, there is a tendency towards more intensive production systems in the urban areas that better satisfy the increasing urban demand than in rural areas. Often, larger urban centres have conspicuous inner and outer zones where cultivation of food crops and market gardening are being pursued vigorously (Binns, 1994). In general, this confirms the model described by Von Thunen in 1826. He concluded that farm products would be grown in series of concentric zones outward from a central market city because readily accessible farmland would be in great demand and, therefore, quite expensive. Livestock production, potatoes and cereals would be raised farther away. Since transport cost to the city increases with distance, there comes a point beyond which it is uneconomical to grow food for the urban centres.

2.2 Urban Agriculture, Food Security and Nutrition

The World Bank (1986) asserts that Food Security and Nutrition is classically defined as "secure access at all times to sufficient food for an active healthy life". The emphasis at the household level is usually placed on the aspect of access, which is in turn related to the entitlements of households (Sen, 1981). The most common entitlements to food at the household level include direct production (farming), exchange (usually exchanging labour for cash and cash for food), or transfers.

Nutritional status can mean many things, but in general usage it has come to mean the growth of pre-school children in comparison to a standard growth reference because malnutrition in childhood is not only an important outcome in its own right, but has also been linked with poor cognitive development, health and productivity later in life (UNICEF, 1998). The concern is primary with "protein-energy", under-nutrition in young children (either stunting i.e. low height for age, or wasting i.e. low weight for age). Many other forms of malnutrition exist, and may be the target of urban agriculture programs, micronutrient malnutrition being the most obvious case. Reviewers throughout the 1990s whether basically pro or con, have suggested that the potential of urban agriculture in alleviating urban food insecurity and malnutrition should be further investigated (Von Braun et al, 1993, Atkinson, 1992).

The initial analysis of urban agriculture in sub-Saharan Africa tended to be concerned with aggregate food supply and noted estimates of the over all quality of food produced in cities, as evidence of the contribution of urban agriculture to food security (Sanyal, 1985; Mvena et al, 1991). But more recent work has tended to focus attention on the level of the household of the urban farmer or livestock keeper, particularly in terms of mitigating the food security and nutrition impact of urban poverty. Lee-Smith et al (1987) reported household income from urban agriculture, and took measurements of middle-upper arm circumference as a measure of malnutrition. However, the latter is primarily a good indicator only of severe wasting under famine conditions. Ogden (1993) reported various indicators of pre-schooler nutritional status in her study of urban food security in Kigali, and noted that urban agriculture was positively associated with nutritional status in some income groups and under some conditions of maternal employment, but urban agriculture was not the central concern of the research, so the results that could be abstracted from the report regarding urban agriculture was inconclusive in terms of general trends.

Mwangi (1995) compared farming and non-farming households in low neighbourhoods in Nairobi, and noted that while mean consumption was well below estimated requirements in all cases, farming households are better off in terms of both energy and protein consumption, and that farmers participating in an organized urban agriculture support programme are significantly better off in both categories. The farming households produced between 20% and 25% of their food requirements, and were significantly less dependent on gifts and transfers. There were few differences in mean nutritional status (expressed as a percentage of the expected mean). Children from non-farming households were somewhat more likely to be moderately malnourished, although Mwangi did not report the statistical significance of these differences. Her conclusion was that urban agriculture has a positive impact on household food security and nutritional status; and that direct support for urban agriculture can increase this impact.

Maxwell et al (1998) report the linkages of urban agriculture and malnutrition in Kampala. When controlling for socio-economic status and other individual and household characteristics, urban agriculture is positively and significantly associated with higher nutritional status in children, particularly in terms of height for age, and there is a significantly lower proportion of moderately to severely malnourished children in households where someone (almost always the mother or primary care giver) is farming.

They suggest that the impact on nutritional status is a result of both higher and more stable access to food due to virtually year-round availability of staple food from urban production, and the ability of mothers who farm to provide more direct child care than women engaged in other economic activities.

The small number of empirical studies that have undertaken actual measurement of the impact of urban agriculture on food security and nutritional status generally supports the hypothesis in the literature of a positive relationship between urban agriculture and the food security and nutritional status of members of households in which someone is practising it. However, the number of empirical cases is small.

2.3 Population Growth and Urbanization

The world's population is increasing at about 85 million every year. According to United Nations' projections, the world's population will grow from roughly six billion today to more than nine billion by 2050. In the same period, Africa's population will almost triple, even under a "medium fertility scenario." This rate is much higher than in India, China or the rest of Asia. The projected growth rates are especially high in West African population. Since 1960, the West African population has more than doubled from 85 million to 215 million in 1993 (Mokwunye et al, 1996; The Economist, 1998).

These figures are closely related to the rapid growth of the world's cities. The United Nations expects that between 1995 and 2050 the number of people living in urban areas will nearly double from 2.8 to 5.3 billion, with about 90% of the growth coming from the developing countries and that Africa's 1985 urban population will have doubled by the year 2000. West Africa's urban population growth rate of 6.3% (1960-1990) is more than twice the rate of the total population (Snrech 1994). Although 40 million people lived in West Africa with 4% in cities in 1930, there were about 190 million with 40% in the cities in 1990. Projected figures for 2020 indicate that 63% of the estimated population of 430 million will be found in urban centres. This implies that more people will live in towns and cities than in rural areas. This trend is alarming in a region with limited resources for providing the necessary urban services. Currently, about 55% of the people in West Africa humid forest zone already lives in cities, although this is only 22% in the Sahel zone (Snrech, 1994). This indicates that in the non-coastal countries, the urbanization will develop less rapidly. According to Obosu-Mensah (1999), food scarcity in sub-Saharan Africa is compounded by increased urbanization, which has removed a significant number of people from the traditional agrarian sector, which feeds the population. He further stated that the World Bank, as well as the United Nations (UN), has noticed a high urban population growth in the sub-Saharan Africa. The UN, for example, estimates that between 1995-2000 the annual rate of change of the urban population in Africa will be about 4.72% per year (United Nations, 1995).

In Ghana, the urban growth for 1995-2000 is estimated at 4.62% as compared to 3.0% for the country as a whole (UN, 1995). An increasing number of sub-Saharan Africans are moving into urban areas, thus making it more necessary for programmes that increase food production. This is presented in Table1.1

Table 1.1 Projected Urban Populations in Some Selected African Countries

Country	Percentage Urban (Year)							
	1950	1980	1990	1995	2000	2005	2010	2015
Angola	7.6	21.0	28.3	32.2	36.2	40.2	44.2	48.1
Botswana	0.3	15.1	27.5	35.0	42.21	48.5	53.5	57.1
Gabon	11.4	35.8	45.7	50.0	53.8	57.3	60.7	63.9
Ghana	14.5	30.7	33.0	35.1	37.9	41.3	45.3	49.2
Kenya	5.6	16.1	23.6	27.7	31.8	35.7	39.7	43. 7
Nigeria	10.1	27.1	35.2	39.3	43.3	47.2	51.1	54.8
Senegal	30.5	43.9	38.4	41.1	44.5	48.4	52.2	55.9
Zambia	8.9	39.7	49.9	54.5	58.7	62.4	65.4	68.3

Source: U.N's World Economic and Social survey 1995

2.4 The Role of Urban Vegetable Production

Urban vegetable production systems need development support because projections are that in less than thirty years, half of the world's population will live in urban areas. Efforts to increase or boost vegetable production play a double role in achieving development policy goals; they reduce malnutrition, and increase income and employment opportunities (De Haas and Gura 1996). Urban as well as peri-urban agriculture offers potential solutions to several problems created by rapid growth in the developing world.

Increased production through the application of efficient technologies to urban and peri-urban agriculture decreases food process and increases consumption, if vegetable production systems are prominent among peri-urban and urban agricultural enterprises, people's consumption of vegetable and, therefore, of vitamins and minerals, will increase, for the poorest of the poor.

Even vegetables grown in the house-garden possess a double advantage: they bring self-reliance in high quality foodstuffs and high income as a result of selling surplus produce on the high market. Vegetable growing requires low investment of capital and is becoming a priority income-generating activity, both in savings and small-scale loan projects and in projects which promote women in development; In fact women are the traditional vegetable growers and they significantly benefit from urban agriculture promotion programme.

In addition, urban farming is a competitive economic activity providing new jobs to many in the city, especially for people with limited mobility, and little capital, including women and children. In Yaoundé for instance, every fifth or sixth household is engaged in urban agriculture (Fodoulop, 1997). In other cities up to two-thirds of all families can be managed in urban agriculture, a lot of them with no other source of income. The world's poorest urban households spend between 50% to 90% of their income on food; for them, urban agriculture offers an opportunity for better diet and a chance to shift household spending towards other needs, such as health care and housing (Rabinovitch and Schmetzer 1997). A simple calculation illustrates the magnitude of the increasing urban employment problem. For a city of 2.5 million inhabitants, assuming a net urban workforce, growth rate of 4%, an average of 100,000 new jobs must be created annually. However, job creation has not kept pace with the work-force growth, resulting in a large number of families who can find jobs in peri-urban agricultural production and distribution (Songsore and McGranahan, 1993).

2.5 The Role of Irrigation in Urban Vegetable Farming in the Greater Accra Region

Most vegetable farmers in the urban areas of Accra consider irrigated horticulture to provide their primary source of revenue. They move from one site to another as dictated by water availability. Some 700 farmers are thus irrigating about 300 hectares at 17 sites around and within Accra. Currently, urban irrigation provides vegetables year-round and contributes to the improvement of the nutritional status of city inhabitants (Sonou, 2000). He also noted that, the proximity to the markets allows for a large array of fresh products of good quality. However, water is a constraint because the cost of pipe-borne water makes it unaffordable to farmers. The use of untreated waste water for irrigation has, therefore, become a widespread practice, with its attendant health hazards. Urban agriculture is a significant part of the informal sector of the economy of most sub-Saharan countries. To define the concept of informal sector, it is almost contrasted with the formal sector. The concept attracts different conceptualizations because of the lack of a clear basis for the concept as well as a wide mirage of economic activities that it covers (Singh, 1994). In this paper, the use the concept of informal sector is in reference to the economic activities with the following characteristics: casualness, easy entry, outside the scope of existing company law or regulations, small scale operation, reliance on household labour and labour intensive. This means the informal sector excludes public sector establishments, as well as large-size and commercial establishments in the private sector. According to Obosu-Mensah (1999), the informal sector is a super structure for the survival of the formal sector of developing economies. Vegetable farming in the urban area of Greater Accra region is carried out in the open spaces along big drains (gutters) streams and dams where the water bodies are used to irrigate the vegetables. Some farmers, however, have access to tap (pipe borne) water. He, therefore, concluded that the land tenure arrangement prevailing in any farming area is very important as it influences farmer's decision to invest in the land.

2.6 A Retrospective Look at Economic Efficiency

According to Gittinger (1982) economic efficiency is one of the three basic objectives involved in cost recovery among income distribution and public saving. Economic efficiency, therefore, seeks to minimize waste and to allocate resources optimally to maximize the net benefit in production.

The intuitive notion of efficiency refers to the achievement of maximum output from a given set of resources: the greater the output, the higher the level of efficiency

(Yotopoulus and Nugent, 1976). Economic growth, particularly, in the agricultural sector depends ultimately on the impact on productive resources and the efficiency with which they are used (Norton and Alwang, 1993). Improved production efficiency can also bring about economic growth. In simple terms, improved efficiency means getting more output for the same input used by allocating them in a better way.

Efficiency may be classified into different types. These include market, technical and allocative (price) efficiencies. Market efficiency shows the degree to which the market is competitive. In other words, it describes the type of economic system and the degree of monopolistic power within it. Technical efficiency describes the degree to which the firms are producing on the production function. The allocative efficiency relates to the degree to which the firms, operating on their production functions, employ the correct amount of inputs to equate marginal revenue to marginal cost of obtaining the last unit of output (Norton and Alwang, 1993). In collective terms, technical and allocative efficiencies give an indication of producers' ability to efficiently use resources available to them, given a particular technology and price regime.

In analyzing "securities in an Arrow-Debreu economy", Rubinstein (1975) considered both production and exchange efficiencies. The study defines production efficiency as a situation where value-maximizing firms make Pareto optimal production decision. In a situation of exchange efficiency, however, participants are not motivated to create exchange arrangement not already provided by the market.

In the study "efficiency and optimal utilization of capital services", Calvo (1975) examines the desirability of different rates of capacity utilization. The study argues that efficient utilization of capital, at any point in time, calls for equating the marginal productivity to the marginal cost of capital services. It concludes that, efficient utilization ratio decreases as ratio of the available capital to labour services increases.

Stevenson (1980) measures technological bias and categorizes technological change in privately owned electric utility generating industry. The study examines the production process in terms of cost and output. On one hand, it asserts that the mark of technological advantage always makes it possible to produce the same level of output with, at least an input set in which the quantity of input is less than what would have been previously required. On the basis of cost, on the other hand, given factor prices and the state of nature constraint, technological change (advantage) permits the firm to produce the same level of output at a lower level of expenditure. The study concludes that a firm with such economic features would have attained a state of internal equilibrium.

In another related study involving scale factor-bias technological change, Galbraith (1956) focused on whether large–scale firms innovate faster than the small scale ones. The study argues that, scale–bias firms that have considerable size of resources associated with the innovation can only adopt technology. It continues that large-scale firms operating with large research budget are able to reduce cost at a faster rate than small-scale firms. On the issue of factor bias, the technologically advantageous firm follows, at least, a cost minimization procedure as the factor-input prices change over time.

In agricultural production, Phiri (1991) compares the actual performance of farmers on the Chinguluwe settlement scheme to the performance targets set by the agricultural development division in Salina in Malawi. The study examines the resource use efficiency of the maize, cotton and groundnut farmers using the gross margin analysis. Assuming that efficiency is a relative measurement rather than the neoclassical economics definition where marginal factor costs are equated to marginal revenue products, the study uses estimates of output (values) as opposed to the mere total volumes produced.

In another related study in Nigeria, Olagoke (1991) compares production costs and returns per hectare in rice production. The study derives a production function using the Ordinary Least Squares (OLS) procedure and obtained the marginal products of rice production inputs. In the analysis, total labour input, total seed input and operating expenses of other capital inputs were regressed on the total yield of paddy rice for the study period. Using the marginal physical product and marginal value product estimates, the regression coefficients of the various variable inputs were estimated to judge the resources that were being used efficiently. While Olagoke (1991) includes family labour in his labour estimates, Phiri (1991) excludes it. Phiri (1991) argues his assumption on the basis that, family labour, in his study was similar across all the respondents and that it is sometimes very difficult to estimate it accurately.

In a study carried out in Nigeria, Olagoke's (1991) findings shows no statistical difference between the net returns from irrigated rice fields and either swamp rice field or upland rice fields. Allocative efficiency tests showed that all resources were underutilized on the sampled fields during the study period. The under-utilization of input resources resulted partly from lack of funds for the employment of adequate levels of input resources. In a similar study, Onyenwaku (1994) estimates the profitability and economic efficiency of pump irrigated crop farms and non-irrigated farms. His study was motivated by the failure of large-scale irrigation farms to attain self-sufficiency in food production in Ghana. Using the technical and allocative economic efficiency parameters, the study sampled a significant number of irrigators and non-irrigators and recorded their resources budgetary allocations, including farm management cost and estimates of gross revenue for the 1991 production year. A comparative analysis of the efficiency for the two farm-types was subsequently carried out. In an estimated production function, Onyenwaku (1994) regresses land, labour, fertilizer, irrigation, capital, miscellaneous inputs and the slope dummies of all the above listed inputs on the monetary value of crops and crop by-products produced during the study period using the OLS. Onyenwaku (1994) found out that, technical efficiency was higher on irrigated farms than on non-irrigated farms. Both farm types were found to be allocatively inefficient in the use of all the resources considered under the study. Relatively, however, land was allocatively used more efficiently in the irrigated Farms. Also, both farm types underutilized land, capital and other farm inputs but irrigating farms overused labour and irrigation services

In all, irrigated farms recorded higher levels of technical efficiency and profit margins. It was, therefore, recommended that a complete package of production inputs be made available for irrigated farms whilst the employment of labour and irrigation services be reduced. But the use of land, labour and other farm inputs could be increased in both farm types, since they were underutilized.

2.7 Conclusion

The contribution of urban agriculture to food security appears to be substantial. It provides substance to many city dwellers and brings the products close to the market as well as some form of direct access to food without having to purchase it on the market, and cash income from sale of agricultural produce. Population growth has turned urban zones into large markets capable of absorbing the local production of urban agriculture.

According to a study conducted by Bagi (1981), it was asserted that irrigation agriculture development has a priority in the present world where production of foodstuffs must keep pace with a rapidly increasing population. A well-planned and efficient irrigation system must at the same time significantly contribute to raising the farmers' standard of living.

This implies not only to the farmers of developed countries but to those in the newly emerging nations such as Ghana, where the need for irrigation is most acute. Difficulties experienced in many countries with agricultural development have led to the current belief that agriculture alone will not be able to solve the food problem the world is faced with. With the extensive research being carried out in an attempt to produce food synthetically, it is however, doubtful despite immense scientific and technological progress in all other fields, that anything will diminish the importance of irrigated agriculture.

The incorporation of some kind of irrigation system into urban agriculture is made necessary at a time when urban population demand for food is more than the supplementation from rural production to addressing the food security situation in the urban centres. The review of literature shows that irrigation can be used to improve on agricultural production in general and urban vegetable production in particular. In view of these an efficiency measure of resource use can also be adopted to estimate the economics of either formal or informal urban vegetable production.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the study's methodology, which includes the description of the theoretical framework and methods of analysis that was adopted to address the study objectives. This study follows closely the methodology adopted by Onyenwaku's (1994), where he estimated the profitability and economic efficiency of pump irrigated crop farms and non-irrigated farms in Nigeria. Some theoretical issues as well as the description of the data requirements, data collection and data sources, sampling techniques and estimation procedures for the parameters employed in this current study have been outlined.

3.2 Methods of Analysis

The study treats objective one (comparing the estimates of the costs, returns and profitability of formal and informal irrigated urban vegetable production), by estimating the cost and returns associated to both systems of vegetable irrigation. The cost of production normally has two components, fixed and variable costs. The former are costs that do not change relative to the level of production in the short-run while the variable costs are production costs that change with the level of production. To estimate each type of costs, both the physical inputs and price of the inputs were determined.

The variable costs cover cost of labour used in the various fields of operation including, land preparation, broadcasting, handpicking of weeds, fertilizer and herbicide application and bird scaring. Other variable costs included were the cost of fertilizer, cost of agrochemicals and other minor (miscellaneous) costs associated with cost of production.

The fixed costs include the costs of irrigation water and land as well as all farm machinery and farm implements. For convenience, the straight-line method of depreciation was used to calculate the depreciated values of farm implements. The straight-line method assumes that all the inputs depreciate evenly over the specified period of its use.

$$D_P = \frac{Co - Sv}{N}$$

Where: D_P = depreciation

C_O = original value

S_V = salvage value

N = expected useful life

3.2.1 Estimation of Total Fixed Cost (FC)

Fixed cost is associated with fixed inputs used in production and it includes cost of land, and the cost of irrigation water. To obtain the total fixed cost over the production period for each farmer, costs of all fixed input components used were summed up. The unit factor price was multiplied by the quantity used, that is:

$$FC_i = \sum_{j=1}^{m} FC_{ij} = \sum_{j=1}^{m} \left(X_{ij} \times C_{ij} \right)$$

Fixed cost of "ith" farmer equals sum of cost of "m" fixed inputs used by "ith" farmer.

$$TFC = \sum_{i=1}^{n} FC_i = \sum_{i=1}^{n} \sum_{j-i}^{m} FC_{ij}$$

Total fixed cost equals sum of fixed cost for 'n' farmers.

Where TFC = total fixed cost for 'n' farmers and 'm' inputs

FC_{ij} = the cost of the 'jth' fixed input component of the ith farmer

$X_{ij} \times C_{ij}$ = the quantity and unit cost of the 'jth' fixed input of the 'ith' farmer

The mean total fixed cost for 60 farmers is given by the summation of the total fixed cost of all the respondents and dividing by the sample size of the farmer

$$MeanTFC = \sum_{i=1}^{n=60} FC_i / 60$$

The computation is repeated for the sub-samples of formal and informal irrigations.

3.2.2 Estimation of Total Variable Cost (VC)

Variable cost arises from employing inputs, which in this case includes the cost of fertilizer, agrochemicals, labour associated with the production and miscellaneous costs. The summation of the cost of all the individual variable input components gives the total variable cost (TVC)

$$VC_i = \sum_{j=1}^{m} VC_{ij} = \sum_{j=1}^{m} \left(X_{ij} \times C_{ij} \right)$$

$$TVC = \sum_{i=1}^{n} VC_i = \sum_{i=1}^{n} \sum_{j-i}^{m} VC_{ij}$$

Where TVC = total variable cost for 'n' farmers and 'm' inputs

VC_{ij} = the cost of the 'jth' variable input component of the ith farmer

$X_{ij} \times C_{ij}$ = the quantity and unit cost of the 'jth' variable input of the 'ith' farmer

The mean total variable cost of the respondent farmer is the sum of all the TVCi divided by the sample size of farmers.

$$MeanTVC = \sum_{i=1}^{n=60} VC_i / 60$$

$$i = 1,2,3 \ldots\ldots 60$$

3.2.3 Estimation of Total Cost (TC)

The total cost incurred in the irrigated vegetable production process is the summation of the total fixed cost and the total variable cost

$$TC_i = TFC_i + TVC_i$$

TC_{ij} = Total cost of the ith farmer

The mean total cost for the respondent farmers is given by:

$$MeanTC = \sum_{i=1}^{i=60} TC_i \Big/ 60$$

3.2.4 Estimation of Total Revenue (TR)

Revenue from each enterprise is obtained by multiplying the prevailing 2001 average market prices by the aggregated harvested output of the vegetables per acre over the growing period considered in this study.

$$TR_i = P \times Q_I$$

TR_i = total revenue of the ith farmer

P = prevailing aggregated average market prices of the year 2001 in cedis

Q_i = aggregated output of vegetable harvested by the ith farmer over the growing period per acre in kg

3.2.5 Estimation of Net Revenue (NR)

The difference between the cost of production and revenue of irrigated vegetable production over the growing period of 2001 results in the net revenue, which is expressed as:

$$NR_i = TR_i - TC_i \qquad i = 1,2,3 \ldots\ldots 60$$

NR_i = net revenue for the ith farmer

TR_i = total revenue for the ith farmer

TC_i = total cost of the ith farmer

3.2.6 Profitability

Four main discounted measures are often applied to agricultural projects to assess profitability: These are the: net present worth, internal rate of return, benefit-cost ratio, and net benefit investment ratio. The mathematics of these discounted measures, and the way we interpret the measures and their limitations is exactly the same whether we are using them for financial analysis or for economic analysis. The difference is only whether we apply the techniques to financial prices or to economic values. Other non-economic criteria for making project decisions exist such as the pay back, peak profit and average profit but they are flawed because they do not consider the time value of money. In this paper the benefit-cost ratio method is employed in the determination or assessment of profitability. This was in an attempt to provide a set of rules to determine whether any element of expenditure should or should not be undertaken. If the benefit-cost ratio is greater than one the venture could be considered profitable. If less than one the venture is considered as non-profitable. If equal to one the farmer is said to break-even.

Where

t = time period

Mathematically, the B-C Ratio is expressed as:

$$B - C\_Ratio = \frac{\sum_{t=0}^{t} TR \Big/ (1+R)^t}{\sum_{t=0}^{t} TC \Big/ (1+R)^t}$$

TR = total revenue

TC = total cost

R = discount rate

This formula is usually suitable when considering a project over a period of time "t", but in this study the benefits and costs were limited to the 2001 study period operations, thus the formula becomes a simple ratio of the benefit to cost:

$$\Pr ofitability = {}^{TR}\!/_{TC}$$

3.2.7 Estimation of Economic Efficiency

Most debate regarding the best method that examines the efficiency in a developing country's agriculture have focused on technical efficiency (Bravo-Ureta and Pinheiro, 1993). This is, however, not a strange observable fact since the term "economics" is so broad that one specific objective will not suffice to explain what it entails fully. Therefore, depending on what one is looking at in a particular situation will influence his choice of method(s). While the physical productivity considerations are important, improvements in economic efficiency will lead to greater benefits to agricultural producers in these countries. In a study conducted by Onyenwaku (1994), about the "Economics of irrigation in crop production in Nigeria" he covered a number of objectives including; efficiency of resource use, tests for constant returns to scale and production costs and returns. Furthermore, in estimating resource use efficiency, the work by Ogunfowora et al (1974) is looked at. They did raise various flaws about the use of some methodologies used to address the resource use efficiency and settled for the best,: - the Cobb-Douglas production function. This and other methodologies outlined by Onyawaku are adopted for this research.

The paradigm regarding the best method to measure farm performance and resource use efficiency is central in a farm management and agricultural economics. Following the principle of production economics exemplified in the theory of the firm, profit maximization has been accorded the primary objective of the farm business although many economists argue that the assumption of perfect competition is a disillusion (Phiri, 1991). Dillon (1999) supports the view that knowledge about the future is imperfect and therefore decision-making in agricultural production takes place in an environment of uncertainty, more especially in the undeveloped agricultural systems regardless of the status of the decision maker.

In analyzing the third objective both technical and allocative efficiency parameters were employed to determine the level of resource use efficiency. By definition, technical efficiency refers to the ability of the firm to obtain highest level of output with given amounts of inputs (Yotopoulos and Nugent, 1976). It is sensitive to the specification of the production function. Technical efficiency has to do with the fixed resources of the firm. Economists consider technical efficiency as an engineering datum and at least in the short-run, it is exogenous and/or a given part of the environment. Allocative (Price) efficiency, on the other hand, is the concept of efficiency in which resources are allocated in the profit maximizing sense so that the marginal value products (MPV) of resources are equal to their unit prices. Specifically, allocative efficiency has to do with managerial decision making about the variable factors of production. As much as the last unit of a resource, that the firm employs, yields as much as it would have yielded in alternative employment, the firm is considered price efficient. Both the absolute and relative allocative efficiencies can be analyzed in the production function framework.

The two components (technical and allocative efficiencies) are quite independent of each other. However, they tend to be interdependent most of the time. Therefore knowledge about both components, especially in this study involving resource use efficiency and productivity levels, would offer a wide scope of understanding and subsequently improve on the performance of the urban vegetable production.

3.2.7.1 Model Specification

The methodology underlying the estimation of technical and allocative efficiencies for this study follows from that of Onyenwaku (1994). The following adjustments are made to achieve the third specific objective.

Technical Efficiency

The study runs two separate regression models: one for informal-irrigated vegetable and a second for formal-irrigated vegetable production in the Greater Accra Region. An analysis of the relative technical efficiencies of vegetable production under the formal and informal irrigation in urban areas was conducted to find out whether the two groups are represented by (a) neutral production function or (b) factor- biased production function.

Neutral production functions imply that the two function differ significantly in one or more of the slope coefficients, whether the intercept terms are the same or not. To test these differences in technologies, the following production function is fitted to the collected data estimated (estimated at 2001 market prices):

CVOutput = f (CVLand, CVLabour, CVFert, CVIrrigat, CVAgrchem, CVMisc)

Where

CVOutput is the aggregated value of vegetable output (in cedis) harvested from individual farms. The output from vegetables (whether in sole stand or in crop mixture) in the farmer's entire field was first obtained in physical terms. The physical units were weighted by the average prices paid for the individual products and then aggregated to obtain the total cedi value of the vegetable produced. The study assumed homogeneity of the vegetable products.

CVLand is the value of land (in cedis). This was estimated as the product of the average seasonal rent on land (in cedis) and individual farm sizes in (acres) cultivated to vegetables. The farm size for any farmer is the total acreage of field cultivated. It was difficult to determine land quality variability within the study areas. Thus, land quality was assumed to be uniform for the entire sample under both formal and informal systems.

CVLabour is the value of man-hours of family and hired labour used on individual farms (in Cedis). The hours worked by both family and hired labour were converted into value terms by applying the minimum average wage at the farm level.

CVFert is the value of fertilizer used on individual farms in cedis.

CVIrrigat is the value of irrigation water used on individual farms (in cedis).

CVAgrchem is the value of agrochemicals used on individual farms (in cedis).

CVMisc is the value of other production expenses (including planting materials and other expenses associated with vegetable production).

The resource efficiency of the two farm types is subsequently determined following Yotopoulos and Nugent's (1976) definition of technical and allocative resource use efficiencies. In this sense the Marginal Value Product (MVPs) of the inputs of the two farms are used as the basis for comparing the input use efficiencies for the two types of farm sizes.

Three functional forms (linear, semi-logarithm and double logarithm) were estimated by ordinary least square (OLS) and the best equation (linear functional form) was selected on the basis of the value of the coefficient of the multiple determinations, R^2, and the signs and statistical significance of the estimated regression coefficients (See Appendix V). The two models for the respective farm types with respect to the three functional forms are specified as follows:

(a) Linear form:

$$CVOutput_f = \alpha_O + \alpha_1 CVLand + \alpha_2 CVLabour + \alpha_3 CVFert + \alpha_4 CVIrrigat + \alpha_5 CVAgrchem + \alpha_6 CVMisc + U_f \quad \text{..................(1)}$$

$$CVOutput_i = \beta_0 + \beta_1 CVLand + \beta_2 CVLabour + \beta_3 CVFert + \beta_4 CVIrrigat + \beta_5 CVAgrchem + \beta_6 CVMisc + U_i \quad \text{..................(2)}$$

(b) Semi-log form:

$$LogCVOutput_f = \alpha_O + \alpha_1 CVLand + \alpha_2 CVLabour + \alpha_3 CVFert + \alpha_4 CVIrrigat + \alpha_5 CVAgrchem + \alpha_6 CVMisc + U_f \quad \text{..................(3)}$$

$$LogCVOutput_i = \beta_0 + \beta_1 CVLand + \beta_2 CVLabour + \beta_3 CVFert + \beta_4 CVIrrigat + \beta_5 CVAgrchem + \beta_6 CVMisc + U_i \quad \text{..................(4)}$$

(c) Double log form:

$$Log\ CVOutput_f = \alpha_O + \alpha_1 LogCVLand + \alpha_2 LogCVLabour + \alpha_3 LogCVFert + \alpha_4 LogCVIrrigat$$

$$+ \alpha_5 LogCVAgrchem + \alpha_6 LogCVMisc + U_f \text{ ....(5)}$$

$$LogCVOutput_i = \beta_0 + \beta_1 LogCVLand + \beta_2 LogCVLabour + \beta_3 LogCVFert + \beta_4 LogCVIrrigat$$

$$+ \beta_5 LogCVAgrchem + \beta_6 LogCVMisc + U_i \text{ ....(6)}$$

U is the error term under either formal and informal irrigated vegetable farm types.

The coefficient of the intercept dummy denotes the level of technical efficiency. The more positive and significant the coefficient, the higher the level of technical efficiency, and vice versa. If the coefficient of the dummy is zero, then the two groups of farms are said to face neutral production function. If at least one of the slope dummies is not equal to zero, then the two groups of farms are said to face factor-biased (non-neutral) production function (Bagi, 1981). In conclusion the decision criteria employed to differentiate between the two farm types are as follows:

1. For a Neutral Production Function:

(i) the constant term $\neq 0 \Rightarrow \alpha_o, \beta_0 = 0$

(ii) the coefficient of the explanatory variables $= 0 \Rightarrow \alpha_i, \beta_i = 0$

$i=1,2,3.................6$

Technical efficiency: constant term is positive and significant $\Rightarrow \alpha_o, \beta_0 > 0$

Technical inefficiency: a constant term is negative and significant $\Rightarrow \alpha_o, \beta_0 < 0$

2. For a Non-Neutral Production Function

(i) the constant $\neq 0 \Rightarrow \alpha_o, \beta_0 \neq 0$

(ii) the coefficient of at least one of the explanatory variables $\neq 0 \Rightarrow \alpha_i, \beta_i \neq 0$

3. For same Production Function;

(i) constant term $= 0 \Rightarrow \alpha_o, \beta_0 = 0$

(ii) coefficient of the explanatory variable $= 0 \Rightarrow \alpha_i, \beta_i = 0$

From the Yotopoulos and Nugent's (1976) technical efficiency criterion, the estimated $\alpha_i's$ are compared to their corresponding $\beta_i's$. If the $\alpha_i's$ are greater than their corresponding $\beta_i's$, then $(\alpha_i > \beta_i)$. Thus formal-irrigated vegetable production obtains higher levels of output than informal-irrigated vegetable production given the same level of input and vice versa.

A-priori Expectation: The a-priori expectations for all the explanatory variables are positive with the magnitude of $\alpha > \beta$.

Allocative Efficiency

A rigorous comparison of the allocative efficiencies of any two groups of farm types requires that they:

- are characterized by constant returns to scale ;
- represent by the same or neutral production function ; and
- face the same configuration of inputs and output prices.

To estimate the allocative efficiencies of the two groups of irrigated farm type, an index known as the allocative efficiency (k_{ij}) is derived using the same Technical Efficiency production function.

A farm is said to be price efficient or allocative efficient if it maximizes profit by equating the value of the marginal product of each variable input to its price. Thus, the allocative efficiency index for each type was calculated as follows:

$$MVP_{ij} = P_j \; MPP_{ij} = r_{ij} \; k_{ij} \text{............}(7)$$

Where MVP_{ij} is the marginal value product of the i^{th} input for the j^{th} irrigated vegetable farm type, MPP_{ij} is the marginal physical product of the i^{th} input for the j^{th} irrigated vegetable farm type, r_{ij} is the ith input price for the j^{th} farm type and k_{ij} is the allocative-efficiency parameter of the i^{th} input of the j^{th} irrigated vegetable farm type.

In this study, the dependent variable, CVOutput, is the aggregated value of vegetables produced (measured in cedis). Thus marginal value products (partial derivatives of output with respect to inputs) and marginal revenue products (partial derivatives of revenue terms of the inputs) will be equal in this analysis. Thus P_j, the price of output, is no longer relevant and the allocative efficiency index may be calculated as

$$k_{ij} = MVP_{ij} \,/\, r_{ij}$$

k_{ij} = the allocative efficiency index in the resource use in jth irrigated vegetable farm type. It gives an indication of how a given input used pays for itself. For the linear models specified in equation 1 and 2 since the output and input variables are in values terms the estimated parameters are the respective Marginal Value Products (MVPs). For instance,

$MVP_{i\,(CVLand)} = \partial\, CVOutput_i \,/\, \partial_H\, (CVLand_i) = \alpha_I$

.: $k_{ij\,(CVLand)} = \alpha_I \,/\, r_{ij}$

where,

$CVOutput_i$ is as earlier defined

$CVLand_i$ is the cedi value of land obtained as the product of the average seasonal rent on land and individual farm sizes cultivated to informal irrigated vegetables (at 2001 market prices) and

$k_{ij\ (CVLand)}$ is allocative efficiency index for land (informal irrigated urban vegetable production).

Decision Rule

The decision criterion is as follows:

- $k_{ij} < 1$, implies that resource is over-utilized,
- $k_{ij} > 1$, implies resource is under-utilized; and
- $k_{ij} = 1$, implies absolute use of resource

If $K_{if} = K_{ii}$ for every point, it implies both groups of irrigated vegetable farm types have equal allocative efficiency. The null (H_0) and alternative hypotheses (H_1) of allocative efficiency are represented as follows:

$H_{0:}\ K_f = K_i$

$H_{1:}\ K_f > K_i$

The general hypothesis of the study is that, technical efficiency in formal-irrigated vegetable production is greater than that in informal irrigated-vegetable production, ($\alpha_I > \beta_I$). In addition, the study hypothesizes that, urban vegetable farmers will allocate resources efficiently in formal irrigated than in the informal irrigated farm type, ($K_f > K_i$).

3.2.8 Contribution of Income from Vegetable to Household Income

Yawson, (1996) defined household as a person or a group of persons who normally live together, pool their financial resources and have common arrangements for feeding, budgeting and other essentials of living. On the basis of this definition, household income is made up of the income of all members of the household. It is the total annual receipts of the persons in the household. In general, there is no single explicitly correct definition of measures of household income. Elusiveness will arise both at the conceptual level and much more significantly, in determining which respondents to question. Nevertheless suggested definitional and methodological framework for the calculation of household income is set below:

A. Income from employment:

Main occupation

- Payment in cash
- Value of bonuses received in additional to cash payment
- Value of payment in the form of food, crops and animals
- Value of payment in the form of subsidized housing
- Value of payment in the form of subsidized transportation
- Value of payment in other forms
- Estimated taxes and social security contribution paid (if wage quoted post tax)

Sub-Total

Add income from secondary and lower levels of occupations (if they exist).

Total Income from employment (I_E)

B. Household agricultural income

- Sales revenue through main outlet
- Sales revenue through other sources
- Value of crops given to landlords
- Value of produce consumed
- Value of vegetables kept for seeds
- Value of vegetables paid to labour

Total agricultural income

Less

- Expenditure on vegetables (crops) inputs
- Expenditure on land
- Depreciation of agricultural capital assets

Net agricultural income = (I_{AG})

C. Remittances received

- Current remittances received in cash aggregated over all donors
- Current remittances received as food aggregated over all donors
- Other current remittances over all donors

Total Remittances received = (I_{R})

D. Non-farm self-employed income

- Revenue from enterprises being operated by household

Total non-farm self-employed income = (I_{N})

E. Other incomes

Other income from government sources

- Value of educational scholarship aggregated over all individuals
- Income from social security/employment benefit
- Income from state pension

Other income from private sources

- Other income from government sources
- Income from private pension/insurance
- Income from dowry/inheritance
- Others

$$\text{Total} = I_O$$

. : Total household income (I_{HH}) is theoretically calculated as follows:

$$I_{HH} = I_E + I_{AG} + I_R + I_N + I_O$$

To achieve specific objective three (i.e. estimating the contribution of income from formal and informal irrigated urban vegetable farming to household income) farm management data was collected on each farmer followed by personal interviews. The information required in the calculation on the seasonal income was rather difficult to get from farmers because:

(a) Most of them did not keep records;

(b) Others were not willing to disclose information

(c) Others too just do not bother to account for their productive activities. They only know it is profitable

To calculate the income from both formal and informal irrigated urban vegetable farming, the following information was collected.

(i) The regular vegetables grown by the farmer;

(ii) Average number of stands of each vegetable on an acre;

(iii) Average number of acres allocated to each vegetable grown;

(iv) Estimated total number of stands of vegetables grown;

(v) Average prices for each vegetable grown (this was based on 2001 prices);

(vi) The income from each vegetable after harvest; and

(vii) Number of harvests per vegetable in a year.

The estimated average seasonal income was calculated as:

$$\frac{\text{Estimated income}}{\text{Total household income}} \times 1000$$

3.2.9. Some Characteristic Features of the Irrigated Urban Vegetable Farming

In achieving the fourth objective (i.e. characteristic features of the irrigated urban vegetable farming) the use of questionnaire and personal interviews were adopted due to their qualitative nature. The questionnaire, addresses the characteristic features such as the sex, age, educational level, major occupation, marital status and household size. Also included were religious status, source of labour, years into irrigated vegetable farming, source of finance, nature of cropping system practised, reasons for coming to Accra, and finally why and when farmers engaged in urban vegetable production. In achieving the specific objective the questionnaire also addressed issues relating to:

1. Lack of resources
2. Pilfering
3. Stray animals and pests
4. Untreated gutter water

5. Methods of land acquisition
6. Eviction from land
7. Source of irrigation water
8. Sources of funding
9. Problems associated with marketing

Other general concerns included:

(i) Improvement in farm income and (ii) Knowledge about, and membership of vegetable grower.

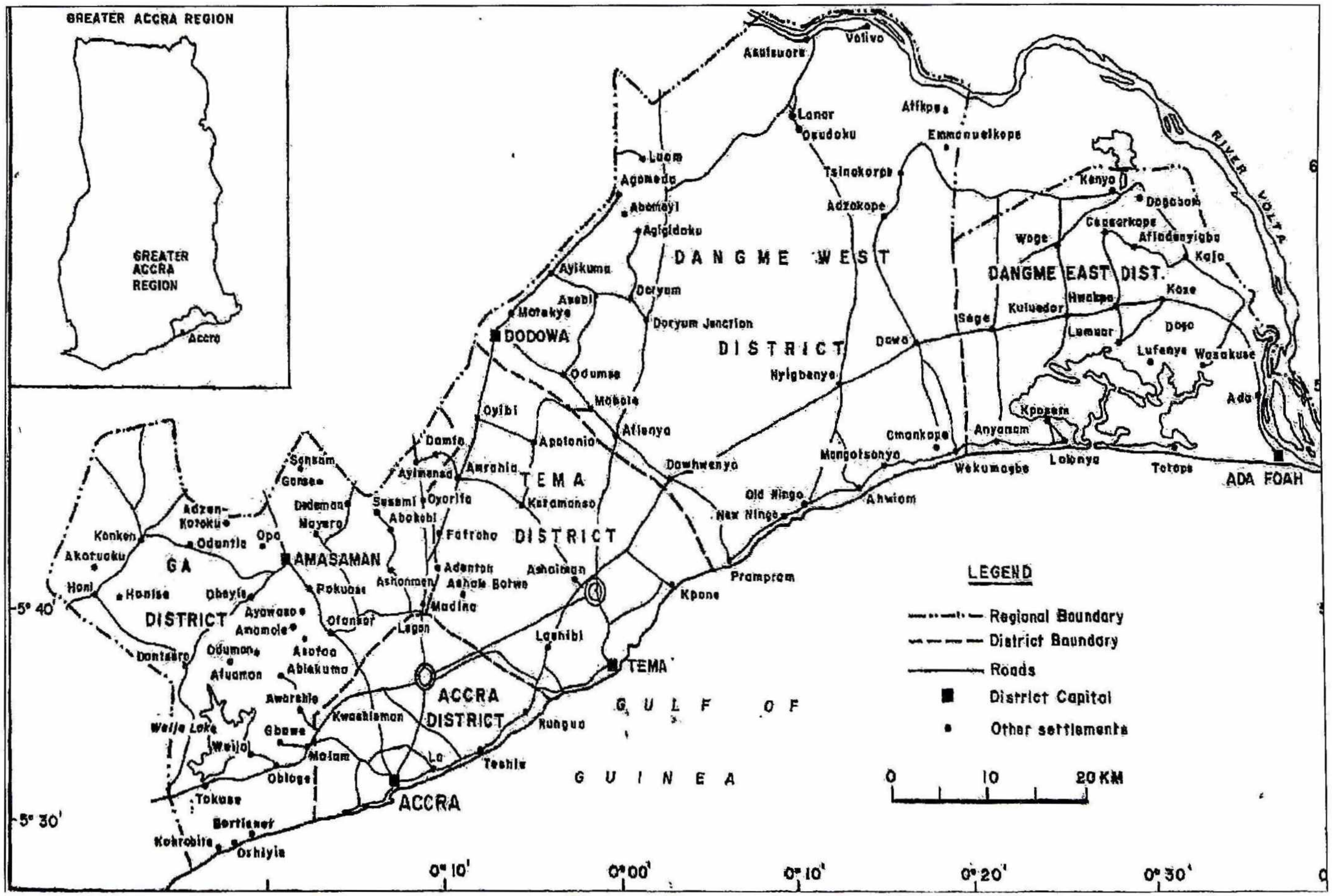
Questionnaire is presented in Appendix I.

3.2.10 Study Area

The study was carried out in the urban areas of the Greater Accra region, the smallest of the ten regions and a major industrial centre in Ghana containing about 10 % of the country's population according to Benneh et al (1993). As shown in Figure 3.1 the region is made up of five districts, namely: Accra (Accra Metropolitan Area), Ga, Tema, Dangbe West and Dangbe East districts. Selected urban centres under each district mentioned, where either formal or informal irrigated vegetable production takes place were covered. The areas are as follows: Plant pool, Odawna, Abossey Okai, Airport area, Kaokudi, Roman Ridge, Avenor, Dzorwolu, Abelemkpe, Teshie, Marine drive, Trade fair area (La), Burma Camp 2, Osu, Labone, Dansoman, Nungua barrier, Atomic Energy commission area, East Legon area and Sakaman all in the Accra district, The Ga district includes Weija and its surrounding environs and lastly the Tema district captures Ashaiman and the Tema motorway areas and Kpong.

These farming areas in the urban centres of the Greater Accra Region were selected based on the recommendation of technical officers of the Food and Agriculture Organization of the United Nations. These farming areas are also among the major areas where vegetable farming activities are undertaken, in addition to the fact that they receive extension services and take part in farmer field schools organized by Ministry of Food and Agriculture (MOFA) and Food and Agriculture Organization of the United Nations (FAO-UN)

FIGURE 3.1 A MAP OF GREATER ACCRA REGION SHOWING THE STUDY AREA



SOURCE: SURVEY DEPT. OF GHANA-ACCRA

3.2.11 Data Sources and Method of Collection

The data for this study were obtained from a cross-sectional survey of 120 purposely-selected urban vegetable producers comprising sixty each of formal and informal irrigated urban vegetable farmers from the three selected districts of the Greater Accra Region with higher urban vegetable growers under the two schemes of irrigation. The questionnaire designed to collect data for the study were then pre-tested in some parts of the Airport and Ashaiman areas with 20 purposely selected vegetable farmers under each of the two systems of irrigation. Interview with the farmers started in March and ended in April 2002. One type of questionnaire was used for the survey. The questionnaire was designed to gather information on socio-demographic characteristics, cost of production and returns, level of inputs used, type of irrigation as well as the type of vegetable grown and problems encountered. In this study, farmers in the various farming systems (formal and informal irrigated vegetable production) were interviewed using both focus group discussions and individual contacts to obtain in-depth information on the research problems and issues involved.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Introduction

This chapter presents the results of the data analyses and discusses the output obtained. These include the socio-economic characteristics of formal and informal irrigated vegetable farmers in the study area, comparative estimates of the costs, returns and benefit-cost ratios. The Ordinary Least Squares (OLS) technique was employed in comparing estimates of the economic resource use efficiencies under the two irrigated vegetable farm types. Finally, a comparative analysis of the contributions of income to the households and the major problems encountered by the formal and informal irrigated urban vegetable enterprises are discussed.

4.1 Socio-Economic Characteristics of Formal and Informal Irrigated Urban Vegetable Farmers in the Study Area.

There is a consensus among various researchers on urban agriculture that various types of people are involved in the practice: both young and old, male and female, rich and poor, educated and uneducated. Some urban farmers are employed in the formal sector. (Lee-smith and Memon, 1994; Mougeot, 1994; Sawio1994; Maxwell, 1993; Maxwell and Zziwa, 1992; Freeman, 1991). Urban farmers have different reasons for farming, depending on their characteristics; the reasons range from economic to socio-cultural. Here the study examines the general characteristics of urban farmers in Greater Accra region and also attempts to bring out the differences in characteristics between the formal and informal irrigated urban vegetable farming identified in the study. General characteristics of respondents have been linked to economic activity through cross tabulation and calculation of percentages.

4.1.1 Gender

Table 4.1 indicates the gender distributions of formal and informal irrigated urban vegetable farmers. The table shows that 78.3 percent and 83.3 percent of the farmers engaged in formal and informal irrigated urban vegetable farming are men with only 21.7 and 16.3 percent respectively being women.

Table 4.1 Gender of Irrigated Urban Vegetable Growers in the Study Area

Gender	Formal Irrigation		Informal Irrigation	
	Frequency	Percentage	Frequency	Percentage
Male	47	78.3	50	83.3
Female	13	21.7	10	16.3
Total	60	100.0	60	100.0

Source: Author's Field Survey (2002)

The perception of urban farmers in Greater Accra affirms the position that men form the majority of urban farmers as previously asserted by other researchers. This view is also strongly held by women farmers and non-farmers in Accra. The dominance of the men in the urban irrigated vegetable farming compared to women can be attributed to the fact that women are not able to compete favourably with men in attaining or accessing land, water, credit, extension services and essential inputs (UNDP, 1996). In addition Ghanaian women, particularly those in the cities, prefer retailing to agricultural production. An assertion made by Maxwell (1997) supports this by stating that "urban retail marketing and petty trading are sectors that have long been dominated by women in West Africa, so it is not surprising to note that these are the most common forms of female livelihood in Accra.

It is impossible to generalize whether men or women form the majority of urban farmers in sub-Saharan Africa because it differs from region to region or from country to country. Some researchers noted that the majority of urban farmers in Africa south of the Sahara are women (Tinker, 1994; Maxwell and Zziwa, 1992; Freeman, 1991). Further, studies of other East African countries have also shown that women form the majority of urban cultivators (Sawio, 1994; Mwena et al 1991; Rakodi, 1998). This reflects women's traditional role in the production to the family (Sawio1994). In many places in sub-Saharan Africa there was the perception that women ought to cultivate because it is the wives' duty to provide the household with food (Sanyal, 1984). These observations in African cities affirm the most important tenet of the labour surplus model that is surplus labour has rendered the less powerful people (especially women) jobless, thus compelling them to engage in urban agriculture. Despite the findings mentioned earlier in the preceding paragraph, it is not accurate to say that women constitute the majority of urban farmers in Africa south of the Sahara. Based on available evidence from past research, it seems more appropriate to say that the majority of urban farmers in East Africa cities are women. Even in East Africa this generalization would still not be accurate. This argument is supported by Freeman's (1991) assertion that it would be inaccurate to label urban agriculture as a sector of exclusively female employment in view of the fact that male cultivators form a significant minority, and in some areas they either equal or outnumber women (Freeman, 1991). Contrary to the general notion regarding the gender of urban farmers in East Africa, most urban farmers in West Africa are men. The present study found that most of the urban irrigated urban vegetable farmers were men.

4.1.2 Age Distribution

The predominant age group for both formal and informal irrigated vegetable was found between the years of 30 and 50. The formal urban irrigated vegetable farming recorded 33.3 and 22.3 percent for males and females whilst the informal irrigated urban vegetable farming produced 16.7 and 8.3 percent for male and female respectively. Thus, a total of 53.6 and 25 percent males and females in their middle age were engaged in formal and informal irrigated urban vegetable farming respectively. The percentage of men and women respondents over 50 years was 13.3 and 6.7 respectively in the formal irrigated urban vegetable farming and 11.7 and 5 for the informal irrigated urban vegetable farming (as shown in Table 4.2).This implies that a total percentage in the older group (>50years) of about 20 and 16.2 of formal and informal irrigated urban farming practices for men and women respectively are engaged. The age group below 30 years recorded 16.7 and 6.7 percent for men and women respectively in the formal irrigated urban vegetable farming whilst a 16.7 and 8.3 percent were recorded for the men and women in the informal irrigated urban vegetable farming. Therefore, young vegetable growers were aged less than 30 years and contributed 23.3 and 25 percent for formal and informal irrigated growers respectively. The small percentages of young farmers confirm the assertion that new migrants to urban areas spend some time looking for wage employment at first. Most of the young migrants continue to look for wage employment while others give up the search and enter the vegetable enterprise.

Table 4.2 Age Distribution of irrigated Urban Vegetable Growers in the Study Area

	Formal Irrigation				Informal Irrigation			
	Frequency		Percentage		Frequency		Percentage	
Age (years)	Male	Female	Male	Female	Male	Female	Male	Female
Less than 30	10	4	16.7	6.7	10	5	16.7	8.3
30-50	20	14	33.3	22.3	18	17	30.0	28.3
Greater than 50	8	4	13.3	6.7	7	3	11.7	5.0
Total	38	22	63.3	36.7	35	25	58.3	41.7
Grand total	60		100		60		100	

Source: Author's Field Survey (2002)

4.1.3 Marital Status

The studies revealed that 56.7 and 71.7 percent of the formal and informal irrigated urban vegetable growers respectively are married. Approximately 23.3 and 16.7 percent of these two groups have never married, the percentage of divorcees were 1.7 and 6.7 percent with 18.3 and 5 percent widowed respectively as indicated in the table 4.3. The high proportion of married couples in vegetable production is a reflection of the heavy family requirement.

Table 4.3 Marital Status of Irrigated Urban Vegetable Growers in the Study Area

Marital status	Formal Irrigation		Informal Irrigation	
	Frequency	Percentage	Frequency	Percentage
Single	14	23.3	10	16.7
Married	34	56.7	43	71.6
Divorced	1	1.7	4	6.7
Widowed	11	18.3	3	5.0
Total	60	100.0	60	100.0

Source: Author's Field Survey (2002)

4.1.4 Religion

Table 4.4 shows the proportion of farmers from different religions engaged in urban vegetable production. Vegetable growers of the Moslem faith were found to dominate in both farming systems, indicating 61.7 and 55 percent in the formal and informal systems, respectively. The Christian faith followed with 36.7 and 41.7 percent for formal and informal irrigation respectively. As indicated in the table, formal and informal irrigators with other religious affiliations represent 16.6 and 3.3 percent respectively. This distribution suggests that any policy action which affects the Moslem religion will adversely affect vegetable production in the study area.

Table 4.4 Religion of Urban Vegetable Growers in the Greater Accra study Area

Religion	Formal Irrigation		Informal Irrigation	
	Frequency	Percentage	Frequency	Percentage
Christians	22	36.7	25	41.7
Moslems	37	61.7	33	55.0
Others	1	16.6	2	3.3
Total	60	100.0	60	100.0

Source: Author's Field Survey (2002)

4.1.5 Length of Stay in the Greater Accra Region

Table 4.5 below indicates the distribution of years spent in the study area by farmers. Approximately 18.3 percent (formal irrigated) and 23.3 percent (formal irrigated) were born in the Greater Accra region, with 10.0 and 11.7 percent of formal and informal irrigated vegetable growers having less than 5 years' stay in the region. Finally about 33.3 and 18.3 percents respectively of formal and informal irrigated urban vegetable growers constitute those who have spent over 20 years in the region. It can be confirm that of stay in Accra of over 6 year indicates the farmers' familiarity with the owners of the land tenure system and the landlord which invariably pave way for them to have access to the land for farming. This is because new entrants do not have access and understanding of the land use pattern in the area they find themselves especially for farming purposes and have less trust from many landowners.

Table 4.5 Length of Stay of Urban Vegetable Growers in the Study Area

Length of stay	Formal Irrigation		Informal Irrigation	
	Frequency	Percentage	Frequency	Percentage
<5years	6	10.0	7	11.7
6-20years	23	38.3	28	46.7
> 20years	20	33.3	11	18.3
Born in Greater Accra region	11	18.3	14	23.3
Total	60	100.0	60	100.0

Source: Author's Field Survey (2002)

4.1.6 Major Occupation

Table 4.6 indicates that 8.3 and 50.0 percent of formal and informal irrigators, respectively, are engaged in formal employment (civil or public services) while the others are in informal employment comprising farming, fishing and artisanship. About 68 percent of formal irrigators take farming as their major occupation as against 42 percent for informal irrigators. This is due to the fact that those who use informal irrigation find themselves in areas where access to farmland is difficult. Besides, farmlands are very small compared to areas available for formal irrigation. It was observed that 13.3 and 8.3 percent are artisans with only 10 percent of formal irrigators engaged in fishing to supplement their household income.

Table 4.6 Major Occupation of Urban Vegetable Growers in the Study Area

Occupation	Formal Irrigation		Informal Irrigation	
	Frequency	Percentage	Frequency	Percentage
Farming	41	68.3	25	41.7
Fishing	6	10.0	0	0.0
Civil/public servant	5	8.3	30	50.0
Artisanship	8	13.3	5	8.3
Total	60	100.0	60	100.0

Source: Author's Field Survey (2002)

4.1.7 Level of Education

Table 4.7 shows that among the formal and informal irrigated vegetable farmers studied, 63.3 and 66.7 percent have basic or elementary education respectively; 25.0 and 20.0 percent completed secondary education, while 8.3 and 13.3 percent of the respective irrigators have not having received any form of education. About 71.6% and 80.0 % have attained basic or elementary education under the formal and informal irrigated urban vegetable farming respectively. Also 3.4 percent had tertiary education under the formal irrigated vegetable farming only and they are the officers in charge of the technical divisions of the Ministry of Food and Agriculture and the Ghana Irrigation Authority.

Table 4.7 Level of Education of Urban Vegetable Growers in the study Area

Level of Education	Formal Irrigation		Informal Irrigation	
	Frequency	Percentage	Frequency	Percentage
Basic	38	63.3	40	66.7
Secondary	15	25.0	12	20.0
Tertiary	2	3.4	0	0.0
No education	5	8.3	8	13.3
Total	60	100.0	60	100.0

Source: Author's Field Survey (2002)

4.1.8 Distance from Source of Water for Irrigation

From Table 4.8, 83.3 and 3.3 percent of the formal and informal vegetable growers, respectively, source their water from a distance of more than 500 metres. Water for the informal system is transferred onto the fields by means of watering cans or buckets from dams, gutters, drains, streams and household pipes or from water hole connected to households' pipe-borne water. On the other hand, transfer of water onto formal irrigation fields is by means of a pumping machine. Approximately 11.7 and 31.7 percent also obtain water from a distance of between 100 to 500 metres for the two forms of vegetable growers respectively with only 65 percent of informal vegetable growers obtaining water for irrigating their fields from a distance less than 100 metres.

Table 4.8 Distance from Source of Irrigation Water to Farm

Distance from source	Formal Irrigation		Informal Irrigation	
	Frequency	Percentage	Frequency	Percentage
<100metres	0	0.0	39	65.0
100-500metres	7	11.7	19	31.7
>500metres	53	88.3	2	3.3
Total	60	100	60	100.0

Source: Author's Field Survey (2002)

From Table 4.8 it can be deduced that the distance from the source of water to the farm determines the type of irrigation to be employed. In view of the importance of water to vegetable production, informal irrigation covers smaller distances to obtain water for their farms since they carry buckets and watering cans in fetching water to irrigate their vegetable farms from near-by streams and big drains and some times tap water.

The vegetable growers, using formal irrigation have their water source mainly from the dam, which is usually a long distance from their farms. Water will, therefore, have to be conveyed through canals onto their fields. It was observed that obtaining water by the informal irrigator was more labour intensive compared to the formal irrigators since the former will have to carry the water onto the fields.

4.1.9 Jobs Other than Vegetable Farming

Table 4.9 shows that about 31.7 and 20.0 percent of the formal and informal irrigators respectively responded ''Yes'' to the question whether they engage in some form of income generating activity apart from vegetable farming. Approximately 68.3 and 80.0 percent of formal and informal irrigators responded ''No'' to the question since they solely engaged in the vegetable farming to supplement the household income and food.

This can be attributed to the higher number of farmers within the middle age brackets who were either re-deployed or unemployed.

Table 4.9 Jobs Other than Urban Irrigated Vegetable Production in the Study Area

Any job apart from vegetable farming	Formal Irrigation		Informal Irrigation	
	Frequency	% Response	Frequency	% Response
Yes	19	31.7	12	20.0
No	41	68.3	48	80.0
Total	60	100.0	60	100.0

Source: Author's Field Survey (2002)

4.1.10 Source of Labour

Table 4.10 indicates that about 53.3 and 60.0 percent of the labour employed under the formal and informal irrigated urban vegetable farming is basically provided by the family while 18.3 and 20.0 percent is solely hired labour. This is observed on plots of absentee farmers who leave the farm in the care of someone else (caretaker). However, 28.3 and 20.0 percent respectively of farmer respondents employed both family and hired labour.

Table 4.10 Sources of Labour Available for Urban Vegetable Growers in the Study Area

Source of labour	Formal Irrigation		Informal Irrigation	
	Frequency	Percentage	Frequency	Percentage
Family	32	53.3	36	60.0
Hired	11	18.3	12	20.0
Both	17	28.3	12	20.0
Total	60	100.0	60	100.0

Source: Author's Field Survey (2002)

4.1.11 Source of Finance

From Table 4.11, approximately 56.7 and 51.7 percent engaged in both the formal and informal irrigation respectively obtain loans from informal sources such as the family, own savings and market mummies. The market mummies who provide most of the funds usually pre-finance the farming activity and also buy the produce after harvest and then pay the difference after sales. The market mummies invariably are the main financiers of most irrigated urban vegetable (either formal or informal) farming in the region. Also, about 25 percent each of the formal and informal irrigated vegetable growers fall on their own savings due to the fact that they have other sources of income and are mainly part time vegetable farmers, while 18.3 and 23.3 percent respectively obtain loans from their family members. Both formal and informal irrigated urban vegetable farmers sourced most of their funds from market mummies.

None of the farmers from the two categories, however, obtained funds from the formal financial institutions such as the banks. It was also observed that the vegetable growers borrow money from members of their network and group without paying any interest and so found it more convenient. The amounts involved are normally not huge, and it is generally for shorter duration. Though the non-institutional credit system to the vegetable growers is at times the source of conflict, it binds growers as well as non-growers together and establishes cordial relationship among them (i.e. the informal arrangement may be between two farmers or between a farmer and a non-farmer). Generally, informal sources of credit are more convenient, available locally and require no documentation and can provide credit quickly (Upton, 1996).

Table 4.11 Sources of Finances Available to Irrigated Urban Vegetable Growers in the Study Area

Sources of finance	Formal Irrigation		Informal Irrigation	
	Frequency	Percentage	Frequency	Percentage
Own savings	15	25.0	15	25.0
Family	11	18.3	14	23.3
Market mummies	34	56.7	31	51.7
Banks	0	0.0	0.0	0.0
Total	60	100	60	100.0

Source: Author's Field Survey (2002)

4.1.12 Need for an Association

Table 4.12 indicates the responses for the need for an association of urban vegetable farmers. The majority (61.7 percent) of the formal irrigators firmly support the need for an association of urban vegetable farmers, to see to their welfare as against the 33.3 percent registered under the informal irrigators. The high percentage response from the formal irrigators is due to the fact that they are well organized and are within a specified area where they can all be easily located compared to the informal group for which farmers are scattered all over the urban centres, hence the low response in favour of group formation.

Table 4.12 Frequency of Response for an Association of Urban Vegetable Growers in the Study Area.

Any need for an association?	Formal Irrigation		Informal Irrigation	
	Frequency	% Response	Frequency	% Response
Yes	37	61.7	20	33.3
No	23	38.3	40	67.3
Total	60	100.0	60	100.0

Source: Author's Field Survey (2002)

4.1.13 Nature of Cropping System

Table 4.13 indicates the nature of cropping system of the farmers in this study adopted. From the table 31.7 and 26.7 percent of formal and informal irrigators, respectively, engaged in monocropping with about 68.3 and 73.3 percent practicing multi-cropping. Depending on the farmers need and location of the farm various crops were grown either as a mono crop or a mixture of crops namely; tomato, onion, pepper, garden-egg, okra, carrot, maize and leafy vegetables. The high percentages recorded in multi-cropping for both irrigation types can be attributed to the high level of security associated with diversity in cultivation to reduce their risk level and increase their share of profits. In addition farmers from either system reckoned that the system of cropping being practised is tied to the area they find themselves and thus would be extremely difficult to change the nature of cropping since it will meet a lot of resistance from the land owners.

Table 4.13 Nature of Cropping System Adopted by Urban Vegetable Growers in the Study Area

Cropping System	Formal Irrigation		Informal Irrigation	
	Frequency	Percentage	Frequency	Percentage
Monocropping	19	31.7	16	26.7
Multi-cropping	41	68.3	44	73.3
Total	60	100.0	60	100.0

Source: Author's Field Survey (2002)

4.2 Costs, Returns and Profitability of Urban Vegetable Farming in the Study Area

The production costs and returns of the two groups of irrigated urban vegetable farms are presented in Table 4.14. The result shows that the gross revenue for formal irrigated vegetable farm is ¢400,000 (¢0.4000 million) per acre with ¢100,000 (¢0.1000 million) per acre for informal irrigated urban vegetable farming. Similarly, the average total cost of production is ¢276,000 (¢0.2760 million) per acre for formal irrigated urban vegetable farms and ¢35,500 (¢0.0355 million) per acre for informal irrigated urban vegetable farms. The resultant net returns are ¢124,000 (¢0.1240 million) per acre for formal irrigated urban vegetable farms and ¢64,500 (¢0.0640 million) per acre for informal irrigated urban vegetable farms. The results revealed the contribution or proportion of variable cost to total cost associated with both formal and informal irrigated urban vegetable farming as 47.0 and 41.7 percent respectively. From Tables 4.14, it could be deduced that the percentage of total cost with respect to total revenue was higher with formal irrigated urban vegetable farm (69 percent) than the informal irrigated vegetable urban farming (35 percent).

These results imply that formal irrigated urban vegetable farms produce higher quantities of output at relatively higher costs of production and returns per acre than informal irrigated urban vegetable farms, and hence increases the profit margin. Consequently, the per acre values of all production inputs are generally higher for formal irrigated urban vegetable farms. This result implies that formal irrigated urban vegetable farms increase the use of all inputs.

Also in Table 4.14 below, the profitability of the two farm types were estimated using the benefit-cost ratios (B-C). The ratio indicates 1.4 and 2.8 for formal and informal irrigated urban vegetable farm. This implies that for the formal irrigated urban vegetable farming a unit cost of investment leads to about 1.4 units of benefits whilst under the informal irrigated urban vegetable farming a unit cost of investment leads to 2.8 units of benefits. Thus both ratios were greater than one, implying that the benefits accrued was higher than the costs associated with the vegetable production over the growing period per acre. From these ratios it can be stated that both farms were profitable with the ratio of informal was higher than the formal irrigated urban vegetable farms.

Table 4.14 Costs and Returns per Acre (in '¢ 'million)

Item	Formal	Informal
Revenue	0.4000	0.1000
Variable Costs		
Agrochemical	0.0500	0.0040
Fertilizer (50-kg bag)	0.0001	0.0008
Labour	0.0400	0.0050
Miscellaneous	0.0400	0.0050
Total variable costs	0.1300	0.0148
Fixed costs		
Irrigation water	0.0700	0.0100
Land	0.0700	0.0100
Depreciation of fixed assets	0.0060	0.0007
Total fixed cost	0.1460	0.0207
Total costs	0.2760	0.035
Net Returns	**0.1240**	**0.0645**
Contribution of Variable costs to Total costs (%)	47.0	41.7
Benefit-Cost Ratio (BCR)	1.4	2.8

Source: author's computation

4.3 Discussion of Regression Results

This section discusses the regression results of the third objective, which seeks to estimate the economic efficiency of resource use under the formal and informal irrigated urban vegetable farms. Several forms of the ordinary least squares (linear, double log and semi-log) were tried and the equation of the best fit was the linear form. The regression results are presented in Appendix VI showing the coefficients of multiple determination (R^2s), the t-ratios and F-statistics associated with the two irrigated vegetable farm types under study. For objective three, Technical and Allocative efficiency tests conducted from the linear model results are presented in Table 4.15 and 4.16 respectively.

Table 4.15 Estimated Linear Production Function for Technical Efficiency Test

Variables	Formal irrigation		Informal irrigation	
	Coefficients	t-statistic	Coefficients	t-statistic
Constant	337615.00	2.70*	60946.33	2.67*
CVLand	0.97	6.70*	0.89	0.43
CVLabour	1.29	5.49*	1.30	1.02
CVFert	78.61	0.58	17.36	2.36*
CVIrrigat	1.35	3.36*	-2.40	-1.33
CVAgrchem	3.48	11.93*	1.03	3.84*
CVMisc	1.79	0.89	1.34	2.40*
R-square	0.97		0.52	
Adjusted R-square	0.96		0.48	
F- Statistic	266.4†		9.57†	
Number of observations	60		60	

Source: Regression results. † F-value significant at 1 percent level and $p<0.01$ (2) insignificant parameters are presented without asterisks (*)

4.3.1 Statistics of Regression Analysis

The R^2 value of 0.97 (Table 4.15) for formal irrigated urban vegetable farm type indicates that about 97.0 percent of the total variation in the aggregated output value of vegetables is explained by the independent variables specified in the model (equation 1). F-statistic is approximately 226.43 at 1 percent level of significance, implying that the explanatory variables jointly significantly influence the dependent variable. Using the same linear functional form, an R^2 of 0.52 (Table 4.15) is obtained for the informal irrigated urban vegetable farm type. It could be said that 52.0 percent of the total variation in the aggregated output value of vegetables is explained by the independent variables specified in the regression model (equation 2). The test proved significant at 1 percent since the computed F- statistic was 9.57. The critical F-value was about 9.57 at 1 percent level of significance implying that the explanatory variation jointly and significantly influence the dependent variable.

4.3.2 Technical Efficiency Comparison

This section discusses the regression results for the two irrigated vegetable farm types (formal and informal). The null hypothesis of the study is that the form of irrigated urban vegetable farming in the Greater Accra region has not brought any significant improvement in the farmer's technical and allocative efficiencies against the alternative hypothesis that it has. This hypothesis is applied to the two forms of irrigated urban vegetable farms (formal and informal) so that the economic efficiency indices for the two farm types could be differentiated and compared.

Testing the above hypothesis with respect to technical resource-use, the MVPs of the formal and informal irrigation and their respective calculated t-statistics were compared with the critical t-value to test the significance of the coefficients.

The regression results in Table 4.15 indicate that, the intercept terms for both the formal and informal irrigated urban vegetable farm types were positive and significant and that, at least one explanatory variable in each case was significantly different from zero. This implies that both formal and informal irrigation of urban vegetable farm types are characterized by factor-biased (non-neutral) production function with some level of technical efficiency. However, the presence of a positive intercept term of +337615 for the formal irrigated vegetable farm type and +60940.33 for the informal irrigated urban vegetable farm type indicates some technical efficiency in both irrigated vegetable farm types. In addition the formal irrigated urban vegetable farming recorded a higher level of technical efficiency than the informal irrigated urban vegetable farming with a higher positive intercept ($\alpha_0 = 337615 > \beta_0 = 60940$).

Concerning the explanatory variable for the formal irrigated urban vegetable farm, the statistical significance of the value of land, labour, irrigation and agrochemicals is consistent with the a-priori expectations. However, the value of fertilizer and miscellaneous items were not statistically significant even though the coefficients were positive. The positive but insignificant coefficients of miscellaneous expenses and value of fertilizer for the formal irrigated urban vegetable farm type, implies that these costs contributed little to the total variation in the value of aggregated output of vegetables from formal irrigation. This insignificance is rather inconsistent with the supply theory but the empirical results could be due to perhaps the relatively low usage levels.

Concerning the explanatory variables for the informal irrigated urban vegetable farm type the statistical significance of the values of fertilizer, agrochemicals and miscellaneous expenses is also consistent with the a-priori expectations. It was found out that the coefficient of the value of irrigation water was negative and statistically insignificant. This could be attributed to the negative and negligible effect of the informal irrigation practices.

4.3.3 Allocative Efficiency Comparison

This section tests the validity of the hypothesis that, farmers will efficiently allocate resources in the formal than informal irrigated urban vegetable farm type. Using the regression results of the linear production function presented in Table 4.15, the allocative efficiency indices for the explanatory variables in the model specified are presented in Table 4.16. Included in this table are the sample means and the marginal value products (MVPs) of the estimates.

The allocative efficiency parameters shown in Table 4.16 indicate that formal irrigated urban vegetable farm type overutilized land, labour and agrochemicals. The results, however, showed that only irrigation water was underutilized. In relative terms agrochemicals seems to be less overutilized whereas labour and land are more overutilized in the formal irrigated urban vegetable farm type than the informal type.

Surprisingly, however, the value of fertilizer and miscellaneous expenses were depicted as unimportant in the supply of the aggregated output of the vegetable and as such, their allocative efficiency indices are not derived. For the informal irrigated urban vegetable farm type, the farms overutilized the fertilizer and agrochemicals. Allocative efficiency indices for land, labour and irrigation were not derived because they showed insignificant and perverse parameters. Relatively, however, the value of irrigation deviates less from absolute resources overutilization than fertilizer. Moreover, given the above resource use-efficiency indices, only values of agrochemicals can be compared across the two irrigated vegetable farm types in this study. This is because only agrochemicals was significant as well as showed the expected a priori signs for the study.

It could, therefore, be said that, the use of agrochemicals during formal irrigation is closer to absolute resource utilization than the case of informal. This is evident from the allocative index of +0.05 for formal and +0.04 for informal (Table 4.16). This implies that agrochemical is eventually attaining absolute resource overutilization, over the period of study.

Table 4.16: Estimates of Sample Means, Marginal Value Products and Allocative Efficiency Indices

Variables	Formal Irrigation	Informal Irrigation
Sample Means (value in ¢)		
Land	71391.60	5062.27
Labour	29954.73	2496.23
Fertilizer	903.46	410.66
Irrigation	67813.40	5289.41
Agrochemical	46947.63	1339.83
Miscellaneous	40307.50	2687.17
Output	337615.00	60946.33
Marginal Value Products (MVPs)		
Land (¢ acre)	0.97	*
Labour (¢ man-day)	1.29	*
Fertilizer (¢ kg)	*	17.36
Irrigation (¢ N)	1.35	*
Agrochemical (¢ litre)	3.48	1.03
Miscellaneous (¢ N)	*	1.34
Factor Prices		
Land (¢ acre)	2500.00	*
Labour (¢ man-hours)	812.50	*
Fertilizer (¢ kg)	*	1607.80
Agrochemical (¢ litre)	70.00	22.32
Allocative Efficiency Indices		
Land	0.0004	*
Labour	0.002	*
Fertilizer	*	0.01
Irrigation	1.35	*
Agrochemical	0.05	0.04
Miscellaneous	*	1.34

Source: Appendix VI
*Estimates / indices were not derived because estimated regression coefficient was not statistically significant.

4.4 Estimates of Household Income Contributed by Urban Vegetable Production

The percentage of household income contributed by irrigated urban vegetable farming ranging from 43.50 to 95.83 percent with an average of 74.85 percent for the formal irrigated urban vegetable farming (Appendix 1). Appendix II also indicates a range of

44.48 to 90.70 percent with an average of 66.97 percent for the informal irrigated urban vegetable farming. The result from the two tables indicates that incomes from both formal and informal irrigated urban vegetable farming are a very significant source of income to households of the farmers. There was, however, a statistical difference between the average contribution of income from formal and informal irrigated urban vegetable farming at a 5 percent significance level. Thus the income contributed by the formal was significantly higher than that from the informal irrigated urban vegetable farming. In both Appendices the estimated Annual Household income (I_{HH}) was statistically significant at 5 percent level. In irrigated urban vegetable farming it is important to note that although household income was the main monetary measure used in this report, it is the general experience in households surveys that it is much more difficult to capture all elements of income and it is therefore inevitable that the measures presented here somewhat understates the total household income. The high and significant levels of income from the formal irrigated urban vegetable can be attributed to the fact that the farmers are into full-time farming. Their farming activities and practices are usually an all year round compared to the informal for which activities and practices are mainly part-time and are not usually engaged in an all year round of farming.

4.5 Major Problems Encountered by Urban Vegetable Farmers in the Study Area

Table 4.17 identifies the main problems encountered by formal and informal vegetable farmers in the Greater Accra study. Urban farming as reported by Obosu-Mensah (1999), is seen generally as an innovative attempt by migrant workers in Greater Accra to alleviate or at least reduce their own poverty through the supplementary income generated by transforming marginal urban waste land into garden plots and watering these with waste water they have recycled. As indicated in the Table 4.17, most farmers employing both forms of irrigation mentioned the following as the major problems: lack of resources, incidence of stray animals and pests, use of untreated gutter water, pilfering and, finally, fear of eviction.

Table 4.17 Major Problems of Urban Vegetable Growers in the Study Area

Major problems	Formal irrigation		Informal irrigation	
	Frequency	Percentage	Frequency	Percentage
Lack of resources	22	36.7	16	26.7
Fear of eviction	0	0.0	20	33.3
Stray animals/pests	16	26.7	6	10.0
Gutter water	0	0.0	15	25.0
Pilfering	2	3.3	3	5.0
No problems	20	33.3	0	0.0
Total	60	100.0	60	100.0

Source: Author's Field Survey (2002)

4.5.1 Lack of Resources

From Table 4.17 about 36.7 percent of the formal and 26.7 percent of the informal irrigated vegetable farmers stated these ''lack of resources'' as a major problem. The farmers involved in this study mentioned lack of resources as their most important problem. The respondents attributed ''lack of resources'' to logistical problems such as inadequate capital, high cost of inputs, lack of credits, limited technological know-how and lack of reliable markets. Most of the farmers mentioned that since they did not have other reliable sources of income, they did not have enough capital to invest in their farming activities. In both forms of farming they noted that without enough money they were not able to acquire the appropriate tools, chemicals and fertilizer needed to improve upon their farming activities. On the issue of lack of capital, the farmers called on the government to set up a financial institution that could cater, specifically, for the provision of funds to urban vegetable farmers. They suggested alternatively, that urban vegetable farmers should be given the same recognition as rural farmers by financial institutions and extend soft loans to them. Most of the formal irrigation farmers complained of high prices of agricultural inputs like chemicals, fertilizers, seeds and tools. The least affordable inputs were chemicals, followed by seeds and fertilizer. Another complaint raised by both categories of urban vegetable farmers was inadequate extension services, even though farmers using formal irrigation receive an appreciable level of extension services. Information from the Ministry of Food and Agriculture indicates that, although not much attention has been given to them, the ministry has located small shops at strategic positions in the city for the supply of vegetable seeds to the farmers. This is to provide the farmers with viable vegetable seeds to maintain constant supply of vegetables throughout the year. The main problem they face in the marketing of their produce is caused by the market women who come to the farm to buy. It was observed that these market women sometimes come later to tell them that most of the produce had gone bad and therefore, pay less than the original price for the produce. From the study formal vegetable farmers receive constant prices for their produce, while the informal receive unstable prices.

The reason was that during the rainy season both formal and informal irrigated vegetable products attract the same price but in the dry season the informal group is at a disadvantage due to limited water for irrigation since they depend mostly on water from stream, drains and, sometimes, gutters. These sources of water do not, flow throughout the year. It was also noted that a lot of the consumers patronized the produce from the formal than the informal irrigation mainly for health reasons. The vegetable from both formal and informal by the farmer is bought directly by market women, mostly high-class residential settlers and people with acquired European dietary standards. It can, therefore, be implied that urban vegetable producers (using either formal or informal form of irrigation) serve the majority of the affluent and the sophisticated people in the urban society. The disparity in the consumption is due to the high market price of the vegetable. This is also the result of high cost of production, marketing and transportation associated with the formal irrigated vegetable enterprise. There are large requirements of weed and pesticide control, water and storage. This, not withstanding the labour intensive nature of the production process, has served to attract the poorest of the poor who virtually have neither assets nor skills to market except their labour to undertake urban vegetable farming as an innovative strategy to supplement household income.

4.5.2 Eviction from Land

The fact that many farmers do not own the land, which they farm on, has been detrimental to the sustainability in vegetable farming in the urban areas of the Greater Accra region. This was made clear by Tinker (1994) when she wrote that "the certainty created by expected harassment keeps farmers from investing in soil and crop improvement'. For those farming on other people's land there is always the threat of eviction so they do not make long-term investments.

From Table 4.17 none of the formal irrigators identified the fear of eviction as a problem, but about 33.3 percent of the informal irrigators identified it as a major problem. The absence of the problem under formal irrigated urban vegetable farming is due to the fact that the land belongs to the government and is sited near the dam with the main aim to use it for farming. It, therefore, makes farmland available to interested farmers who apply for it for the intended purpose. The informal irrigated urban vegetable farmers, however, occupy plots that belong to private owners who might want to develop the land at any time; more over, there is no contractual agreement between owners of the land and the farmers. In the case of informal irrigated urban vegetable farmers, most of them interviewed complained of being threatened by eviction. Some said their vegetables have once been destroyed but because vegetable farming is their main source of income they came back. These threats of eviction had really made them uncertain about the future of vegetable farming in the urban centres. Often the purpose of giving out undeveloped land is to prevent it from being over grown with weeds and also encroachments. This is an attempt by landlords to avoid infringing upon a municipal council by-law which requires the owners of any premises to remove, or trim to size any tree, shrubs or hedges overhanging or interfering in any way with works of the council (Ordinance No.9 section 51:1, 1953). Where the gardens use by-ways along streets and drains they are required to apply to the municipal council which has the power to allocate land in the ownership of the council for farming purposes and to regulate the system of farming of such land (Ordinance No 9 section 51, 1953).

However, most farmers never apply for the right of use of such plots of land nor obtain the required permit. They simply move in and occupy the land and therefore subject themselves to frequent eviction. In view of this the association of small-scale vegetable growers won a major victory when they forced landowners and the city authorities to agree to give prior and early notice of eviction. Another significant victory the association has won is in changing prohibitive and restrictive municipal regulations concerning land use, sanitation and the damming of water channels. In the past, municipal regulations, for instance, prohibited the obstruction of any river, streams or watercourse or open street drain (Ordinance No.9 section 51, 1953). By fighting for the recognition of vegetable farmers and their legitimate role in the functioning of the city, the association was able to have a policy dialogue with the city authorities. This dialogue has enhanced collaboration between the city authorities and the vegetable farmers. In the view of this, municipal regulations have had been changed to reflect the new attitude of the municipal authorities.

According to Section 51, subsection 3 of the Local Government Act 462 (1993), it stipulates that 'subject to this act, any action, programme or project plan or unless the proposed activity obstructs or interferes with community right of space, the following activities shall not require prior permit from District Planning Authority:

(a) Subsistence farming;

(b) Farming and other activities carried out in any settlement of not more than 5000 people; and

(c) Small scale vegetable and flower gardening

Until these changes, the regulations have been unfavourable and regulatory Section 51, subsection iv of the local government Ordinance 9 of 1953, for instance states that it shall be the duty of every council in a municipal area to allocate land in the ownership of the council for farming purposes and regulate the system of farming for such land. The Local Government Act 54 (1961) and the PNDC Law 207 (1988), which replaces the 1953 legislation, also maintains the same regulatory stance.

In addition to the favourable slant in municipal legislation, other areas of cooperation between the farmers and the Accra Metropolitan Assembly have been good. For instance, the conspicuous lack of levies or taxation on the activities of the farmers is an indication of the favourable attitude of the government and city authorities towards farming in the city.

4.5.3 Stray Animals and Pests

From the study both categories of farmers complained of the incidence of stray animals and pests, which constituted about 26.7 and 10.0 percent of formal and informal irrigated urban vegetable farmers respectively (Table 4.17). Stray animals especially ruminants such as goats and rodents that destroy growing and matured vegetables were of great concern to the farmers since it drastically reduces the expected yields. In a study conducted by Obosu-Mensah (1999), farmers complain say that "it is very disappointing to go to your farm and find out that goats have grazed on your vegetable and or pigs have destroyed your beds: this they say, is so discouraging that we think of stopping cultivating but, well we should not stop cultivating, and that if anything at all it is the stray animals and pests which should be stopped from destroying our vegetables". However, the informal irrigators have relatively less problems because; they virtually spend their entire day on the farm either by themselves or their relatives. On the other hand, formal irrigators stay far from their farm thereby having little control over these animals with respect to their vegetables.

4.5.4 Untreated Gutter Water

From the Table 4.17 only farmers who engage in formal irrigated vegetable production employ the use of water from dams to irrigate their vegetables. This was confirmed with a zero percentage response in the use of gutter water from irrigation by formal irrigators. In the case of informal irrigators, about 25 percent (15 out of 60) of farmers interviewed use water from the gutter for irrigation. This was attributed to the nearness of these farms to the city centres and drains along the road such as the Osu Castle Link, Airport area, Cantonments, Teshie, Tema and Dzorwulu Plant Pool areas.

The majority of urban farmers grow vegetables because they believe that it grows faster and requires a large quantity of water to grow properly. Therefore, it follows that urban farmers' need adequate source of water supply. In Accra the main supply of water to the general public is tap (pipe-borne) water. However, tap water is not a convenient source of water for urban farmers because it is expensive and unreliable. While the formal irrigated vegetable farmers mentioned that water for irrigation was not a problem, farmers engaged in informal irrigation consider water as their major problem but are able to solve that by the use of water from drains and gutters. The problem people have with the use of gutter water was that it was untreated and consequently can be a source of disease outbreak, thus confirming the fear of some consumers and sellers. The informal irrigated vegetable farmers, however, find nothing wrong with irrigating the vegetables with such water. According to them no one has ever complained to them about it and, more so they also consume it.

4.5.5 Pilfering

Stealing of vegetables was noted to constitute an important problem, by the vegetable farmers in the urban centres in the Greater Accra region. According to them they engage in vegetable cultivation in order to produce vegetables for their own consumption and mostly for sale to supplement household income. Consequently, their motivation to cultivate decreases when their vegetables are stolen. According to the farmers, lower motivation has led to lower productivity in some instances, thus lowering their profit margin. It follows, therefore, that a farmer who has little or no pilfering related problems gains more from urban vegetable farming than those whose vegetables are a target of thieves. Almost all the respondents interviewed in the study mentioned stealing as a problem. From Table 4.17 the incidence of pilfering was found not very significant among the formal and informal irrigator respectively. In both situations most of the farmers said they are helpless as far as stealing of their produce is concerned. They have, therefore, resolved to form a vigilant group to keep watch over their crop.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

One of the main assertions in this work is that urban agriculture is increasing in sub-Saharan Africa. As long as rural residents with farming background migrate to urban areas, as long as the urban formal sector is unable to employ all the migrants to urban areas and as long as many urban residents do not earn enough income from the formal sector to cater for themselves, there will be urban agriculture. Vegetable farming in the urban areas of Greater Accra region is carried out in the open spaces along big drains or gutters and streams (informal), and dams (formal) where the water bodies are used to irrigate the vegetables. Some farmers, however, have access to tap (pipe borne) water. Urban farmers have different reasons for farming, depending on their characteristics; the reasons range from economic to socio-cultural.

5.1 Summary and Conclusions

The predominant age group of sampled vegetable farmers was between the years of 30 and 50 years for both categories of irrigators. This constitutes the middle age bracket. Vegetable growers of the Moslem faith were found to dominate both in the formal and informal irrigated vegetable farming systems with 61.7 and 55 percent respectively. The Christian faith followed with 36.7 and 41.7 percent for formal and informal irrigation respectively. The study also showed that 18.3 percent (formal irrigation) and 23.3 percent (informal irrigation) of respondents were born in the Greater Accra region with 10.0 and 11.7 percent of formal and informal irrigated vegetable growers having less than 5 years stay in the region. Finally about 33.3 and 18.3 percent respectively of formal and informal irrigated urban vegetable growers constitute those who have spent over 20 years in the region. It was found that long stay in Accra of over 6 years indicates farmers' familiarity with the land tenure system and the landlord which invariably paves way for them to have access to the land for farming. On the contrary new entrants do not have access and understanding of the land use pattern in the area in which they find themselves, especially, for farming purposes and have less trust from many landowners.

It was realized that about 71.6 and 80.0 percent have not attained more than basic or elementary education under the formal and informal irrigated urban vegetable farming respectively. It was also observed that 3.4 percent had tertiary education under the formal irrigated vegetable farming only. These are the officers in charge of the technical divisions of the Ministry of Food and Agriculture and the Ghana Irrigation Development Authority.

From the study 83.3 and 3.3 percent of the formal and informal vegetable growers source their water from a distance of more than 500 metres respectively. This could be attributed to the fact that the system of irrigation employed depends on the distance from the source of water in view of the technological differences being applied. In view of the importance of water to vegetable production, informal vegetable farmers cover smaller distances to bring water onto their farms from near-by streams, big drains and, sometimes, tap water.

The formal irrigated vegetable growers have their water source mainly from the dam, which is usually far from their farms. Water will, therefore, have to be conveyed through canals onto their fields. It was observed that obtaining water by the informal irrigator was more labour intensive compared to the formal irrigators since the former will have to carry the water onto the fields.

None of the farmers from the two categories, however, obtained funds from the formal financial institutions such as the banks. It was also observed that the vegetable growers borrow money from members of their network and group without paying any interest and so found it more convenient. The amounts involved are normally not huge, and it is generally for shorter duration. Generally, in comparing informal sources to formal sources of credit, they are more convenient, available locally and require no documentation and can provide credit quickly. The result reveals gross revenue of ¢400,000 per acre for formal irrigated urban vegetable farming and ¢100,000 per acre for informal irrigated urban vegetable farming. These results implies that a formal irrigated urban vegetable farms produce higher quantities of output at relatively lower cost of production and returns per acre than informal irrigated urban vegetable farms and hence increases the profit margin.

The Benefit-to-Cost ratios of 1.4 and 2.8 for formal and informal irrigated urban vegetable farms reveal that, a unit cost of investment will lead to about 1.4 and 2.8 units of benefits under formal and informal irrigated urban vegetable farming respectively. This result, therefore, shows that both systems were profitable with ratios greater than one, even though the ratio of informal was higher than the formal irrigation system.

In estimating the technical and allocative efficiencies under both systems of farming, several linear forms of the ordinary least squares (linear, double log and semi-log) were tried and the equation of the best fit was the linear form. Using the same linear functional form, an R^2 of 0.97 and 0.52 was obtained for the formal and informal irrigated urban vegetable farms respectively. The regression results indicate that the intercept terms for both the formal and informal irrigated urban vegetable farm types were positive and significant. In addition, at least one explanatory variable in each case is significantly different from zero. This implies that formal and informal irrigation urban vegetable farm types are characterized by factor-biased (non-neutral) production function with some technical efficiency. However, an intercept term of +337615 for the formal irrigated vegetable farm type as against +60940.33 for the informal irrigated urban vegetable farm type show that, the farmers, at least, maintain their technical resource-use efficiency in any of the irrigated vegetable farm types ($\alpha > \beta$). The results also show that, the explanatory variables for the formal irrigated urban vegetable farm type was statistically significant for the values of land, labour, irrigation and agrochemicals which were consistent with a priori expectations. However, the value of fertilizer and miscellaneous expenses were not statistically significant even though the coefficients were positive. The positive but insignificant coefficients of miscellaneous expenses and value of fertilizer for the formal irrigated urban vegetable farm type, implies that miscellaneous expenditure and value of fertilizer associated with formal irrigated urban vegetable farm type, made negligible contributions to the total variation in the value of aggregated output of vegetables from the formal irrigated urban vegetable farm type. The insignificance of the coefficient of fertilizer and miscellaneous expenses is rather inconsistent with the supply theory. This empirical result could be due to, perhaps, the relatively low usage levels.

Concerning the explanatory variables for the informal irrigated urban vegetable farm type the statistical significance of the value of fertilizer, agrochemicals and miscellaneous expenses is also consistent with a-priori expectations. It was found out that the coefficient of the value of irrigation water was negative and statistically insignificant. This could be attributed to the negative and negligible effect of the informal irrigation practices. It is likely for new adopters (without much information on soil water requirement with regards to the vegetables) to have misused the water in the informal vegetable farming. It is worth noting that, excessive use of irrigation water application could result in reduced vegetable yields, and here again, the soil condition might have been just fertile enough for optimal vegetable output without irrigation water application.

Allocative efficiency parameters indicate that, formal irrigated urban vegetable farm type over utilized the land, labour and agrochemicals. The results, however, show that only irrigation water was under underutilized. In relative terms agrochemicals seem to be less overutilized whereas labour and land are more overutilized under the formal irrigated urban vegetable farm type.

Surprisingly, however, the value of fertilizer and miscellaneous expenses were depicted as unimportant in the supply of the aggregated output of the vegetable and as such, their allocative efficiency indices are not derived. Moreover, given the above resource use-efficiency indices, only values of agrochemicals can be compared across the two irrigated vegetable farm types in this study. This is because only agrochemicals was significant and showed the expected a priori signs for the study.

It could, therefore, be said that the use of agrochemicals during formal irrigation is closer to absolute resource utilization than the case of informal. This is evident from the allocative index of +0.05 for formal and +0.04 for informal, and implies that agrochemicals is eventually attaining absolute resource over utilization, over the period of the study (2001).

The result indicates that both formal (74 percent) and informal (6.94 percent) irrigated urban vegetable farming are a very significant source of income to households of the farmers. The income from the formal was higher than that from the informal irrigated urban vegetable farming. It is important to note that although household income was the main monetary measure used in this report, it is the general experience in household surveys that it is much more difficult to capture all elements of income and therefore, inevitable that the measures presented here somewhat understate the total household income. The high and significant levels of income from the formal irrigated urban vegetable is due to the fact that the farmers are mostly full-time and their activities and practices are all year round farming compared to the informal in which farmers are mainly part-timers and do not usually engage in an all year round of farming.

The farmers involved in this study mentioned lack of resources as their most important problem and the respondents attributed the lack of resources to logistic problems such as inadequate capital, high cost of inputs, lack of credits, limited technological know-how and lack of reliable markets. It was noted that not much attention has been given to urban vegetable farmers, but from the study, formal and informal urban irrigated vegetable farming in the Greater Accra region have come to stay.

5.2 Policy Recommendations

In the face of the set objectives and the findings of this study the under listed recommendations are deemed relevant in addressing the issues in the study.

(1) There should be a bye-law that stipulates that before a piece of land is taken away from a cultivator, he/she should be given at least three months notice, depending on the vegetable under cultivation. In this regard in order to prevent conflict between cultivators and landowners, both parties should agree on the type of vegetable to be cultivated on the land. In this case cultivators should not use land without the prior notice of landowners.

(2) Apart from steps to increase output of urban farmers, the government should put protection mechanisms in place to protect the health and safety of both the urban farmer and the consumer especially vegetables from the informal irrigated farm types. Health officials should go round to check and advice cultivators on the type of water they could use.

(3) The management and operations of the two categories of farmers could device a resource allocation strategy on vegetable farm inputs such as land, labour, fertilizer and agrochemicals with the assistance of the relevant expertise. This approach could help reduce the excessive utilization of other resources.

(4) Government should encourage private landlords to rent land to urban farmers through incentives like tax relief. In addition, city farming must be incorporated in conventional land use in the study area.

(5) Legitimate recognition of the important role of vegetable farming as a rich source of nutritional food supplement and food supply, income, employment and environmental management must be provided to the farmers.

(6) Government needs to collaborate with farmers and research institutions to identify strategies to remove pollutants in waste water used for the informal irrigated vegetable farming.

5.3 Limitations of the Study

The study faced several difficulties. Firstly, most of the farmers do not keep farm management records. For such cases, too long a time was required to embark on thorough and comprehensive interviews to arrive at reliable data set most of which date back as far as 1999 and beyond. Secondly, technical efficiency is sensitive to the specification of the production function; hence, there is a caution as to the generalization of the results outside the scope of the study. Another constraint was that the sample size was small and might have affected the estimates of the parameters in the model.

REFERENCES

Amegashie D.P.K (1994) *A Re-appraisal of the Afife Irrigation Project* (An Unpublished MPhil Thesis), Department of Agricultural Economics, University of Ghana, Legon.

Arku S. Doe, Tetteh D. (1998) *Environmental Assessment of Urban Agriculture in Accra.* In Armar-Klemsu, M: Maxwell, D., ed. Urban Agriculture in the Greater Accra metropolitan Area. Final report.

Atkinson S.(1992) Food for the Cities: *Urban Nutrition Policy in Developing countries. Urban health Policy Unit.* Department of Public Health and Policy, London School of Hygiene and Tropical Medicine.

Bagi F.S. (1981) "Economics of Irrigation in Crop Production in Haryana.*''In Issues in Africa Rural Development* (2nd edition), Bret S.A, and 1994.Arlington, Virginia, Winroch International.

Bardach J. E. (1982) Food *and Energy, Problem of Third World Cities*. Paper Prepared for Conference on Urbanization and National Development. East West Center Honolulu, Hawaii.

Benneh G., Songsore J., Nabila J.S., Amuzu A.T., Tutu K.A., Yangyuoru, Y. and McGranahan G.(1993) *Environmental Problems and Urban Household in the Greater Accra Metropolitan Area (GAMA):* Ghana, Stockholme: Environmental Institute.

Binns, T. (1994) *Tropical Africa*. New York: Routledge.

Burgess, R., Carmona, M.and Kolstee, F (eds.) (1997) The Challenge of Sustainable Cities: *Neoliberation and Urban Strategies in Developing Countries*, London and New Jersey, Zed books.

Bravo-Ureta B.E.and Pinheiro A., (1993) Efficiency Analysis of Developing Country Agriculture: A Review of the Frontier Function Literature. *Agricultual Research Economics* Review 22.pp28-101.

Calvo G.A. (1975) 'Efficiency and Optimal Utilization of Capital Services'; *American Economics Review*. Vol.65.No1. March 1975 pp181-186.

Deelstra, T.J. (1987) Urban Agriculture and Metabolism of Cities. *Food and Nutrition Bulletin,* Vol9, No2 pp5-8, The United Nation University.

De Haas J., Gura S. (1996) Vegetable and Poverty*: A Contradiction or a Challenge.*

Agriculture and Rural Development, 3 (1), 44.

Dillon J., L., and Heady E., O (1999) *Agriculture Production Function.* Iowa State University Press, Ames. Iowa. pp97-98

Dittoh, S. (1991) Efficiency of Agricultural Production in Small and Medium Scale Irrigation in Nigeria: *Issues in African Rural Development*1991,ed.Doss, C.R. and Oslo, C. 152-74 Arlington,Virginia:Winrock International.

Drenchsel, P., Quansah, C., Penning, F.V. de. (1999) *Applied Research for Peri-Urban Area.* ISRAM Newsletter 44, pp 5-7.

Fodopulop K. (1997) Activities Urbaines: L'Informal Salit et Degrade. In: *Eco Vox Dossier, CIPCRE.Cameroun12*. pp2.

FAO-COAG (1999) The 'COAG Paper' Report of the COAG Secretariat to the COAG, FAO, Rome in: Jacobi, P., Drescher; A.W., Amend, J.2000.*Urban Agriculture-Justification and Planning Guidelines*: Urban vegetable promotion project .htt://cityfarmers.org/uajustification.html.

Freeman, Donald B (1991) A City of Farmers: *Informal Urban Agriculture in the Open Spaces of Nairobi*, Kenya. Montreal: McGill: Queen's University Press.

Economist (1998) cited in Drenchsel et al (1999). *Emerging Markets Indicators*: Population.Vol.346 (8059) 130. In Drenchsel, P. Quansah.C, Penning, F.V, de 1999:Urban and Peri-Urban Agriculture in the West Africa Characteristics, Challenges and Need for Action.

Galbraith J .K. (1956) The American Capitalism, Boston: *In American Economic Review*, George Borts H., (ed), and Vol IXX.

Ghana Statistical Service ,Ghana Statistical Household Survey (1999, 2000)

Gittinger J.P. (1982) *Economic Analysis of Agricultural Projects*. Second edition, The John Hopkins University Press, Baltimore and London, pp223.

Gura S. (1996) *Vegetable Production*: A Challenge for Urban and Rural Development. Agriculture and Rural Development

Hake, A. (1977) *African Metropolis*: Nairobi Self-Help City, St Martins Press, New York.

Hart, K. (1970) *Small-Scale Entrepreneurs*: In Ghana and Development Planning Studies 6(4): pp104-120

IDRC (1993) *Farming in City*: The Rise of Urban Agriculture. IDRC, Ottawa ON, Canada: IDRC Reports 21(3).

Kler .J, M. (1987) Small-Scale Agriculture Production in Urban Areas in Poland: *Food and Nutrition Bulletin. Vol.9* (2) 1987.The United Nation University.

Lee-Smith. and Memon P.A.(1994) "*Urban Agriculture in Kenya*". In: Mougeot (ed) City Feeding People.Ottawa:IDRC.

Maxwell, D. and Zziwa, S. (1992) *Urban Agriculture in Africa.* Nairobi Acts Maxwell, D. (1993) "Farming Logic in Kampala". In Luc Mougeot at al. (eds). *The Rise of Urban Agriculture. Reports Vol.2*1.No3.Ottawa:IDRC.

Maxwell D., Carol L. and Csete J. (1998) "Does Urban Agriculture help to present malnutrition" *Evidence of Kampala.FCND Discussion Paper* No 43,Washington: International Food Policy Research Institute.

Maxwell D.G. (1995) 'Alternative Food Security Strategy.' A Household Analysis of Urban Agriculture in Kampala. *World Development* Vol 23, No.10, pp1669-1691, Britain

Mokwunye A, U., De Jager A. and Smailing E. M.A., ed (1996) Restoring and Maintaining the Productivity of West African Soils: *Key to Sustain Development*: Miscellaneous Fertilizer Studies No 14.International Fertilizer Development Center of Africa, Lome, Togo

Midmore D.J. (1996) Sustainable and Ecologically Sound Vegetable in Peri-urban Farming. *Agriculture and Rural development*, 3(1), 50-52

Mougeot Luc (1993) Urban Food Self-Reliance Significance and Prospects: *In Farming in the City*: The Rise of Urban Agriculture Reports, Vol.21, No. 3,Ottawa: IDRC

Lee-Smith D., Mutsembi M, Davinder L., Garthuru K. (1987) *Food Production and the Cooking Fuel Situation in Urban. Kenya*.Naroibi.Mazinga Institute.

Mvena Z.S.K., I. J. Lupanga and M.R. Mlozi (1991) Urban *Agriculture in Tanzania*: A Study of Six Towns Morogiro; Tanzania: Sokoine.University of Agriculture.

Mwangi A. (1995) *The role of Urban Agriculture for Food Security in Old Income Areas in Nairobi*; Leiden: African Studies Center.

Nazario M. de L (1984) The *Unofficial Economy and the Crisis*: A Brazilian Debate: Ecodevelopment News, pp33-35.

Norton W. and Alwang J. (1993) Introduction *to Economics of Agricultural Development*.McGraw Hill.Inc.pp85-88.

Nugent Rachel (1976) *The Significance of Urban Agriculture*, Pacific Lutheran University Washington, USA.

Obosu-Mensah K. (1999) *Food Production in Urban Areas*: A study of Urban Agriculture in Accra, Ghana; Ashgate Publishing Limited, England

Ogden C. (1993) *Urban Malnutrition: Material Activities and Child Nutrition in Kigali*; I, Rwanda; Unpublished Ph.D. Dissertation, Cornel University.

Ogunfowora, O. (1974) "Farm Survey as a Data Base for Analysis Planning: Experience from Kwara State of Nigeria, *Rural Development Paper* No.14, Department of Agricultural Economics and Extension, University of Ibadan, Ibadan.

Olagoke M.A. (1991) "Efficiency of Resource Use in Rice Production System in Anambra State Nigeria": *Issues in African Rural Development* (2nd edition). pp319-342.

Onyenwaku C. E. (1994) The Economics of Irrigation in Crop Production in Nigeria: *Issues in African Rural Development* (2nd edition) pp129-138.

Phiri C., D. (1991) An American Evaluation of Smallholder System in Chingulewu Settlement Salience Malawi. *Issues on Africa Rural Development* (2nd edition). pp319-342.

Rabinovitch, J., and Schmetzer, H., (1997) cited in Drenchsel at al (1999) Urban Agriculture: Food, Job and Sustainable Cities. *Agriculture and Rural Agriculture Development*, 4(2), 44- 45. In: Drechsel.P, Quansah, C.

Rubinstein M. (1975) Security Market Efficiency in an Arrow-Debreu Economy. *American Economics Review* Vol.65, No.5 December 1995, pp812-823.

Sawio Camillus (1994) "Breaking New Grounds in Dar-es-Salam": In Farming in the City. *The Rise of Urban Agriculture Reports* vol.21, No.3. Ottawa: IDRC.

Sachal, Ignancy and Dana Silk (1987) Introduction: Urban Agriculture and Self-Reliance. *Food and Nutrition Bulletin* vol.9 No.2. The United Nations University.

Sanyal B. (1985) Urban Agriculture: Who Cultivates and Why? A Case Study of Lusaka, Zambia: *Food and Nutrition Bulletin*. Vol, 3, pp15-24.

Schilter, C (1991) Urban Agriculture, A Job Creating Activity in Subsistence Economies (The Case of Lome). *World Agricultural Economies and Rural Social Abstracts*.

Sen A. (1981) *Poverty and Famine:* An Essay on Entitlement and Deprivation, Oxford Clavendon Press.

Singh, Surjit (1994) Urban *Informal Sector*. New Delhi: Rawat Publications.

Smith, Nasr J., and Annu R. (1996) Urban *Agriculture*: A Neglected Resource for Food, Jobs and Sustainable Cities. New York: UNDP.

Snrech S. (1994) Pour *Preparer L'avenir de L'Afriqyue de L'ouest*. Une Vision a L'horizon 2020 OCDE/BAD/CILSS.

Songsore J., and McGranahan G. (1993) Environmental Wealth and Health: Towards an Analysis of Intra-Urban differentials Within the Greater Accra Metropolitan Area,, Ghana, *Environment and Urbanization* 5(2)10-34.

Sonou, M. (2000) *Peri- urban Irrigated Agriculture and Health Risks in Ghana*, pp33.

Stevenson, R. (1980) "Measuring Technological Bias" *American Economic Review*, Vol 70 No 1. pp 162-173, March 1980.

Streiffeler F. (1987) Improving Urban Agriculture in Africa: A Social Perspective: *Food and Nutrition V*ol.9, No2.The United Nation University.

The Economist (1998) Emerging Markets Indicators: *Population. Vol.*346 (8059): 130. In: Drenchsel P., Quansah C., Penning, F., V de, 1999: Urban and Peri-Urban Agriculture in West Africa: Characteristics, Challenges, and Needed Action.

Tindal D. (1978) Commercial *Vegetable Gardening*. Oxford University Press. Great Britain.

UN (1995). U.N's World Economic And Social survey.

UNDP (1993) Urban *Agriculture for Food Security, Jobs and Water Recovery*: Round Table Top Local Government Officials. Second International Colloquium of Mayors on Governance for Sustainable Growth and Equity, New York.

UNDP (1996) Urban Agriculture: Food, Job and Sustainable Cities. *United Nations Development Programme Publication. Series Habitat* (ii), Vol1, UNDP. New York. In Jacobi.P, Drechsel, H.W., Amend, J., 2000: Urban agriculture: Justification and planning guidelines: Urban vegetable promotion project.

UNICEF (1998) Reaching *Children and Women of the Urban Poor*. Occasional paper series No 3.New York: UNICEF.

UNDP (1994) *World Urbanization prospect,* (1994). New York

Von Braun J.M., McComb J., Mensah B.F. and Rajul Pan dja-Lorch (1993) *'Urban Food*

Insecurity and Malnutrition in Developing Countries: Trends, Policies and Research Implication 'Washington D.C: International Food Policy Research Institute.

Von Thune, J. H. (1986) Derisolietre Staat. In: De blij H.J and Muller P.O 1988:*Geography Regions and Concepts*. John Wiley and Sons. New York.

World Bank (1986) *Poverty and Hunger*; Issues and Options for Food security in Developing Countries, Washington: World Bank.

Wade, I. (1987) Community Food Production in Cities of Developing Nations. *Food and Nutrition Bulletin Vo*l.9 (2). The United Nation University.

World Resource Institute (1996) *World Resources: The Urban Environment*. New York and Oxford University Press.

World Bank (1986) *Accelerated Development in Sub-Saharan African*: An Agenda for Action (The Berg Report). Washington, DC,; World Bank.

Yawson Abeiku (1997) *The Contribution of Urban Farming to Household Income in the Greater Accra Metropolitan Area* (An Unpublished B.Sc. Dissertation,) Department of Agricultural Economics, University of Ghana Legon

Yeung , Yue-Man(1987). Examples of Urban Agriculture in Asia, *Food and Nutrition Bulletin* 9(2),14-23.

Yotopoulus P. A. and Nuggent T.B.(1976) *Development Economics* (Empirical Investigation) Harpers and Rows, Publishers.

Zakariah S, Lamptey, G., M., Maxwell, D.(1998) 'Urban Agriculture in Accra Description Analysis.' In Armar-Klemeson and Maxwell *Urban Agriculture in the Greater Accra Metropolitan Area*. Report to IDRC.Legon: NMIMR.

APPENDIX I

QUESTIONNAIRE

(PERSONAL INTERVIEW GUIDE)

Questionnaire on a comparative study of formal and informal irrigated urban vegetable production in the Greater the Accra region

SECTION A: INTRODUCTION

Serial number of farmer............................

Date of interview.....................................

Name of farmer (optional)..........................

Location /Town /Village............................

What type of irrigation do you employ? Formal ☐ Informal ☐

SECTION B: DEMOGRAPHIC CHARACTERISTICS

1.Age:

Below 20 years = 1

21- 30 years = 2

31- 40 years = 3 ☐

41- 50years = 4

Above 50 years = 5

2.Gender: Male ☐ female ☐

3.Level of education:

Primary /JSS = 1

Secondary /SSS = 2 ☐

Post-secondary = 3

Tertiary = 4

No education = 5

Non-formal education = 6

Others (specify) = 7

5. Marital status:

Single = 1

Married = 2

Divorced = 3

Separated = 4

Widowed = 5

6. What is your social status in the community?

Leader =1

Landlord =2

Tenant =3

Ordinary =4

Other (specify) =5

7. Religion:

Christian =1

Moslem =2

Traditional =3

No religion =4

Other, specify =5

8.Household composition and education.

Age group	Gender Male female	Number in school	Number completed
Under 15			
15-50			
Above 50			

SECTION C: FARMING ACTIVITIES

9.How many years have you been in vegetable farming?....................years

10.Please indicate the farm size (area)? ....Acres

11.How many beds/acres do you raise for production of the vegetables?.................

12.What is the value of your crop and crop by-product in Cedi per bed?...............

13.What is the cost of fertilizer / manure per bed? ....

14.How much Cedis do you spend on irrigation water on the farm?..............

15.What much is the flow of capital services from agricultural machinery, equipment, implements and tools?..................................

16.In your perception, rate the effectiveness of the sources of labour. Please circle your rating against each source.

Perception of effectiveness					
Sources of labour	Very Effective	Effective	Moderate	Less Effective	Least Effective
Family	5	4	3	2	1
Hired	5	4	3	2	1
Communal	5	4	3	2	1
Caretaker	5	4	3	2	1

17.what is (are) your source(s) of finance?

1=Own savings ☐ 2= Family ☐ 3= Bank loan ☐

4= market mummy ☐ 5= other, specify…………….

18.Have you received any financial assistance from any financial institution?

Yes ☐ No ☐

19.Remittances received during the 2001 planting year?………………..

20. What is your income from non-farm self –employment (if any)………………

21.The table below lists the crop with their costs associated for the activities in the production processes per bed.

Activity /crops	Tomato	Onion	Pepper	Garden eggs	Okra	Carrot	Maize	Leafy Vegetables
Land preparation								
Planting								
Harvesting								
Others								
Total								

22. The table below provides the list of vegetables (crops) and the revenues associated per acre over the growing season

Crops	Tomato	Onion	Pepper	Garden eggs	Okra	Carrot	Maize	Leafy Vegetables	Others
Revenues									

APPENDIX II

Estimates of Household Income of Formal Irrigated Urban Vegetable in the study Area

Farmer	Estimated Annual Household Income (I_{HH}) (Millions of ¢)	Estimated Income from formal Irrigated urban Vegetable in (Millions of ¢)	% Contribution to Vegetable Household Income
1	1.35	1.15	85.50
2	1.05	0.99	94.38
3	0.82	0.74	90.66
4	1.70	1.41	82.92
5	1.60	0.78	78.61
7	0.78	0.75	95.83
8	1.50	1.23	82.28
9	1.20	1.00	83.68
10	1.64	1.10	66.34
11	1.60	1.24	78.98
12	2.90	2.36	94.34
13	2.10	1.19	86.62
14	1.59	1.23	64.01
15	1.66	1.25	61.69
16	0.98	0.40	95.31
17	1.70	1.70	80.61
21	1.98	1.05	52.83
22	1.00	0.80	80.09
23	1.09	0.92	84.63
24	1.24	0.93	75.34
25	1.30	0.90	69.35
27	2.00	1.31	65.49
28	1.27	0.95	74.62
29	2.33	1.99	85.44
30	2.04	1.90	93.02
31	2.48	1.97	79.62
32	3.00	2.63	87.68
33	2.35	1.77	75.39
34	3.10	2.65	85.49
35	1.97	1.65	83.98
36	2.21	1.92	87.05
37	3.48	2.19	63.00
38	1.51	1.22	81.16
39	1.22	0.84	68.85

40	1.79	1.33	74.31
41	1.68	1.19	71.12
42	1.83	1.12	61.25
43	3.13	2.89	92.49
44	1.81	1.40	77.23
45	1.66	1.19	71.64
46	1.38	0.99	71.99
47	1.60	1.01	63.06
48	1.56	1.02	65.23
49	2.80	1.22	43.50
50	2.00	1.72	85.98
51	1.45	0.95	65.45
52	1.65	1.10	66.67
53	1.52	1.10	72.99
54	2.06	1.25	60.80
55	1.74	1.09	62.72
56	1.04	0.86	82.57
57	1.76	1.02	57.95
58	1.64	1.29	78.78
59	1.70	1.09	64.03
60	1.36	0.88	64.83
Total	110.58	81.03	
Mean	3.63	1.35	74.85

Source: Author's computation from the field

APPENDIX III1

Estimates of Household Income of Informal Irrigated Urban Vegetable in the Study Area

Farmer	Estimated Annual Household income (I_{HH}) (Millions of ¢)	Estimated income from informal irrigated urban vegetable in (Millions of ¢)	% Contribution to Household Income
1	1.73	1.15	66.72
2	1.46	0.99	68.11
3	1.34	0.74	55.61
4	2.44	1.41	57.77
5	1.70	1.15	67.53
6	1.54	0.78	50.38
7	1.25	0.75	59.80
8	1.81	1.23	68.19
9	1.53	1.00	65.76
10	1.64	1.09	66.34
11	2.84	1.26	44.48
12	3.40	2.74	80.47
13	2.91	1.82	62.51
14	1.66	1.02	61.68
15	1.84	1.02	55.68
16	1.53	0.93	61.08
17	1.45	0.99	68.82
18	0.76	0.44	57.89
19	1.78	1.08	60.74
20	2.43	1.37	56.42
21	1.50	1.05	69.94
22	1.20	0.81	66.75
23	1.30	0.92	71.01
24	1.60	0.93	58.57
25	1.65	1.00	60.69
26	1.31	0.90	68.82
27	1.98	1.31	66.15
28	1.72	0.95	55.11
29	2.73	1.99	72.93
30	2.50	1.90	75.78
31	2.60	1.97	75.94
32	2.90	2.63	90.70
33	2.54	1.77	69.75
34	3.63	2.65	73.01

35	2.00	1.65	82.56
36	2.57	1.92	74.84
37	2.94	2.19	74.58
38	1.98	1.22	61.81
39	1.22	0.84	68.85
40	1.79	1.33	74.31
41	1.79	1.19	66.71
42	1.83	1.12	61.25
43	3.62	2.89	79.77
44	1.61	1.40	86.83
45	1.56	1.19	76.27
46	1.38	0.99	71.99
47	1.42	1.01	71.09
48	1.66	1.02	61.45
49	1.90	1.22	64.10
50	2.20	1.72	78.17
51	1.50	0.94	63.26
52	1.97	1.10	55.91
53	1.62	1.12	68.48
54	1.76	1.25	71.16
55	1.74	1.09	62.72
56	1.40	0.87	61.34
57	1.67	1.02	61.08
58	1.64	1.29	78.82
59	1.70	1.09	64.07
60	1.35	0.88	65.63
Total	113.99	77.32	
Mean	1.90	1.29	66.97

Source: Author's computation from the field

APPENDIX IV

Input Data for Regression Analysis (Formal Irrigation)

CVOUTPUT	CVLAND	CVLABOUR	CVFERT	CVIRRGAT	CVAGRCHEM	CVMISC
378550.00	208100.00	65100.00	400.00	79200.00	8750.00	17000.00
117050.00	20000.00	27600.00	650.00	52800.00	6000.00	10000.00
101552.00	10000.00	26400.00	352.00	52800.00	4000.00	8000.00
194250.00	50000.00	14280.00	670.00	52800.00	21500.00	55000.00
153530.00	50000.00	14280.00	450.00	52800.00	26000.00	10000.00
105550.00	10000.00	16800.00	450.00	52800.00	16500.00	9000.00
115770.67	16666.67	28000.00	354.00	52800.00	1950.00	16000.00
197630.67	66666.67	45600.00	564.00	52800.00	26000.00	6000.00
154751.33	33333.33	6720.00	398.00	96800.00	5500.00	12000.00
182518.66	83333.33	12000.00	352.00	61133.33	8700.00	17000.00
155930.00	25000.00	35700.00	430.00	79200.00	5600.00	10000.00
131971.43	28571.43	27428.57	571.43	52800.00	5600.00	17000.00
257700.00	50000.00	16000.00	200.00	52800.00	8700.00	130000.00
134400.00	20000.00	19200.00	400.00	52800.00	27000.00	15000.00
121700.00	20000.00	28000.00	400.00	52800.00	5600.00	14900.00
489110.00	400000.00	17280.00	430.00	52800.00	5600.00	13000.00
138420.00	40000.00	19600.00	320.00	52800.00	8700.00	17000.00
723970.00	500000.00	46050.00	520.00	79200.00	85000.00	13200.00
186099.67	66666.67	36000.00	33.00	52800.00	13600.00	17000.00
157494.99	33333.33	26483.33	345.00	53133.33	28200.00	16000.00
134660.00	20000.00	14580.00	280.00	52800.00	27000.00	20000.00
95103.00	10000.00	14160.00	543.00	52800.00	9500.00	8100.00
123233.33	16666.67	31150.00	333.33	53083.33	15000.00	7000.00
145250.00	40000.00	29120.00	530.00	52800.00	13200.00	9600.00
99840.00	10000.00	16100.00	540.00	52800.00	13200.00	7200.00
116240.00	20000.00	16560.00	280.00	52800.00	20000.00	6600.00
205691.67	66666.67	57333.33	325.00	52666.67	17000.00	11700.00
125307.00	20000.00	35520.00	587.00	52800.00	8000.00	8400.00
286843.00	75000.00	39600.00	543.00	79200.00	86500.00	6000.00
239303.00	24000.00	14720.00	243.00	53840.00	86500.00	60000.00
230453.00	60000.00	23200.00	453.00	52800.00	34000.00	60000.00
438812.00	300003.00	18640.00	479.00	52800.00	6890.00	60000.00
255696.00	60000.00	28440.00	456.00	52800.00	54000.00	60000.00
387965.00	150000.00	53000.00	465.00	79200.00	42800.00	62500.00
185731.67	16666.67	32000.00	365.00	52800.00	23900.00	60000.00
232647.00	25000.00	62500.00	547.00	79200.00	5400.00	60000.00
237162.00	4000.00	33920.00	342.00	52800.00	86500.00	59600.00
167964.00	4000.00	33600.00	564.00	52800.00	17000.00	60000.00
101107.00	2000.00	19040.00	267.00	52800.00	17000.00	10000.00
173553.00	8000.00	42400.00	453.00	43200.00	17000.00	62500.00

139442.00	10000.00	22300.00	342.00	52800.00	20000.00	34000.00
152000.00	40000.00	9800.00	400.00	52800.00	15000.00	34000.00
115165.66	40000.00	465.66	400.00	52800.00	4500.00	17000.00
229812.50	100000.00	1069.50	543.00	79200.00	15000.00	34000.00
149672.86	40000.00	472.86	400.00	52800.00	22000.00	34000.00
119918.25	10000.00	418.25	200.00	52800.00	22000.00	34500.00
125067.00	20000.00	19520.00	547.00	52800.00	22000.00	10200.00
126680.00	20000.00	13280.00	400.00	52800.00	22000.00	18200.00
169490.00	40000.00	31360.00	630.00	52800.00	22000.00	22700.00
214560.00	100000.00	31360.00	400.00	52800.00	22000.00	8000.00
114660.00	10000.00	16960.00	200.00	52800.00	22000.00	12700.00
138987.00	20000.00	31360.00	327.00	52800.00	22000.00	12500.00
140220.00	10000.00	11520.00	400.00	52800.00	22000.00	43500.00
116220.00	10000.00	19520.00	200.00	52800.00	11000.00	22700.00
234166.00	100000.00	36600.00	566.00	52800.00	16000.00	28200.00
202450.00	100000.00	26250.00	400.00	52800.00	6000.00	17000.00
127125.00	3000.00	13125.00	200.00	52800.00	24000.00	34000.00
172400.00	40000.00	36000.00	400.00	52800.00	20000.00	23200.00
144350.00	20000.00	12750.00	200.00	52800.00	10000.00	48600.00
105900.00	10000.00	19500.00	600.00	52800.00	22000.00	1000.00

Source: Author's computation from field

APPENDIX V

Input data for Regression Analysis (Informal Irrigation)

CVOUTPUT	CVLAND	CVLABOUR	CVFERT	CVIRRIGAT	CVAGCHEM	CVMISC
180450.00	10000.00	65100.00	400.00	79200.00	8750.00	17000.00
117050.00	20000.00	27600.00	650.00	52800.00	6000.00	10000.00
101552.00	10000.00	26400.00	352.00	52800.00	4000.00	8000.00
194250.00	50000.00	14280.00	670.00	52800.00	21500.00	55000.00
153530.00	50000.00	14280.00	450.00	52800.00	26000.00	10000.00
105550.00	10000.00	16800.00	450.00	52800.00	16500.00	9000.00
115770.67	16666.67	28000.00	354.00	52800.00	1950.00	16000.00
197630.67	66666.67	45600.00	564.00	52800.00	26000.00	6000.00
154751.33	33333.33	6720.00	398.00	96800.00	5500.00	12000.00
182518.67	83333.33	12000.00	352.00	61133.33	8700.00	17000.00
155930.00	25000.00	35700.00	430.00	79200.00	5600.00	10000.00
131971.43	28571.43	27428.57	571.43	52800.00	5600.00	17000.00
257700.00	50000.00	16000.00	200.00	52800.00	8700.00	130000.00
134400.00	20000.00	19200.00	400.00	52800.00	27000.00	15000.00
121700.00	20000.00	28000.00	400.00	52800.00	5600.00	14900.00
489110.00	400000.00	17280.00	430.00	52800.00	5600.00	13000.00
138420.00	40000.00	19600.00	320.00	52800.00	8700.00	17000.00
723970.00	500000.00	46050.00	520.00	79200.00	85000.00	13200.00
186099.67	66666.67	36000.00	33.00	52800.00	13600.00	17000.00
157495.00	33333.33	26483.33	345.00	53133.33	28200.00	16000.00
134660.00	20000.00	14580.00	280.00	52800.00	27000.00	20000.00
95103.00	10000.00	14160.00	543.00	52800.00	9500.00	8100.00
123233.33	16666.67	31150.00	333.33	53083.33	15000.00	7000.00
145250.00	40000.00	29120.00	530.00	52800.00	13200.00	9600.00
99840.00	10000.00	16100.00	540.00	52800.00	13200.00	7200.00
116240.00	20000.00	16560.00	280.00	52800.00	20000.00	6600.00
205691.67	66666.67	57333.33	325.00	52666.67	17000.00	11700.00
125307.00	20000.00	35520.00	587.00	52800.00	8000.00	8400.00
286843.00	75000.00	39600.00	543.00	79200.00	86500.00	6000.00
239303.00	24000.00	14720.00	243.00	53840.00	86500.00	60000.00
230453.00	60000.00	23200.00	453.00	52800.00	34000.00	60000.00
438812.00	300003.00	18640.00	479.00	52800.00	6890.00	60000.00
255696.00	60000.00	28440.00	456.00	52800.00	54000.00	60000.00
387965.00	150000.00	53000.00	465.00	79200.00	42800.00	62500.00
185731.67	16666.67	32000.00	365.00	52800.00	23900.00	60000.00
232647.00	25000.00	62500.00	547.00	79200.00	5400.00	60000.00
237162.00	4000.00	33920.00	342.00	52800.00	86500.00	59600.00
167964.00	4000.00	33600.00	564.00	52800.00	17000.00	60000.00
101107.00	2000.00	19040.00	267.00	52800.00	17000.00	10000.00

173553.00	8000.00	42400.00	453.00	43200.00	17000.00	62500.00
139442.00	10000.00	22300.00	342.00	52800.00	20000.00	34000.00
152000.00	40000.00	9800.00	400.00	52800.00	15000.00	34000.00
115165.66	40000.00	465.66	400.00	52800.00	4500.00	17000.00
229812.50	100000.00	1069.50	543.00	79200.00	15000.00	34000.00
149672.86	40000.00	472.86	400.00	52800.00	22000.00	34000.00
119918.25	10000.00	418.25	200.00	52800.00	22000.00	34500.00
125067.00	20000.00	19520.00	547.00	52800.00	22000.00	10200.00
126680.00	20000.00	13280.00	400.00	52800.00	22000.00	18200.00
169490.00	40000.00	31360.00	630.00	52800.00	22000.00	22700.00
214560.00	100000.00	31360.00	400.00	52800.00	22000.00	8000.00
114660.00	10000.00	16960.00	200.00	52800.00	22000.00	12700.00
138987.00	20000.00	31360.00	327.00	52800.00	22000.00	12500.00
140220.00	10000.00	11520.00	400.00	52800.00	22000.00	43500.00
116220.00	10000.00	19520.00	200.00	52800.00	11000.00	22700.00
234166.00	100000.00	36600.00	566.00	52800.00	16000.00	28200.00
202450.00	100000.00	26250.00	400.00	52800.00	6000.00	17000.00
127125.00	3000.00	13125.00	200.00	52800.00	24000.00	34000.00
172400.00	40000.00	36000.00	400.00	52800.00	20000.00	23200.00
144350.00	20000.00	12750.00	200.00	52800.00	10000.00	48600.00
105900.00	10000.00	19500.00	600.00	52800.00	22000.00	1000.00

Source: Author's computation from field

APPENDIX VI

Regression Results

Results from Linear Regression of Formal Irrigated Urban Vegetable Production
Dependent Variable: CVOUTPUT
Method: Least Squares
Date: 06/03/02 Time: 11:51
Sample (adjusted): 1 60
Included observations: 60 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CVLAND	0.972533	0.031950	6.743948	0.0000
CVLABOUR	1.921110	0.236370	5.491870	0.0000
CVFERT	78.593840	14.07307	0.584424	0.6985
CVIRRIGAT	1.346481	0.401258	3.355645	0.0015
CVAGRCHEM	3.495866	0.091825	11.93424	0.0000
CVMISC	1.795862	0.112407	0.88413	0.0000
CONSTANT	337615.00	29471.58	2.700337	0.4868

R-squared	0.967910	Mean dependent var	337615.0
Adjusted R-squared	0.964277	S.D. dependent var	156997.0
S.E. of regression	296723.34	Akaike info criterion	23.54317
Sum squared resid	4.67E+10	Schwarz criterion	23.78751
Log likelihood	-699.2950	F-statistic	266.4316
Durbin-Watson stat	2.177657	Prob (F-statistic)	0.000000

Results from Linear Regression of Informal Irrigated Urban Vegetable Production
Dependent Variable: CVOUTPUT
Method: Least Squares
Date: 06/03/02 Time: 10:50
Sample: 1 60
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CVLAND	0.893065	0.207380	0.430641	0.0001
CVLABOUR	1.288227	1.261751	1.020983	0.3119
CVFERT	17.361828	135.2698	2.358196	0.5636
CVIRRIGAT	-2.401231	1.804140	-1.330956	0.1889
CVAGROCHEM	1.034818	0.908219	3.836870	0.0003
CVMISC	1.343206	0.745926	2.399173	0.0200
CONSTANT	60946.33	109377.1	2.669482	0.0101

R-squared	0.520049	Mean dependent var	390681.6
Adjusted R-squared	0.465715	S.D. dependent var	179339.2

S.E. of regression	131087.6	Akaike info criterion	26.51440
Sum squared resid	9.11E+11	Schwarz criterion	26.75874
Log likelihood	-788.4320	F-statistic	9.571341
Durbin-Watson stat	1.872091	Prob (F-statistic)	0.000000

Results from Semi-Log Regression of Formal Irrigated Urban Vegetable Production
Dependent Variable: LGCVOUTPUT
Method: Least Squares
Date: 06/03/02 Time: 15:03
Sample (adjusted): 1 60
Included observations: 60 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CVLAND	8.59E-07	5.55E-08	15.48363	0.0000
CVLABOUR	1.43E-06	4.10E-07	3.496819	0.0010
CVFERT	1.54E-05	2.44E-05	0.630875	0.5308
CVIRRIGAT	1.51E-06	6.96E-07	2.173170	0.0343
CVAGRCHEM	1.11E-06	1.59E-07	6.951288	0.0000
CVMISCEL	1.86E-06	1.95E-07	9.525190	0.0000
CONSTANT	5.140053	0.051152	100.4849	0.0000

R-squared	0.906729	Mean dependent var	5.495176
Adjusted R-squared	0.896170	S.D. dependent var	0.159834
S.E. of regression	0.051503	Akaike info criterion	-2.985085
Sum squared resid	0.140584	Schwarz criterion	-2.740745
Log likelihood	96.55256	F-statistic	85.87321
Durbin-Watson stat	1.867683	Prob (F-statistic)	0.000000

Results from Semi-Log Regression of Informal Irrigated Urban Vegetable Production
Dependent Variable: LGCVOUPT
Method: Least Squares
Date: 06/03/02 Time: 11:35
Sample: 1 60
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CVLAND	3.87E-08	3.14E-07	0.123226	0.9024
CVLABOUR	3.81E-06	1.91E-06	1.997461	0.0509
CVFERT	0.000378	0.000205	1.848201	0.0702
CVIRRIGAT	-1.22E-06	2.73E-06	-0.448623	0.6555
CVAGCHEM	2.85E-06	1.37E-06	2.074872	0.0429
CVMISCEL	1.01E-06	1.13E-06	0.893127	0.3758
CONSTANT	6.014771	0.165503	36.34235	0.0000

R-squared	0.241140	Mean dependent var	6.285983

Adjusted R-squared	0.155232	S.D. dependent var	0.215811
S.E. of regression	0.198354	Akaike info criterion	-0.288244
Sum squared resid	2.085252	Schwarz criterion	-0.043904
Log likelihood	15.64733	F-statistic	2.806940
Durbin-Watson stat	1.693885	Prob (F-statistic)	0.019068

Results from Double Log from Informal Irrigated Urban Vegetable Production
Dependent Variable: LGCVOUPT
Method: Least Squares
Date: 06/03/02 Time: 11:42
Sample: 1 60
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGCVLAND	-0.007699	0.053829	-0.143021	0.8868
LGCVLABOUR	0.175627	0.054273	3.236002	0.0021
LGCVFERT	0.310683	0.128668	2.414601	0.0192
LGCVIRRGAT	0.139259	0.388901	0.358082	0.7217
LGCVAGRCHEM	0.119660	0.072393	1.652906	0.1043
LGCVMISC	0.113782	0.067897	1.675816	0.0997
CONSTANT	3.118896	1.844983	1.690474	0.0968

R-squared	0.310859	Mean dependent var	6.285983
Adjusted R-squared	0.232843	S.D. dependent var	0.215811
S.E. of regression	0.189023	Akaike info criterion	-0.384616
Sum squared resid	1.893674	Schwarz criterion	-0.140275
Log likelihood	18.53847	F-statistic	3.984559
Durbin-Watson stat	1.865329	Prob (F-statistic)	0.002307

Results from Double Log from Informal Irrigated Urban Vegetable Production
Dependent Variable: LGCVOUTPUT
Method: Least Squares
Date: 06/03/02 Time: 12:11
Sample (adjusted): 1 60
Included observations: 60 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGCVLAND	0.230103	0.023779	9.676705	0.0000
LGCVLABOUR	0.043245	0.023049	1.876225	0.0661

LGCVFERT	0.067161	0.054113	1.241131	0.2200
LGCVIRRGAT	0.416569	0.194859	2.137794	0.0372
LGCVAGRCHEM	0.144822	0.030619	4.729784	0.0000
LGCVMISC	0.187752	0.028507	6.586147	0.0000
CONSTANT	0.542577	0.958499	0.566070	0.5737

R-squared	0.777077	Mean dependent var	5.495176
Adjusted R-squared	0.751840	S.D. dependent var	0.159834
S.E. of regression	0.079622	Akaike info criterion	-2.113762
Sum squared resid	0.336006	Schwarz criterion	-1.869422
Log likelihood	70.41286	F-statistic	30.79165
Durbin-Watson stat	2.010094	Prob (F-statistic)	0.000000