# Irrigated Urban Vegetable Production in Ghana

## Characteristics, Benefits and Risks

**Emmanuel Obuobie**

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**Pay Drechsel**

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**IWMI - RUAF - CPWF**

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**The authors:**

IWMI's research group on urban and peri-urban agriculture started operations in Ghana in 1999[1] under the coordination of Dr. Pay Drechsel. Pay has over 20 years of professional experience in natural resources management and has been living in Ghana for the past eight years. He is an expert in urban agriculture in Africa, a board member of the 'RUAF Foundation' and in the steering committee of the CGIAR initiative 'Urban Harvest'. Since 2005, Pay has been heading IWMI's new global research theme on "Agriculture, Water and Cities". He works closely with Dr. Liqa Raschid-Sally who has more than 25 years of professional experience in wastewater management in agriculture with special focus on Asia and Africa, and Dr. Olufunke Cofie, who is the coordinator of the Network of Resource Centres on Urban Agriculture and Food Security (RUAF) in Anglophone West Africa. The three are supported by a number of staff including Philip Amoah, George Danso, Bernard Keraita and Emmanuel Obuobie, who started their scientific careers as MSc students in IWMI's projects on urban and peri-urban agriculture in Ghana. Today, they are Ph.D. students having affiliations with universities in Ghana, Canada, Denmark and Germany, respectively. George is an Agricultural Economist, Philip studied Environmental Science/Microbiology, and Ben and Emmanuel graduated as Irrigation and Water Engineers. All authors are IWMI staff based in IWMI's Office for Africa in Ghana. The team has over 40 publications on urban and peri-urban agriculture to its credit.

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[1] This was still under IBSRAM (International Board for Soil Research and Management), which became part of IWMI in 2001.

# CONTENTS

# Foreword

Exotic vegetables, like lettuce, are not part of the traditional Ghanaian diet. However, more than 200,000 urban dwellers eat them daily on Accra's streets, and in canteens and restaurants. About 90% of the perishable vegetables are produced in closest market proximity due to their fragile nature and the common lack of cold transport and storage. These vegetables are a preferred cash crop, which can lift poor farmers out of poverty. On the other hand, farmers have huge problems finding in and around the cities unpolluted water sources for irrigation. This dilemma is directly linked to uncontrolled urbanization and poor sanitation. Ghana is in this regard a representative example for sub-Saharan Africa.

Over the last five years, IWMI's research in Ghana has had a major thrust in **urban and peri-urban agriculture** in general and irrigated (open-space) vegetable farming in particular. This book summarizes results from a large number of students' theses and research reports. It gives a comprehensive overview of urban and peri-urban vegetable farming in Ghana's major cities, and highlights besides economic impacts, consequences and perceptions related to the use of wastewater. The book ends with recommendations on how in a low-income country like Ghana health risks for consumers could be effectively reduced, while simultaneously supporting the important contribution of open-space urban and peri-urban agriculture. The book will certainly serve students, the academia and policy makers as an invaluable resource.

Akiça Bahri
Director for Africa
IWMI

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Pay Drechsel

May 2006

IWMI: International Water Management Institute: **www.iwmi.org**

RUAF: Resource Centres on Urban Agriculture and Food Security: **www.ruaf.org**

IDRC: International Development Research Centre: **www.idrc.ca**

CPWF: Challenge Program on Water & Food: **www.waterandfood.org**

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# 1. Introduction

*This chapter informs about urbanization in Africa in general and Ghana in particular, the general role of urban agriculture and the common use of polluted irrigation water. It describes our focus on irrigated smallholder vegetable production and our understanding of the terms "urban" vs. "peri-urban" and "wastewater". It also gives an overview on the chapter of the book, the origin of the data and the objective of this publication.*

## 1.1 The urbanization challenge

The world has entered the 'urban millenium' as Kofi Annan, UN Secretary General, stated. Taking Africa as an example, its population will almost triple by 2050 and this will be primarily in the urban and peri-urban areas. The projection is that by 2015 there would be 25 countries in sub-Saharan Africa with higher urban than rural populations; by 2030 this would be already 41 countries (UN-Habitat, 2001). Already today, about 44% of the population in the West African subregion lives in urban areas (UN Population Division, 2004), compared to only 4% in 1920. The same 44% applies to Ghana, and this number will rise rapidly as some of Ghana's (peri)urban areas have annual growth rates of more than 6 to 9% (Ghana Statistical Service, 2002; see Chapter 2). One cause for the increasing urban population is the influx of migrants from rural areas in search of better livelihoods. The migrant influx into the city resulted in shanty suburbs and slums, mostly in the center of the city.

## 1.2 Urban and peri-urban agriculture

Central to the urbanization phenomena are quantitative and qualitative changes in urban food demand. These changes challenge food production, rural-urban linkages, transport and traditional market chains. Specialized urban and peri-urban farming systems appear, like large-scale poultry production or urban and peri-urban agriculture.

Urban and peri-urban agriculture can be broadly defined as the production, processing and distribution of foodstuff from crop and animal production, fish, ornamentals and flowers within and around urban areas (cf. Mougeot, 2000). Although the terms "urban agriculture" and "peri-urban agriculture" are often used synonymously, we will use these terms as appropriate as possible. A major question for quantitative studies is where the peri-urban area ends and the rural hinterland begins (Brook and Davila, 2000; Simon et al., 2006). In our context we will refer with "**urban**" to the administrative city boundary while "**peri-urban**" is used for lands outside the immediate perimeter of the city but within a radius of up to 40-km of the city center (see Chapter 2).

In Ghana, *urban* crop farming comprises of two forms: (i) open-space production for the urban market, and (ii) backyard gardens cultivated mostly, but not only, for home consumption (Table 1.1).

**Table 1.1:** The two major categories of urban and peri-urban crop farming in Ghana.

| Farming systems | Urban areas | Peri-urban areas |
|---|---|---|
| **1. Market production** (cultivation on undeveloped urban land) | Irrigated vegetables (year-round or seasonal), flowers and ornamentals; rain-fed cereals | Irrigated vegetables (mostly seasonal), fruits; rain-fed cereals |
| **2. Subsistence production** (cultivation at the house) | Backyard or front yard farming | Home gardens; farming around homestead |

Source: Drechsel et al. (2006a; simplified).

In this book, we will focus on the first category, i.e. **smallholder vegetable production for city markets** with more emphasis on urban than peri-urban areas. These farming systems are usually found in lowlands or along streams, which are unsuitable or forbidden for construction purposes, but favourable for seasonal or year-round irrigation.[1]

The United Nations Development Programme estimated in 1996 that about 800 million people are actively engaged in urban agriculture worldwide and 200 million are considered to be market producers (UNDP, 1996). Market gardening focuses in many regions on easily perishable crops with short shelf life, which complements rural food production where cold transport to the cities and cold-storage facilities are not available. In Ghana, urban vegetable farming dates back to the arrival of Europeans. It is likely that the vegetables were grown in the gardens created around the castles and forts along Ghana's Gold Coast from the 16$^{th}$ century onwards (Anyane, 1963). Today, nearly all perishable vegetables consumed in Ghana's cities are also produced in their urban and peri-urban areas (see Chapter 4). The same applies to Dakar, Bamako, Dar es Salaam, and other cities, where depending on crop and season, between 60 and 100 % of the consumed leafy vegetables are produced within or close

[1] For a general baseline study of vegetable production in Ghana see Nurah (1999).

to the respective cities[2] mostly on irrigated open spaces (Mbaye and Moustier, 2000; Drechsel et al., 2006b; Smith, 2002). This indicates that urban agriculture could be an important means of attaining a balanced local food supply. Apart from increasing food security through a direct supplement of households' food, urban agriculture in developing countries can also increase employment and income, which in turn, will enable people to purchase food to improve their diet or increase their general food security.

## 1.3 Sanitation, water quality and irrigation

Other than increase in urban food demands, the upsurge of urban populations has far outpaced urban sanitation infrastructure. This does not only apply to Ghana. About 2.4 billion people in the developing world lack access to basic sanitation and about two-thirds of the population in developing world have no hygienic means of disposing of excreta with even a greater number lacking adequate means of disposing of wastewater (UNDP, 2002; Niemczynowicz, 1996). Basically, 85% of wastewater generated from urban centers worldwide ends up in the environment in its untreated form. Also in Ghana only a minor share of the wastewater is treated and less than 5% of the population has sewerage connections. Most domestic grey water passes through storm water rains into streams and/or the ocean (Chapter 6). Urban and peri-urban smallholders in search of irrigation water hardly find any unpolluted surface water or end up using water from drains. Thus the discussion of irrigated urban and peri-urban agriculture in Ghana is also a discussion of wastewater use and food safety. In the context of this book we refer to the term "wastewater" as the continuum from **raw wastewater** to domestic wastewater in drains [seasonally diluted by surface run-off after rains], partially treated wastewater or **polluted stream water**. All these forms are used in urban vegetable production, and the last one is most common in peri-urban Ghana (Chapter 7). Keraita (unpublished) estimated for Ghana an area of about 3,300 ha irrigated with "wastewater" as defined above, mainly during the dry seasons. This is an equivalent of about 60% of the total area currently under formal irrigation (schemes) in the country.

Wastewater use in agriculture is not new, and with the general global increase in water scarcity, it is seen as a key component of Integrated Water Resource Management (IWRM) supporting water savings for domestic purposes. However, the use of (raw or diluted) wastewater in its untreated form could have negative impact on public health and the environment. In Ghana, like throughout the subregion, the major health concern has

[2] Some data, like "90% of 'all' vegetables" (Accra, CENCOSAD), are persistently cited although they are wrong. High percentages only apply to certain leafy vegetables.

specifically been with **microbiological pathogens from domestic sources** (Drechsel et al., 2006a; Chapter 9). The flow of industrial effluents into urban and per-urban streams is relatively seldom as most industries are along the ocean. Thus water pollution from heavy metals does in most cases not exceed common irrigation standards (Cornish et al., 1999; Keraita and Drechsel, 2004). Possible exceptions in Ghana are streams passing gold mining areas.

It is in this context of low irrigation water quality that we studied urban and peri-urban vegetable production. Topics included its general importance, farm practices, economics and externalities, gender, wastewater use, produce quality, stakeholder perceptions, etc. as reflected in the Table of Contents.

## 1.4 Objective and overview of the book

The purpose of the book is to summarize different studies initiated and supported by IWMI in Ghana over the last five years on urban and peri-urban agriculture in general, and irrigated urban and peri-urban vegetable production in particular. About 10 university departments representing various disciplines contributed to this product by involving about 40 BSc, MSc and PhD students from Ghana and abroad. The book complements as Ghana country case study the related West Africa overview provided by Drechsel et al. (2006a).

The book starts by giving a short description of the main farming sites and characteristics of urban farmers involved in wastewater irrigation in Ghana’s major cities. A special focus has been placed on gender issues in Chapter 3 while Chapter 4 and 5 describe financial, economic and marketing aspects. This is followed by a detailed description of the urban wastewater management and sanitation situation in Ghana, water quality used in farming and the quality of vegetables found in Ghanaian markets (Chapters 6 to 9). Chapter 10 focuses on stakeholders’ perceptions of urban agriculture and wastewater use. Institutional and legal aspects are discussed in Chapter 11. The book ends with Chapter 12 highlighting options for appropriate health risk reduction strategies and remaining crucial research gaps from different perspectives.

# 2. Study sites, cropping systems and profile of farmers

*Most information in this book was obtained from our field studies carried out in Ghana's three major cities of Accra, Kumasi and Tamale. Additional surveys were carried out in Cape Coast and Takoradi. This chapter gives a description of the cities in view of urban agriculture. It also shows the main cropping systems and characteristics of urban farmers involved in irrigated open-space vegetable production.*

## 2.1. The study sites in Ghana

Ghana lies at the shore of the Gulf of Guinea in West Africa and occupies a total area of about 24 million ha. To the North, it borders Burkina Faso, Togo to the East and Ivory Coast to the West. The country is divided into ten administrative regions and six ecological zones, dominated by semi-deciduous forest and Guinea savannah (Figure 2.1).

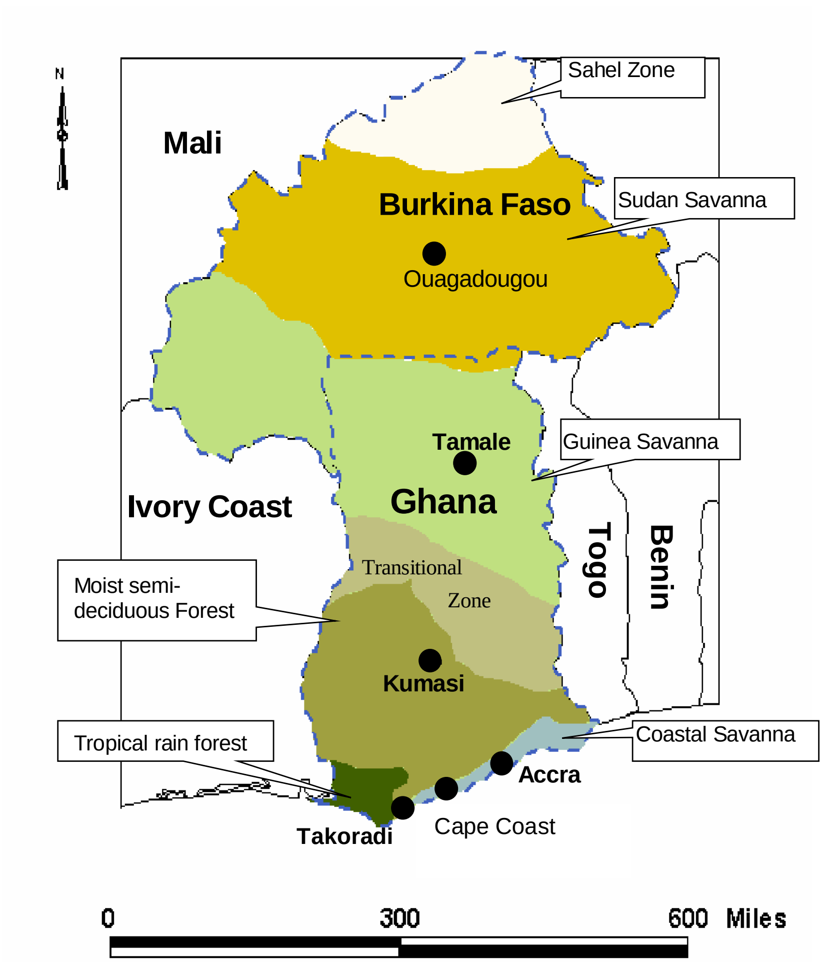



**Figure 2.1:** A map showing the location of the major study cities in Ghana

The topography is predominately gently undulating with slopes less than 5%. Rainfall ranges from 600 mm/yr in the coastal zone to 2200 mm/yr in the southwestern rainforests. In most parts of the country there is one distinct rainy season and one dry season lasting longer in the Northern parts of Ghana than in the South (Quansah, 2000).

About 64% of Ghana's surface falls on the Volta Basin, but with Tamale only one of Ghana's major cities. Ghana has a population of about 19 million, with an annual growth rate of 2.7% and its population density stands at 79 persons per $km^2$, going up from 55 persons per $km^2$ in 1984. Forty four percent of the population lives in urban areas. The Greater Accra region (hosting the Capital City Accra) is the most densely populated with almost 900 persons per sq. km and the most urbanized as 88% of its almost 3 million people live in the urban areas (Ghana Statistical Service, 2002).

Agriculture is the mainstay of the Ghanaian economy. It contributes to 36% of the GDP and employs 60% of Ghana's labor force (ISSER, 2002). About 36% of Ghana's population lives below the poverty line (US$ 1/day) (Lamptey, 2006). Poverty is substantially higher in rural areas and northern Ghana than in urban areas and southern Ghana (Ghana Statistical Service, 1999).

The three largest cities, Accra, Kumasi and Tamale, were selected for this study as they represent a cross-section through the agro-ecological zones of Ghana. Accra lies in the Greater Accra and administrative region and falls under the coastal savannah zone, Kumasi in the Ashanti Region falls under the humid forest zone while Tamale is in the Northern Region and falls under the Guinea savannah zone (Figure 2.1, Table 2.1). The following pages present brief descriptions of the three cities and their urban agricultural activities with focus on irrigated open-space farming. Some additional information is provided for Takoradi and Cape Coast.

**Table 2.1:** Mean annual climate data of Accra, Kumasi, Tamale

| | **Rainfall (mm)** | **Tempe-rature ($^0$C)** | **Relative humidity (%)** | **Sunshine duration (hrs)** | **Wind velocity (km/day)** | **Potential evaporation (mm)** |
|---|---|---|---|---|---|---|
| Accra | 810 | 27.1 | 81 | 6.5 | 251 | 1504 |
| Kumasi | 1420 | 26.1 | 77 | 5.4 | 133 | 1357 |
| Tamale | 1033 | 28.1 | 61 | 7.3 | 138 | 1720 |

Source: Agodzo et al., 2003

## 2.2 Irrigated urban agriculture in Accra

Accra is the capital city of Ghana and covers an area of about 230 to 240 km². In its current administrative boundary, it has an estimated population of 1.66 million (Ghana Statistical Service, 2002). Accra's population growth rate is about 3.4 % annually, which is constrained by the outdated boundary of the city. The actual population growth takes place behind this boundary where the Ga and Tema districts grew between 1984 and 2000 at a rate of 6.4 and 9.2%, respectively. Including both districts, we get the functional boundary of (Mega) Accra, as the urban dwellers perceive it, with 2.7 million inhabitants (Twum-Baah, 2002). About 60 percent of Accra's population lives in informal settlements or slums in the centre of the city while the middle and upper class moves to its periphery. About 10 % of Accra's inhabitants are Moslems in an otherwise mostly Christian community.

Accra lies within the coastal-savanna zone (Figure 2.1) with low annual rainfall averaging 810 mm distributed over less than 80 days (Table 2.1). The rainfall pattern of the city is bimodal with the major season falling between March and June, and a minor rainy season around October. Mean temperatures vary from 24 ºC in August to 28 ºC in March. Natural drainage systems in Accra include streams, ponds and lagoons (e.g., Songo, Korle and Kpeshie). Floodwater drains and gutters are used for grey water, and often drain into the natural system, polluting heavily the lagoons and Accra's beaches.

In Accra, about 680 ha are under maize, 47 ha under vegetables and 251 ha under mixed cereal-vegetable systems (Figure 2.2; 2.3). Irrigated urban vegetable production takes place on more than seven larger sites. IWMI (unpublished) estimated on average about 100 ha under vegetable irrigation in the dry season. Some of the sites have been in use for more than 50 years (Anyane, 1963).

About 50-70 additional hectares are distributed over 80,000 tiny backyards (often just a few plantain and chicken) involving nearly 60% of Accra's houses (IWMI and RUAF, unpubl.). This figure is much higher than the one of Maxwell and Armar-Klemesu (1999) who surveyed mostly low-income and high-density suburbs.

The extent of the peri-urban area of Accra was estimated following the methodological approach described by Adam (2001) for Kumasi. Based on the results, we propose an average radius of 38 km from the city center (Figure 2.4), with more outreach along the Accra-Kumasi road, and less in-between the major roads. In this peri-urban area, farmland is increasingly converted into settlements but agriculture still plays a significant role. A major feature are large-scale pineapple plantations which support, among others, the European market.

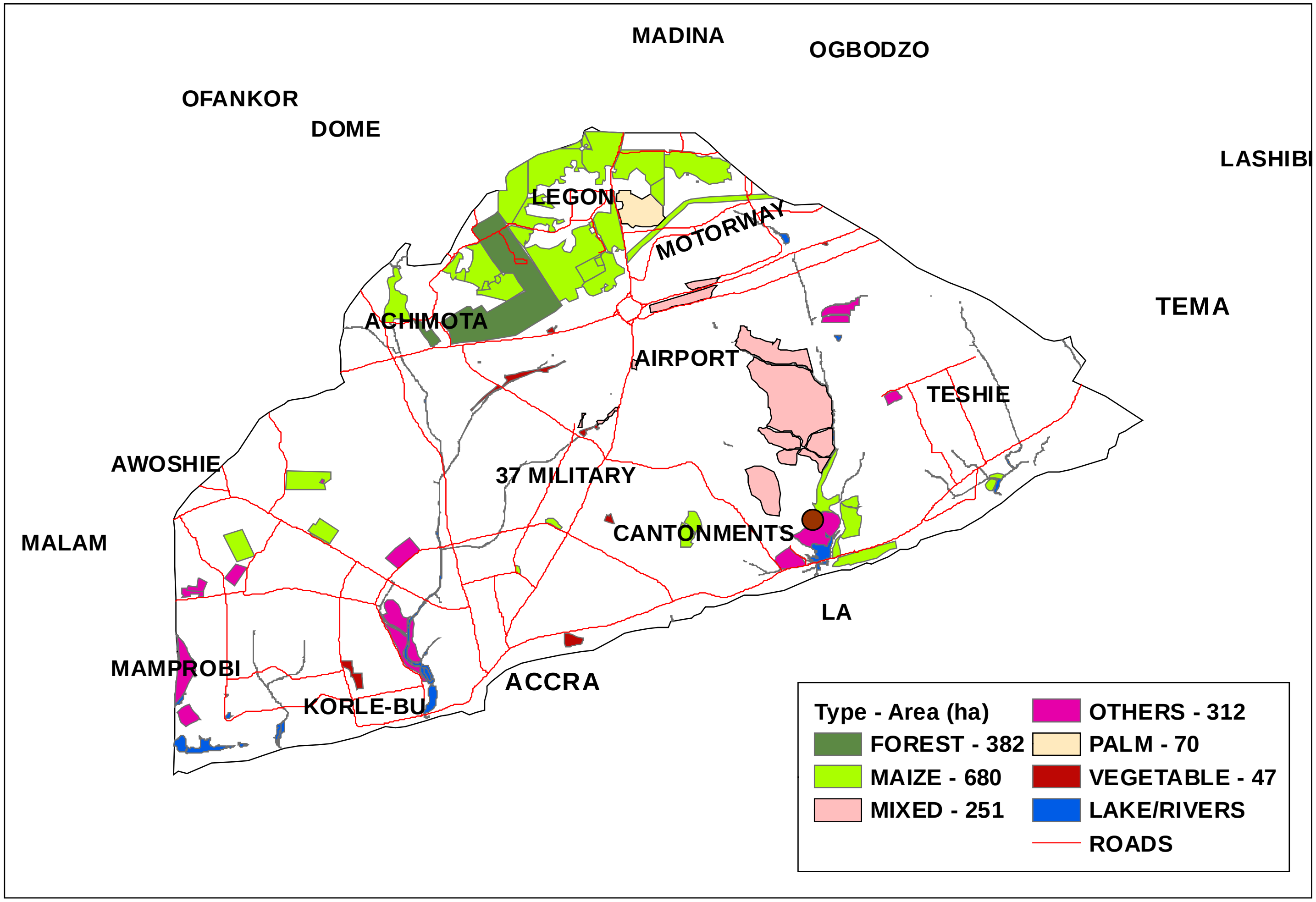



**Figure 2.2:** Map showing open spaces and (farming) activities on them in Accra (Kufogbe et al., 2005)

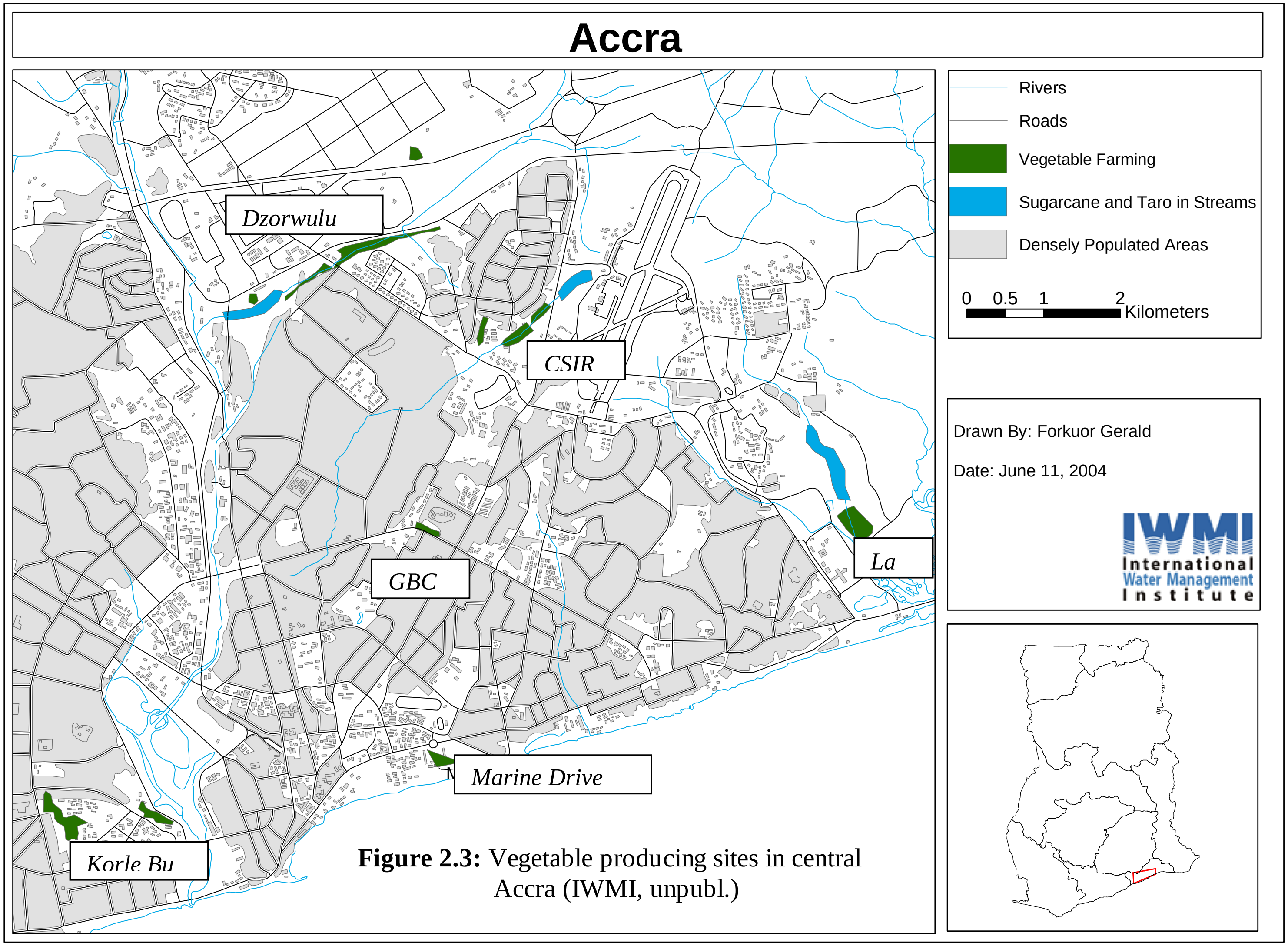



**Figure 2.3:** Vegetable producing sites in central Accra (IWMI, unpubl.)

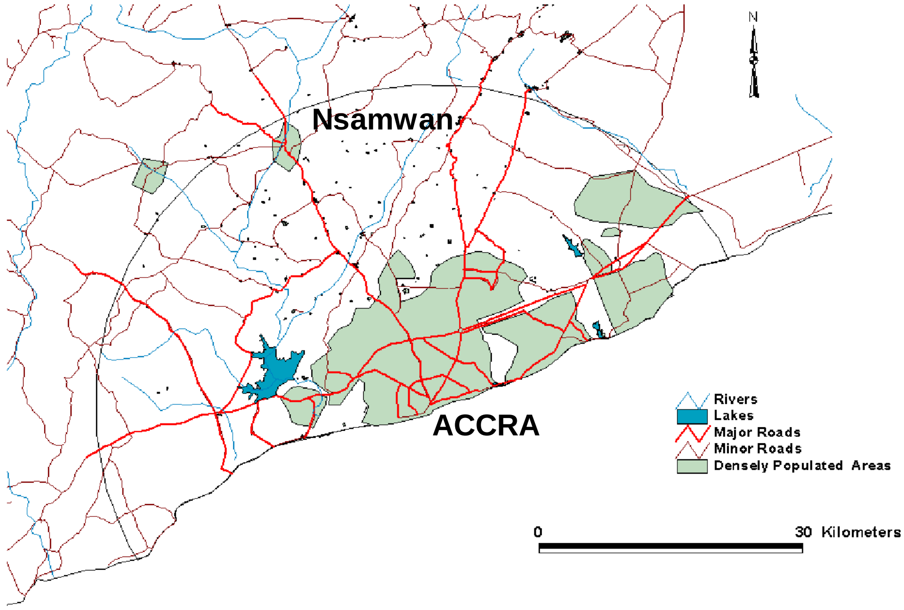



**Figure 2.4:** Approximate boundary between Rural and Peri-Urban Accra. The identification of the boundary followed the methodology described by Adam (2001).

**Major irrigated vegetable farming sites in Accra**

In Accra, there are about 800-1000 vegetable farmers of whom 60% produce exotic and 40% indigenous local or traditional vegetables. Some of the modern or exotic crops cultivated are lettuce, cabbage, spring onions, and cauliflower while the more traditional crops are tomatoes, okro, garden eggs (aubergine) and hot pepper. Plot sizes under cultivation in the city range between 0.01-0.02 ha per farmer, and max. 2.0 ha in peri-urban areas. The plot sizes of most of these sites have diminished over time because of land loss to estate development and widening of drains. This has led to reduced land reservations along the drains which used to be cultivated. An additional problem faced by farmers in relation to their farm size is tenure insecurity and low soil fertility. The locations of some of the irrigated (open-space) vegetable farming sites in the city is shown in Figures 2.2 and 2.3.

Some mayor areas are:

- **"Marine drive"** at the Independence Square**:** Farming in the area began before 1983 by a religious organization and was aimed at providing employment for the youth and reclaiming the land. The land being cultivated belongs to the department of Parks and Gardens and was originally zoned by AMA as an open space in line with the beautification of the metropolis. However, lack of funds, time and logistics have motivated the Department of Parks and Gardens to enter into informal agreement with farmers and release the land to them to promote ‘‘agro-forestry with inter-cropping’’. Though they have no formal farmer’s organization, farmers have a spokesman. The site currently has 98 farmers (97 male, 1 female) aged between 18 and 60 years. The potential farming area covers 3.6 ha. Water is provided through a narrow wastewater drain connecting the inner-urban area called “Ministries” and the ocean.

- **“Dzorwulu/Plant Pool”.** The site covers an area of 15 ha. It is divided into two sites by a major road with in total about 60 male farmers and 2 female farmers. One part, “Plant Pool”, next to the high-tension area of Volta River Authority (VRA) has 34 farmers, two of whom are women. The other side has 28 male farmers. A mutual agreement has been formalized with VRA for farming in the area as a way of maintaining it and to prevent any non-agricultural encroachment. River Onyasia cuts across the farming sites. The river is channeled in this part of Accra like a drain and has a similar function. Some farmers use pipe-borne water, most however water from the major drain or smaller drains channeled into shallow reservoirs (dug-outs). There are about 77 of such small ponds on this site. Some are also filled with piped water.

- **“La”:** This is the oldest and largest irrigated site in Accra with up to 400 vegetable farmers. The majority of them use wastewater from the drains of the nearby (military) “Burma” camp. About 50 farmers use pipe-borne water while five use water from a treatment pond of the only partially functioning treatment plant. It is the only site in Ghana where “treated” wastewater is used and in Accra where furrow irrigation is practiced. La is also unique as there are an equal number of men and women farming. The site has a functional farmers association and measures in total nearly 100 ha, with about 40% under irrigation, otherwise rainfed farming or fallow land.

- **“Korle-bu”**: The farming site neighbors the largest hospital in Ghana. Most farmers are junior hospital staff like watchmen, cleaners, etc. who farm to supplement their income. The cultivated land area covers about 10 ha, but is decreasing due to building activities. Several attempts have been made at forming a farmers association but without success.

> The site has about 80 farmers (only one female), most of them being migrants from the northern regions of Ghana and Burkina Faso. The land belongs to the hospital and farming is done under an informal arrangement to keep the area clean and prevent non-agricultural encroachment. Water is derived from drains, which pass through the hospital compound and staff flats.

Other sites are, for example in the Airport Residential Area around the CSIR and IWMI offices or close to the Ghana Broadcasting Company (GBC).

## 2.3 Irrigated urban agriculture in Kumasi

Representing the middle belt of Ghana, Kumasi is the capital town of Ashanti Region and the second largest city in Ghana with a population of 1.0 million and an annual growth rate of 5.9% (Ghana Statistical Service, 2002). Daytime population – attracted by Kumasi's large central market - is estimated at 1.5 to 2 million people. Kumasi itself has a total area of 225 km² of which about 40% is open land. Kumasi has a semi-humid tropical climate and lies in the tropical forest zone (Figure 2.1) with an annual average rainfall of 1420 mm with about 120 days on which it rains in the year. The rainfall pattern of the town is bimodal with the major season falling between March and July and a minor rainy season around September and October. The mean monthly temperature of the area ranges from $24^0$C to $27^0$C. Important streams and rivers include the Owabi River, which flows through the suburb of Anloga; Subin River, which passes through Kaasi and Ahensan; and Wiwi River, which runs through the local university campus (KNUST). Due to the hilly landscape of Kumasi, most streams run through inland valleys unsuitable for construction and of high value for urban vegetable production.

The population of Kumasi comprises mainly Ashanti and other ethnic groups, with about 20% being Moslems. At least two of three households have some kind of backyard farming. A much higher percentage has at least a few plantain crops or chickens (IWMI, unpubl.). This corresponds with the estimates of KNRMP (1999). The peri-urban area of Kumasi has a radius of approximately 40 km from the city center (Blake and Kasanga, 1997, Adam, 2001). It is characterized – among others - by a concentration of large poultry farms (the largest farm has depending on the season up to 300,000 birds). Lying in the "tuber belt" of West Africa, cassava, plantain, maize and other traditional staple food crops are dominant on upland sites, often accompanied by dry-season vegetable farming especially along streams.

**Major irrigated vegetable farming sites in Kumasi**

In urban Kumasi, most land where farming is done belongs to government institutions, private developers etc. There are about 41 ha in the urban area under vegetable irrigation[1] while the peri-urban area has more than 12,000 hectare under irrigated vegetable farming mostly during the dry season (Cornish and Lawrence, 2001), twice as much as under formal irrigation in the whole country. The main farming sites in the urban area are shown in Figure 2.5.

Some well-known sites are:

§ **Gyinyase/Engineering:** This is the largest urban vegetable-farming site in Kumasi (21.8 ha). It is located next to the local university (KNUST[2]) in an inland valley. The site has a diversity of crops, and farmers practice in part organic farming. Shallow wells are used extensively and there is a well-established farmers organization.

§ **Georgia Hotel:** This farming site is located behind Georgia Hotel and covers about 0.4 ha. It has 3 male farmers with their families cultivating spring onions, cabbage, green pepper, garden eggs and red onions. The land belongs to the hotel and the farmers are allowed to cultivate it. This is the only urban site in Ghana where farmers use sprinkler irrigation so far. Farmers use pipe borne water although the pipe connection does not appear to follow official regulations.

§ **"D-Line/Weweso":** Covering an area of about 3.1 ha, this site is located beside the Kumasi-Accra road (next to the KNUST police station) and farmers predominantly cultivate spring onions. It has about 30 farmers organized in an association. The water source is a small stream, which receives untreated effluents from a significant number of households.

[1] Total area used for open space farming in the city (incl. tubers, cereals) is about 70 ha.
[2] Kwame Nkrumah University of Science and Technology

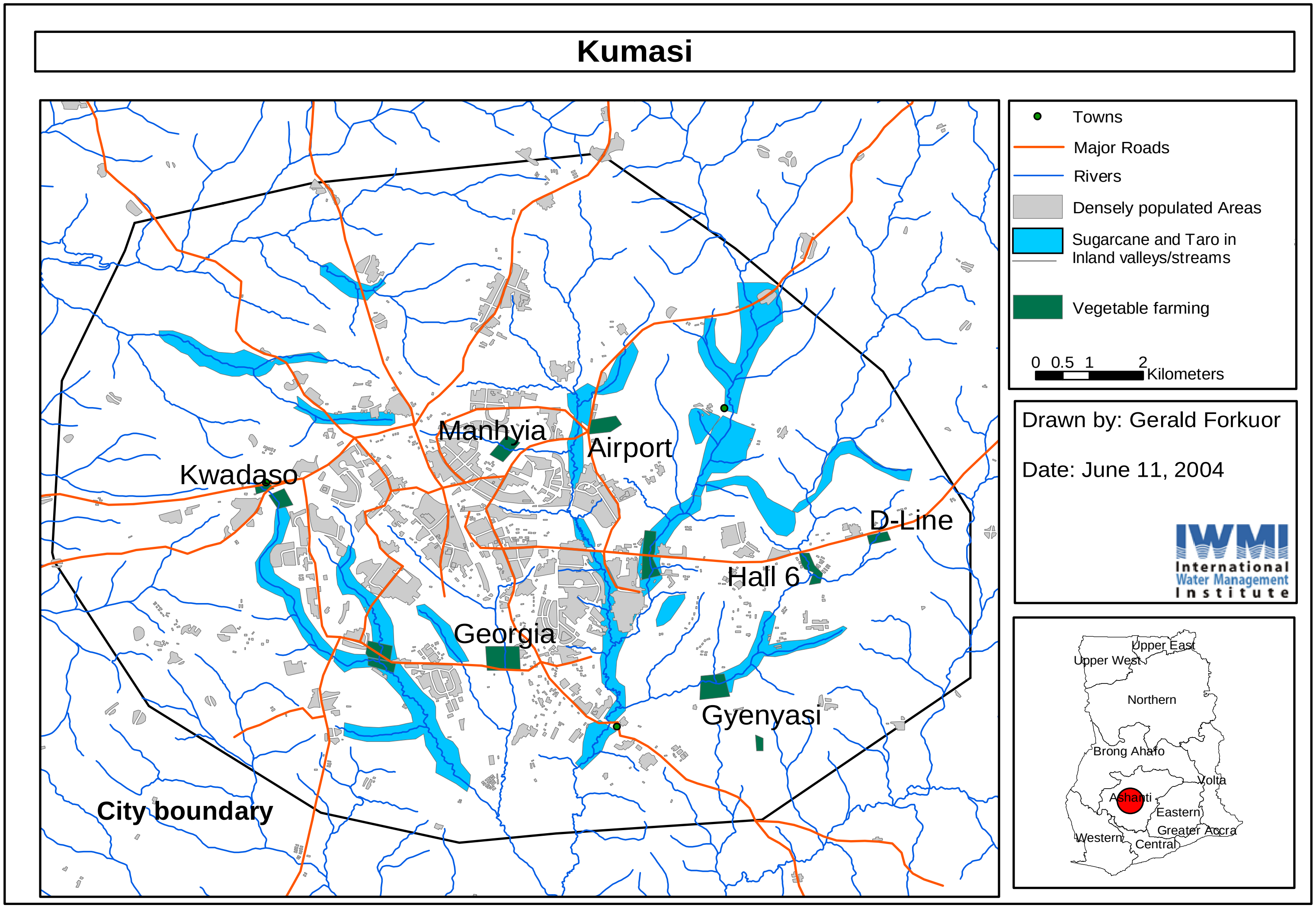



**Figure 2.5:** Vegetable producing sites in urban Kumasi (IWMI, unpubl.)

## 2.4 Irrigated urban agriculture in Tamale

Tamale is the capital of the Northern Region. The Tamale district is covering a large area of about 930 $km^2$ including the city itself and about 30 surrounding villages. Urban Tamale extends up to 10 km from the city center, while peri-urban Tamale extends in average up to 40 km along its major East-West and North-South roads, but only about 15 km in-between (IWMI, unpubl,)[3].

The population of Tamale city is about 200,000 and of the whole district about 300,000 with a comparatively low growth rate of 2.5% (Ghana Statistical Service, 2002). Tamale lies in the Guinea-savanna belt (Figure 2.1) with only one rainy season from April/May to September/October, followed by a prolonged dry season. As a result the Municipality is poorly endowed with water bodies. There are few seasonal streams, with enough water during the rainy season but which dry up during the dry season. However, the average annual rainfall is higher than in Accra with about 1033 mm over about 95 days of intense rain. The dry season lasts usually from November to March. Maximum day temperatures range from 33ºC – 42ºC while minimum night temperatures range from 20ºC – 22ºC. Average relative humidity is 90% during the day and 96% in the night.

Tamale generally lags behind the municipalities in the southern part of the country in providing various services. The dominant ethnic group is Dagomba with Dagbani the widely spoken local language. About 60% of its population are Muslims. Every fourth household has a backyard with at least a few crops or poultry (IWMI, unpubl.).

**Main irrigated vegetable farming sites in Tamale**

As there is no main stream passing through Tamale and since the groundwater table is low, most farming is done along wastewater drains, near dams with small reservoirs, broken sewers or near dugouts. About 40% of the vegetable farmers are farming all year round. Fifty-two per cent depend on polluted water sources (Zibrilla and Salifu, 2004). Most attempts to explore groundwater in the municipality failed. The average depth of successful wells is about 60 meters.

Figure 2.6 shows some of the major farming sites in and around the city center. The total area under informal irrigation is about 33-40 ha in urban Tamale and 70 ha in the urban fringe. Apart from a few sites, farmers in the other areas cannot farm year-round due to lack of water,

[3] The assessment of the area was based on the approach outlined by Adam (2001).

or because landowners (who are also farmers) take back their land in order to grow their own cereals during the rainy season (Zibrilla and Salifu, 2004; Amarchey, 2005).

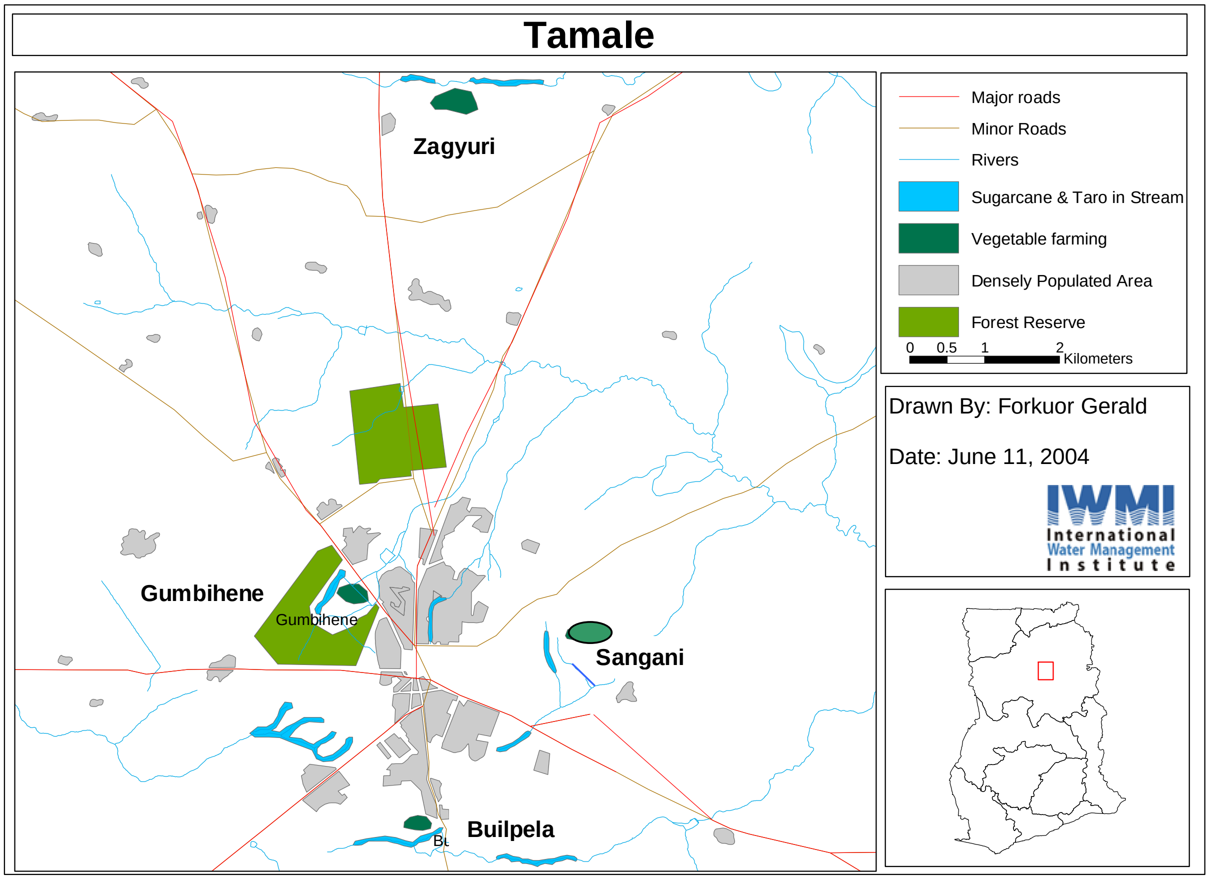



**Figure 2.6:** Selected urban vegetable production sites in Tamale (IWMI, unpubl.)

Examples of some well-known urban farming sites are:

§ **Builpela (Bulpeila):** this site is about 2 km from the center of Tamale. Farmers use a dam that was built in 1960 to supply water for domestic use, livestock and vegetable cultivation. The area under vegetable cultivation is about 2.6 ha. Other reports mention 6.8 ha (Zibrilla and Salifu, 2004).

§ **Sangani:** it is located 2 km North-East of Tamale town center. Farmers use a dugout well meant for domestic use. Depending on the source, the area under cultivation varies between 0.5 to 4 ha.

§ **Water Works:** named after a dam originally built to provide water for Tamale Municipality, the reservoir is now heavily polluted. Water flows through it and is used by farmers who have farms next to the stream originating from the dam. Vegetable irrigation at Gumbihene Water Works, Gumbihene New Dam and Gumbihene Old Dam cover in total 13.5 to 22 ha.

§ **Zagyuri:** this site is near Kamina Barracks and farmers use untreated sewage from a broken sewer. The site is 8 km from the city center and covers according to different sources in total about 7-12 ha.

In Tamale, some farmer associations, NGOs, municipal authorities and research institutions form the 'Urban Agriculture Network – Northern Ghana' under facilitation of *Action Aid*. A main task of the network is advocacy for land security (Amarchey, 2005).

## 2.5 Irrigated urban agriculture in other cities

***Cape Coast:*** The Central Region in general and the Cape Coast municipality in particular are known for their high tourist potential. A large number of beach resorts, hotels and guest lodges warrant a high and unceasing demand for vegetables within this area. However, our surveys showed that there is almost no irrigated vegetable farming taking place within Cape Coast except for the premises of Cape Coast University where almost a hectare of exotic vegetables is cultivated year round using pipe-borne water. The bulk (over 90 %) of the vegetables consumed in and around the Cape Coast municipality comes from as far as Togo or Kumasi and rural areas surrounding the Cape Coast District (e.g. Nsadwir).

Based on interviews and observations, reasons assigned to the insignificant level of urban vegetable production include: (1) general scarcity of non-saline surface or ground waters including perennial streams; (2) saline nature of soils, and (3) unsuitable hilly topography with flood-prone flat lands. Particularly during the dry season (October-March) when vegetable prices would allow high returns, the biophysical potential for irrigated urban agriculture is very low. Significantly fewer migrants from the North (than e.g. in Accra) and a local preference for fishing are further factors limiting the in-situ development of irrigated vegetable production.

***Takoradi:*** In the Takoradi municipality, there exist a number of urban and peri-urban irrigated vegetable production sites where a considerable amount of vegetables is produced. These are located in areas commonly known as Air force, Airport Ridge, PTC[4] and Kwesimintsim (near 'Obiri' lotteries). The total area covers about 3 hectares (Figure 2.7). Farm sites at both the Air force and Airport ridge are all located on lands that belong to the

[4] Pioneer Tobacco Company©

Air force. Almost every farmer cultivates year round. Majority of farmers in Takoradi use streams as water source. Streams crossing the town are highly polluted as they function as natural drains for urban wastewater.

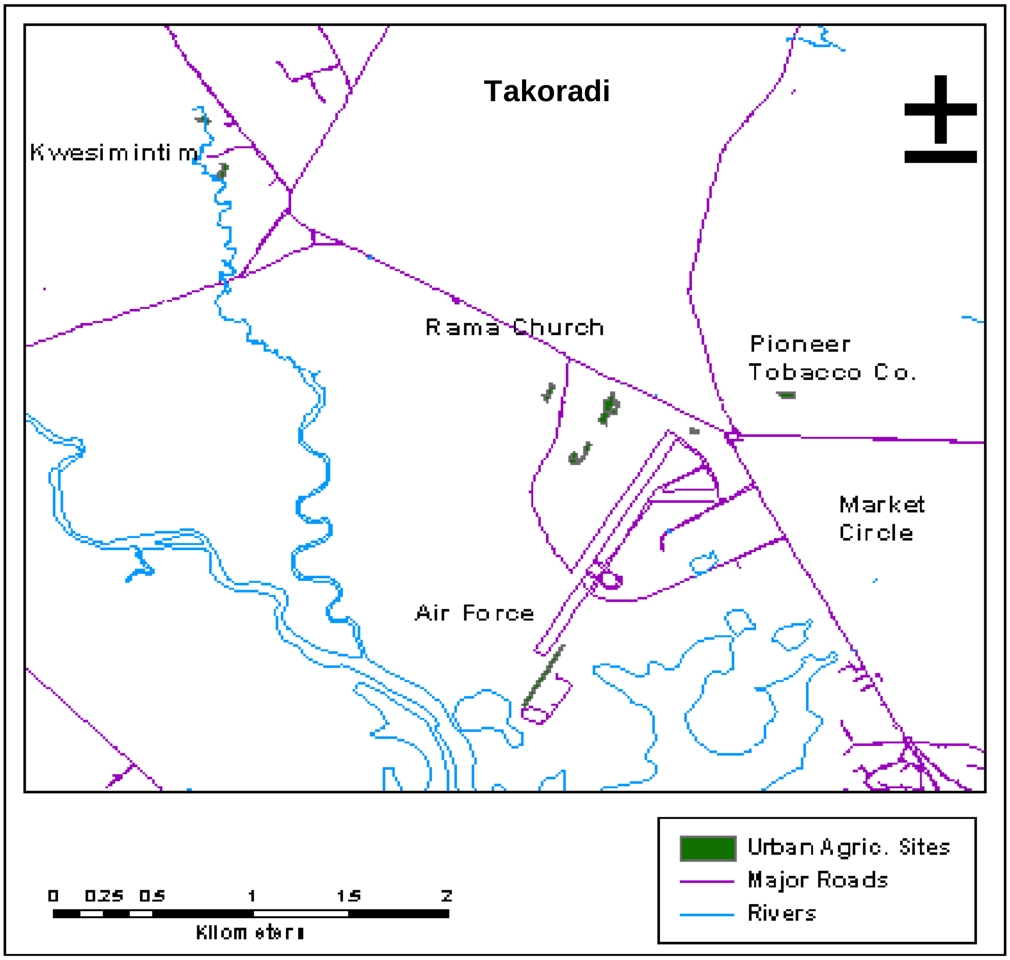



**Figure 2.7:** Location of some urban vegetable production sites in Takoradi (IWMI, unpubl.)

## 2.6 General farming characteristics

Open space vegetable farming is mainly for commercial purposes. Only farmers specialized in traditional (indigenous) vegetables consume a part of their produce. In Kumasi, vegetable farming is done all-year-round, whereas in Accra and especially in Tamale many of the vegetable sites are (also) used for maize and sorghum in the rainy season. Also in peri-urban areas, in particular around Kumasi, vegetables are mostly produced in the dry season when prices are high. Farm sizes are increasing from urban to peri-urban areas with usually less than 0.1 ha in the cities and up to 1.5 ha in peri-urban areas. Vegetable farming is done on raised beds and an average bed covers an area of 3-8 $m^2$. Due to high labor requirements (land preparation, weeding, watering etc) farmers with bigger land areas have to hire labor or rent a water pump. Urban farmers use their own labor, although a “brother” might help. In peri-urban areas more family labor is used. Poultry manure is all-over the preferred and cheapest nutrient source, but also fertilizer is used, especially on cabbage.

Most urban farming sites are on lands belonging to government institutions and departments and private developers who have not yet started constructing. Preferably, farming is done in reserved areas along streams and other water sources. Farmers normally do not pay for such land and only have an informal agreement with the landowner. As such there is no security of tenure as they are allowed to farm only as long as the owners do not need the land. On other sites, belonging for example to the Air force authorities in Takoradi, farmers pay a fee to use the land. Such arrangements are, however, seldom enforced. In general, as you move to the peri-urban areas, land tenure becomes more secure because land is owned under customary rights and distributed according to traditional regulations (Flynn-Dapaah, 2002). One exception in the urban context is the site of La, Accra. The customary owners of land are the members of the La stool, one of the Ga chieftaincies. Non-indigenous farmers who want to farm in the area have to enter into some kind of agreement with customary owners by paying rent (e.g. US$ 4 per ha/season) or agree on sharecropping. With the existence of inheritance land tenure arrangement, a piece of land continues to remain in a family for a long period of time until the land is disposed off by the family. Nevertheless, parts of the La land has been cultivated for more than 100 years. For a more detailed account on land tenure and rights in and near Accra, see Flynn-Dapaah (2002) and Obuobie et al. (2003).

More than 15 types of vegetables are cultivated in the study areas. Table 2.2 shows that the most commonly grown urban vegetables are also the most perishable (leafy) ones, which have to be produced in market proximity as long as cold transport is lacking. These are often “exotic” (non-traditional) vegetables, which reflect imported diets and are consumed raw in salads, such as lettuce, spring onions, and cabbage. In peri-urban areas, on the other hand, more traditional diet vegetables like ayoyos (*Corchorus sp*) and alefi (*Amaranths)* or less perishable (fruity) vegetables like garden eggs and tomatoes are grown. Another noticeable feature is the specialization that sometimes occurs in farming sites. For instance, farmers in

D-line in urban Kumasi predominantly plant spring onions while their counterparts at Gyinyase plant lettuce. It is summarised that availability of water is one of the factors influencing such a decision and the nature of the soil as well. Specialization is another reason; in some villages around Kumasi, farmers prefer certain vegetables, while in the neighbouring villages other vegetables are grown. In Tamale, quite a number of local vegetables are cultivated in the urban areas, a response to a less multi-cultural demand.

**Table 2.2:** Common crops and crop combinations in urban Kumasi (IWMI, unpubl.)

| Main crops | | Associated crops | |
|---|---|---|---|
| **Crops** | **Harvest/year** | **Crop** | **Harvest/year** |
| Lettuce | 9-10 | Cabbage | 1 |
| Spring onions | 6 | Cabbage | 2 |
| Cabbage/cauliflower | 3-4 | None | None |
| Carrots[1] | 6 | Spring onions | 2 |
| Green pepper[2] | 6 | Lettuce | 6 |
| Radish: Red<br>Radish: White | 8<br>5 | Green pepper | 2 |
| Ayoyo, Alefi | 6 | Red onions | 3 |

[1] Rotation and intercropping pattern depends on the season, rotation is the most common.
[2] Mostly intercropping

Table 2.3 shows the most common peri-urban crop combinations within a given year. Crop rotation is carried out depending on the demand for a particular product and as a strategy to control pests and diseases.

Though vegetable farming continues in the urban areas in the rainy seasons, in many farming sites, farmers also cultivate some maize, yam etc., alongside, which are used for subsistence. In marshy areas the parallel crops are sugarcane and cocoyam. During the rainy season, only a minority of **peri**-urban farmers shifts to year-round vegetable farming (e.g. tomatoes in the Akumadan area). There are three reasons for this: the importance of maize and cassava for home consumption (mentioned by 52% of the farmers interviewed); the lower price of vegetables in the rainy season (40%); and the increased risk of pest attacks (8%).

**Table 2.3:** Common crop combinations in peri-urban Kumasi.

| Main crop | Subsidiary crops in rotation* |
|---|---|
| Cabbage | Lettuce/spring onion, cabbage, green pepper/sweet pepper |
| Lettuce | Cabbage/spring onion |
| Maize | Cassava, plantain/cocoyam/cassava |
| Okro (okra) | Tomato, cocoyam, cassava, garden eggs |
| Spring onion | Pepper, garden eggs, okro |
| Pepper | Cabbage, tomato, garden eggs |
| Tomato | Cabbage, pepper, okro |
| Plantain | Cocoyam, cassava, maize |
| Oil palm | Cassava, cocoyam, maize |

*In order of importance in the rotation

Source: Gyiele (2002a)

## 2.7 Profile of urban vegetable farmers

Most urban open-space farmers in Ghana have rural backgrounds and had some experience in farming before coming to the urban areas. They come to town mainly to seek good employment opportunities, to trade, or to attend school for higher education. They take up urban agriculture to earn enough money to open the way for these principal targets. With low investments and returns possibly after a few weeks, many farmers have realized that urban vegetable production is a profitable venture. A study conducted by Obosu-Mensah (1999) in Accra revealed that out of 200 urban farmers interviewed, 66% had no intention to stop farming even if they were offered regular salaried employment. This was because open-space urban agriculture could bring in very good earnings in spite of the risks of crop loss etc. Those who expressed that they would stop one day, mentioned sickness and loss of land as major factors that could compel them to stop farming.

Table 2.4 shows the religious status of farmers interviewed in comparison with the regional data from the population census carried out in 2000. We see that mostly Muslims are found in open-space farming. This may be explained by the fact that mostly Muslims from the Northern part of the country migrate towards the cities in search of job opportunities. Urban agriculture might be their first choice but could also be the second if they do not succeed otherwise because of low levels of education.

**Table 2.4:** Religious status of urban farmers compare to the regional average

| Religious affiliation | Northern Region (%) | Farmers in Tamale (%) | Greater Accra Region (%) | Farmers in Accra (%) | Ashanti Region (%) | Farmers in Kumasi (%) |
|---|---|---|---|---|---|---|
| Christians | 19 | 13 | 83 | 30 | 78 | 61 |
| Moslems | 56 | 86 | 10 | 67 | 13 | 37 |
| Others | 25 | 1 | 7 | 3 | 9 | 2 |

Sources: IWMI, unpubl.

A random sample of farmers from the three cities showed that 50-80% were between 20 and 40 years of age (Table 2.5). This group represents those in the working class who migrate to cities to look for jobs and end up in farming to either supplement their income or because they failed to get paid jobs. Accra had the highest percentage of farmers over 40 years.

**Table 2.5:** Age distribution of farmers in the cities

| Age | Kumasi | | Accra | | Tamale | |
|---|---|---|---|---|---|---|
| | Frequency | % | Frequency | % | Frequency | % |
| Below 20 | 4 | 4 | 7 | 5 | 1 | 1 |
| 20-30 | 33 | 33 | 45 | 33 | 19 | 25 |
| 31-40 | 35 | 35 | 30 | 21 | 41 | 54 |
| Above 40 | 28 | 28 | 56 | 41 | 15 | 20 |

Sources: IWMI, unpubl.

**Gender and household size.** Open space irrigated urban vegetable farming in Ghana is predominantly male dominated (Chapter 3). On the average, only less than 10% of all urban open-space farmers were women and many of them cultivate indigenous vegetables. This concurs with earlier findings (e.g. Obosu-Mensah 1999, Gbireh 1999, Armar-Klemesu and Maxwell, 1998). In all the cities, more than a half of the farmers are married and occasionally involve their wives in the marketing of produce. In contrast to farming, women dominate vegetable marketing, especially retail. Chapter 3 will have a special look at gender issues.

Table 2.6 shows the household sizes of the farmers in the three cities. While Accra and Tamale showed a wide distribution in household size, Kumasi was exceptional in that farmers were either single migrants or had households of up to 5 members. Very few farm households exceeded this. In all, the mean household size was 2 for Kumasi and 4 for Accra and Tamale against the average figures of 2000 population census of 5.1, 4.5 and 6.1 for Kumasi, Accra and Tamale respectively. The largest households had 8, 16 and 18 members in Kumasi, Tamale and Accra respectively.

**Table 2.6:** Household size of farmers in the three cities

| Family size | Kumasi | | Accra | | Tamale | |
|---|---|---|---|---|---|---|
| | **Frequency** | **%** | **Frequency** | **%** | **Frequency** | **%** |
| Alone | 35 | 35 | 28 | 20 | 11 | 15 |
| 1-5 | 59 | 59 | 67 | 49 | 38 | 50 |
| 6-10 | 6 | 6 | 36 | 26 | 23 | 30 |
| Above 10 | 0 | 0 | 7 | 5 | 4 | 5 |
| Total | 100 | 100 | 138 | 100 | 76 | 100 |

Source: IWMI, unpubl.

**Educational level.** Though there is a wide variation in literacy levels, many urban open-space farmers are illiterate. Kumasi and Accra show higher levels of literacy among farmers compared to Tamale (Table 2.7) where most farmers are illiterate. However, the illiteracy in Tamale is not restricted to urban farmers but a general issue in Northern Ghana.

**Table 2.7:** Educational status of farmers

| Educational attainment | Northern Region % | | Greater Accra Region % | | Ashanti Region % | |
|---|---|---|---|---|---|---|
| | **Regional** | **Tamale** | **Regional** | **Accra** | **Regional** | **Kumasi** |
| Illiterate | 79 | 79 | 29 | 48 | 43 | 35 |
| Primary | 15 | 17 | 45 | 4 | 45 | 51 |
| Secondary | 4 | 3 | 18 | 44 | 8 | 12 |
| Tertiary | 2 | 1 | 8 | 4 | 4 | 2 |

Source: IWMI, unpubl.

These findings should not be extrapolated to urban agriculture in general. Backyard gardens, for example, can be found in all parts of the society.

**Economic profile.** Urban farming provides employment and income for a chain of beneficiaries, such as farmers, market sellers, suppliers of agricultural input, etc. and therefore contributes to the national economy, also in Ghana (Obosu-Mensah, 1999, Danso et al., 2002a, Drechsel et al., 2006a; see Chapter 4). Out of 138 farmers interviewed in Accra, about 60% totally rely on irrigated vegetable cultivation as their only source of income, while 33% do it as a supplementary source of income. In Tamale, with more seasonal vegetable production, majority of vegetable producers use it to supplement their incomes from staple crop farming. Only a minority of open-space cultivators uses urban vegetable farming as a one-off means of getting money for a later investment or as source of food (Figure 2.8). In general, farmers of exotic vegetables do not consume their own produce.

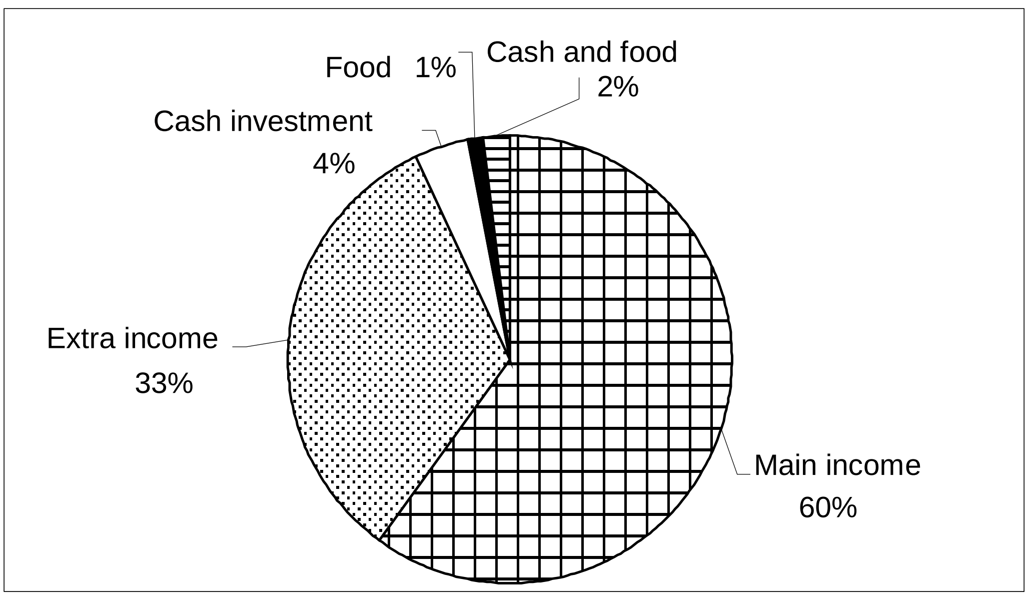



**Figure 2.8:** Main objectives of farmers cultivating vegetables in Urban Accra

Among those for whom farming was a secondary activity in Accra, watchmen/security guards were predominant (57%) while others were masons, painters, mechanics or cleaners. The case of Kumasi is similar to that of Accra.

In summary, we can describe the average urban vegetable farmer in Ghana as portrayed in Box 2.1.

**Box 2.1:** The "average" vegetable farmer in urban open spaces of Ghana.

The typical Ghanaian urban vegetable farmer cultivates exotic vegetables like cabbage, cucumber, lettuce, onion, cauliflower, and green pepper on an area of land between 0.01 and 0.12 ha. Cultivation is done year-round. The average vegetable farmer is a male and within the age group of 31-40 years.

About education, the average farmer could have either acquired a primary or secondary school education or be an illiterate, often with some education from an Arabic (language) school. The average urban farmer is religious. In Kumasi, the chances that he is a Moslem (vs. Christian) are 2 out of 5 farmers; in Accra 3 out of 5; and in Tamale, it is 4 out of 5. He is married and occasionally his wife markets his produce. In many cases however, he would have regular visits from market women who also might provide him with credit. The average vegetable farmer, if he is in Accra or Kumasi will grow vegetables as his main occupation and primary source of income. His major extra occupation, if in Accra, would be security guard job. In Tamale, cultivating vegetables will be his major occupation. He has on the average 5 dependants in Accra and Kumasi and between 6 and 10 in Tamale. Usually, his dependants are supported by income from his farm. A cousin might assist him; otherwise the farm work is not a family business.

The average urban vegetable farmer is a migrant from a rural area in Ghana and has some experience in farming before coming to the city. Normally, farming is not his main aim for coming to the city. He gets into farming some time after arriving in the city when he finds out that he is not able to favourably compete for a job in other sectors. However, once he is established in producing vegetables, it becomes a serious business and he does not want to quit even when he finds better salaried employment. He knows his extension officer but has stopped expecting any advice on his key problems like price fluctuations and marketing of produce, pest control and quality seed supply.

His main source of irrigation water is an open drain if he is in Accra or Tamale, or (polluted) surface water if he is in Kumasi or Takoradi. In all cases, he does not own the land, but he uses it for free or for an informal fee. His "informal" status and low tenure security limit his access to credit and investments in farm infrastructure. When asked about his occupational health risks through his exposure to wastewater, he does not consider it an issue, like he does not perceive his normal living conditions (without own toilet and piped water) as peculiar or unhealthy.

Source: IWMI farm survey data (2000-2005).

# 3. Gender in irrigated urban vegetable farming

*This chapter focuses on gender issues in irrigated urban agriculture and attempts to explain why men dominate irrigated vegetable production in Ghanaian cities in particular and West African cities in general. It also refers to the dominance of women in vegetable marketing.*

## 3.1 General situation

Studies done in many cities in Africa, particularly in East Africa indicate that majority of urban farmers are females. Examples include Kenya, Mozambique, Tanzania, Uganda, Zambia, and Zimbabwe. This has been attributed to the fact that women continue to bear primary responsibility for household sustenance and well-being (Chancellor, 2004), or because of their lower educational status than men, thus, having fewer opportunities of finding suitable wage employment in the formal sector (Obosu-Mensah, 1999). However, there are large differences between countries, cultivated crops (traditional vs. exotic) and between subsistence production and market gardening. In a survey comparing 20 cities in West Africa, men dominated open-space vegetable farming in 16 cities in 10 of 13 countries (Table 3.1).

**Table 3.1**: Gender ratio in open-space farming in various cities of West Africa (in percent)

| Country | City | Female (%) | Male (%) |
|---|---|---|---|
| Benin | Cotonou | 25 | 75 |
| Burkina Faso | Ouagadougou | 38 (0-72) | 62 |
| Cameroon | Yaoundé | 16 | 84 |
| Côte d’Ivoire | Abidjan, Bouaké | 5-40 | 60-95 |
| Gambia | Banjul | 90 | 10 |
| Ghana | Accra, Kumasi, Takoradi, Tamale | 10-20 | 80-90 |
| Guinea | Conakry, Timbi-Madîna | 70 | 30 |
| Mali | Bamako | 24 | 76 |
| Mauritania | Nouakchott | 15 | 85 |
| Nigeria | Lagos, Ibadan | 5-25 | 75-95 |
| Senegal | Dakar | 5-30 | 70-95 |
| Sierra Leone | Freetown | 80-90 | 10-20 |
| Togo | Tsévié, Lomé | 20-30 | 70-80 |

Source: Drechsel et al. (2006a).

To understand the role that gender plays in urban vegetable production in Ghana, a pilot appraisal was conducted among vegetable farmers and traders in Accra, Kumasi, Tamale and Takoradi. The surveys showed that most vegetable retailers are women, while open-space farmers in the cities are often in 9 of 10 cases men (Table 3.1). In peri-urban areas and urban household backyard gardening, on the other hand, the situation can be different (IWMI, unpublished).

## 3.2 Male dominance in urban open-space vegetable farming

The pilot assessment was not able to answer all questions, but allows some preliminary conclusions under consideration of the available literature.

### Cultural and economic constraints

Societal definition of gender roles provides a supportive explanation for why men dominate open-space vegetable farming in urban Ghana. Generally, cash crop farming is considered in most Ghanaian communities as work for men. The reason might however be that women have in many cases less access to land (see below) and resources to commence market-oriented farming (Zibrilla and Salifu, 2004). In fact, many women who farm usually cultivate crops such as ayoyo and other indigenous vegetables, which require low initial capital investment for seeds. An example is the Zagyuri site in Tamale. In neighbouring Ouagadougou, more women than men grew traditional vegetables for subsistence supply and as cash crop, but more men than women grow higher-priced exotic vegetables solely for income generation (Gerstl, 2001).

### Access to land

Land issues were mentioned as a major constraint for women in Tamale (Zibrilla and Salifu, 2004). In fact, in some regions, under customary law, women do not have a right to hold land except through male relatives or as widows. However, they can have user rights unless land is in short supply. Sometimes they are pushed towards more marginal plots. In the other study cities both male and female farmers explained that most urban land being cultivated belongs to the government (see also e.g. Obosu-Mensah, 1999) and therefore access does not depend on customary rules and one's gender but rather on the individual's ability to lobby among those who farm already or with the caretaker/watchman of the plot.

#### Nature of vegetable production

In peri-urban settings, farming remains a family business. Staples are grown in the rainy season and indigenous or fruity vegetables in the dry season if plots close to streams are available. Although men dominate among vegetable farmers, women take part in many farm activities (Table 3.2). Together with their children, they are especially involved in water supply, i.e. carrying water from its source to barrels for domestic use or to farm plots (Cornish et al., 2001). Women also irrigate with buckets or pans but are hardly seen irrigating simultaneously with two watering cans and never seen operating a motor pump. A wife's duty to her husband might undermine her attempts at farming for herself.

**Table 3.2:** Division of farm tasks by sexes in peri-urban Kumasi

| Tasks {x = usually applicable; - = less applicable} | Men | Women/children |
|---|---|---|
| Clearing the bush | x | - |
| Raising beds | x | - |
| Nursery | x | - |
| Planting and transplanting | x | x |
| Weeding | x | x |
| Fertilizing | x | - |
| Spraying | x | - |
| Manual fetching and transport | - | x |
| Manual watering using bucket | x | x |
| Manual watering using two cans | x | - |
| Mechanical watering (using pump) | x | - |
| Harvesting | x | Market women |

Source: Cornish et al. (2001); modified.

In urban settings, farming is less a family business but more of an individual enterprise. Families might live on the other side of town or still in their rural homestead, and men purely produce for the market. They are less interested in competing with those fruity vegetables like tomatoes but specialize in exotic and leafy ones which are too perishable for longer transport and can provide seasonally very high revenues on the urban markets (like lettuce, cabbage, spring onions). Leafy vegetables require careful nursing and much more frequent irrigation than those vegetables produced in peri-urban areas. Irrigation can take between 40 and 70% of farmers' time and will be carried out in all seasons, as already after 1-2 days, without rain, lettuce looses its fresh look and market value (Danso et al., 2002a, Tallaki, 2005). The most affordable and common method in Ghana and the sub-region is that water is conveyed in two

15-litres watering cans over about 50-100 m distance to irrigate the crops. In contrast to the general practice of women and children carrying water on the head, the cans cannot be transported as head load. This task is usually taken oven by men. Also in peri-urban areas, men irrigate especially the water demanding and often more profitable crops like cabbage, cucumber, and cauliflower, while female farmers grow less water-demanding and less profitable indigenous crops like okra (okro), yoyos (*Corchorus sp*), and alefi (*Amaranths)* as also reported by Kessler et al. (2004).

Women could be assisted through the provision of credit facilities and/or subsidies to own a treadle pump for irrigation instead of having to lift the watering cans. However, trials in Accra showed that many urban farmers rejected treadle pumps as pump and water hose require two farmers at the same time and pulling the hose can damage the young vegetables or their beds very severely. Moreover, farmers did not know where to store the (relatively heavy) pump over night.

Land preparation is another arduous task and is usually done by men. It is mostly an issue in peri-urban areas where the fields along streams are only opened for dry season cultivation. In urban areas, cultivation is on most sites year-round, an exception can be inundated inland valleys in Kumasi. For clearing, independent women cultivators depend on male laborers (paid labor). Women with limited financial resources to employ help, eventually cultivate smaller plots than their male colleagues.

Another decisive activity in the cultivation of some exotic vegetables is the nursing. The surveys of Cornish et al. (2001) showed that women had less experience in this field and correspondingly less related skills. As seeds are expensive, nursing skills are crucial for the whole business, which requires high germination rate and survival of the seedlings (Obuobie et al., 2004).

## 3.3 Female dominance in marketing of urban farm produce

In contrast to vegetable farming, women dominate the vegetable marketing sector, in particular retail. This is not a particular situation in Ghana but also common elsewhere (Gerstl, 2001). However, there are differences between crops. There are crops, which are traditionally handled by men, while others are “women crops”. Among vegetables, cabbage, sweet pepper and cucumber are normally associated in Ghana with men, while lettuce, carrots, spinach, okra, garden eggs and others are associated with women. This differentiation is less binding on urban farms where men grow whatever gives profit, but obvious in wholesale and retail. While there are many male cabbage wholesalers, there are hardly any male lettuce wholesalers. Men also dominate the supply of canteens and restaurants with vegetables. Women's general dominance in retail is partly attributed to the Ghanaian tradition that retail in general is a woman's job, though with exceptions.

Both men and women involved in marketing vegetables see marketing as a quicker way to make money on daily basis, unlike farming which takes some months with staple crops before a farmer receives income from his farm activities. Though some men expressed the willingness to sell their own produce on the market, they are held back by the prevailing culture, i.e. men might wholesale certain crops but retail even less. Those who tried to enter this non-traditional domain complained about non-transparent procedures and often gave up unless they had insider support (E. Opare, pers. communication). Thus women handle 60-90% of domestic farm produce from the point of origin to consumption. Often, they have contract with the farmers, harvest themselves the best beds, and make their living as wholesalers or vendors. Women pursue marketing activities as their primary means of obtaining cash income for household expenditure. They appreciate the low initial investments compared to farming.

These market vendors are not necessarily members of the household of vegetable farmers. In fact, majority of them are not related to the farmers. Women vendors control the income they generate from the sale of vegetables and use it to support the family. Their income, especially of wholesalers, can be higher than of the farmers (Drechsel et al., 2006a). Women spend mainly on food and sometimes on clothing for the children, while the men spend their income on accommodation, children's school fees, utility bills and other major needs or projects of the family. Women also sometimes save part of their income and use it to support their husbands in major projects. Though men and women in a household may not have formally agreed on who spends on what, generally, the Ghanaian culture has already defined who bears what responsibility in the home and this is inherent, at least in the more traditional parts of the society.

## 3.4 Conclusions

In Ghana, there appears traditionally a clear gender differentiation between cash crop farming men and women engaged in retail. Wholesaler can be of both genders, depending on the crop. But the picture is not that simple as there are many exceptions. More studies are required to analyse the reasons and constraints, which result in this differentiation, and options for more gender equality.

# 4. Financial benefits and trade-offs

*This chapter explores some of the financial and economic aspects of urban and peri-urban agriculture in Ghana. Cost-benefit analysis comparisons were made of farm finances of common rural, peri-urban and urban farming systems. Some studies also tried to quantify benefits for the society and to cost externalities related to soil nutrient depletion and health impacts from increased urban malaria events and through pesticide use.*

## 4.1 Financial analysis

Urban and peri-urban farmers involved in open space agriculture have little alternatives to using polluted water from streams, drains and dug wells. Only in a few cases do they have access to pipe-borne water and can afford its use. In Kumasi, urban farmers mostly use watering cans while peri-urban farmers often use pumps to convey water from rivers and streams to their farms, which are often farther away from water sources than the plots in urban areas. Due to human limitations on the number and size of cans that can be handled, manual irrigation requires frequent trips to the water source which makes irrigation tiring, time-consuming and labor intensive. Labor for watering accounts for 13% of total cost (excluding family labor) and 38% of time. Even higher percentages are possible in drier areas and sandy soils, like along the beaches of Lomé (Tallaki, 2005). When water is pumped, the cost for hiring pumps is estimated to be from US$ 40-70 per dry season (ca. 3 months). In general, manual labor is more expensive per volume of water delivered (US$ 3-6 per $m^3$) compared to using pumps (USD 0.6-5 per $m^3$) (Cornish et al., 2001).

In analysing costs and returns a major factor accounted for was therefore the cost of water, which includes hiring of pumps, cost of labor for watering and other activities. Weeding, which is also labor intensive was rated as the most expensive activity by the farmers accounting on average for about 23% of total cost. Most farmers who use manual labor rarely pay for it as they depend on family labor. They hire laborers occasionally for larger numbers of beds, but rarely pay more than US$ 11 per season.

Though the water used has some nutrients, vegetable farmers also use significant amounts of other types of soil nutrients as well as pesticides. In Kumasi, the use of poultry manure is very common due to its easy availability and low price (US$ 0.2 per sack). Only a few farmers use mineral fertiliser in addition to this (mostly for cabbage). In peri-urban Kumasi, many more vegetable farmers use mineral fertiliser (US$ 14 per 50kg NPK) but combine it with poultry manure when possible (Drechsel et al., 2004). Variations are related to the crops cultivated by the farmers.

Table 4.1 shows farm income data based on costs and returns as recorded by farmers in Kumasi, Takoradi and Accra. The data correspond with records from other cities in West Africa (Drechsel et al., 2006a). Income varies depending on the type of crop, season, farm size and investments in labor and improved irrigation facilities, e.g. motor pumps.

**Table 4.1:** Monthly net income from irrigated mixed vegetable farming in Ghana (US$ per actual farm size).

| City | Monthly income (US$) |
|---|---|
| Accra | 40-57 |
| Kumasi | 35-160 |
| Takoradi | 10-30 |

Comparing different farming systems, the data from the Kumasi study show that urban farmers with access to irrigation water are able to cultivate all year round and can reach annual income levels of US$ 400 to 800 (see Table 4.2). This is twice the income they would earn in the rural setting. However, being successful this way requires careful observations of market demand. The greatest factor influencing farmers' profits is less the yield obtained but producing at the right time what is in short demand and the ability to sell consistently at above average prices (Cornish and Lawrence, 2001).

**Table 4.2**: Revenue generated in different farming systems

| Location | Farming system | Typical farm size (ha) | Net revenue (US$) per actual farm size per year (range) |
|---|---|---|---|
| Rural/peri-urban | Rain-fed maize or maize/cassava | 0.5-0.9 | 200-450 [a] |
| Peri-urban | Dry-season vegetable irrigation *only* (garden eggs, pepper, okra, cabbage) | 0.4-0.6 | 140-170 |
| Peri-urban | Rain-fed maize combined with dry-season, irrigated vegetables | 0.7-1.3 | 300-500 [a] |
| Urban | Year-round irrigated vegetable farming (lettuce, cabbage, spring onion) | 0.05-0.2 | 400-800 |

[a] These are typical values; subsistence production has been converted to market values. In case farmers use parts of their maize and cassava harvest for home consumption, the actual net income would be lower. Source: Danso et al (2002a).

As urban farming is land and labour constrained, typical farm sizes range between 0.05 and 0.2 ha in Kumasi. Comparing the different farming systems, urban wastewater vegetable production in Ghana generates the highest net revenues per hectare. Even with plot sizes that are significantly smaller than in rural areas, urban farmers earn at least twice as much as rural farmers.

An analysis of the different dry-season vegetable production systems in peri-urban Kumasi showed that the combination of pepper, cabbage, tomato, and garden egg yielded the highest profit per hectare among the common peri-urban crop combinations being practiced in the survey area. It was obvious that whenever cabbage was part of the combination, the net profit was high. Cabbage has become a major component of street food and the modern diet of the urban middle and upper class income households (Gyiele, 2002a).

Even though cabbage- based crop combinations were the most profitable crop enterprises, only about 10 % of the farmers around Kumasi engaged in cabbage production. The reasons for this low figure are not hard to find. There is first of all the harsh competition from urban farms specialized in cabbage production. In contrast to urban sites in Accra, the farms in Kumasi have a relatively higher tenure security (university land) and more fertile soils. In addition, cabbage production is very input intensive, especially in view of irrigation and pest control. This entails a correspondingly higher expenditure on labor and plant protection chemicals. This is one instance where, despite high profits arising out of high physical efficiency in production, few farmers are willing to undertake it due to higher investment in cash and time. On the other hand, most vegetables offer a quick cash return. Comparing profit as percentage of production costs, the traditional mixed cultivation with oil palms ranked highest but would require much longer investment periods (Gyiele, 2002a).

## 4.2 Comparing informal and formal irrigation

Abban (2003) carried out a comparative study between vegetable production in the informal (urban) production sector (Accra city) and commercial irrigation schemes (Greater Accra Region). He interviewed 60 farmers in each system, most of them practicing multi-cropping. The author concluded that the gross revenues were four times higher in formal irrigation schemes but also eight times the (variable and fixed) production costs. The resulting net returns still favoured formal irrigation with an income twice as high as in informal urban irrigation. The benefit-cost ratio in the production period, however, was twice higher in urban agriculture, making it an interesting venture for migrants trying to establish a livelihood with little start capital and in need of quick returns.

### 4.3 Socio-economic impact and urban food supply

Urban agriculture can be market oriented, subsistence oriented or serving both purposes. It may be practiced as a sole source of income or to supplement immediate household food requirements and is often carried out alongside other forms of employment (Box 4.1).

Important is to differentiate under the general umbrella of "urban agriculture" between on-plot and off-plot farming, or in other words: backyard gardening and open-space market farming (Table 1.1, Chapter 1). Both contribute to different development goals. While backyard gardening usually serves subsistence purposes and improves farmer's food security, market gardening aims at cash generation and contributes first of all to poverty reduction.

**Box 4.1:** Wastewater irrigation and livelihoods (three stories)

**Accra:** Our farmer is a 51-year-old lady, regularly employed as a teacher, who farms part-time at a site using drain water. She is a Christian and is married with five children; she has secondary school education and lives in Osu, one km from the farm. She owns a food-processing machine (corn mill) from which she earns ¢200,000 (about $ 25) per month. She earns the same amount from teaching and her husband, an administrative officer, also contributes ¢200,000 per month. But more substantial is that she can add up to ¢450,000 from her vegetable beds per cropping period, and a crop like lettuce requires only one month. She says "This small piece of land keeps my family in a better status and supports the education of our children".

**Kumasi**: A 32-year-old female farmer who owns about 30 beds, cultivating mainly leafy vegetables explains: "I am a seamstress but I cannot survive without these vegetables. In most cases, I have to pre-finance sewing of the dress with income derived from vegetable production because it can take somebody more than two months to pay for the cost of the dress. I am getting my everyday expenditure from these beds".

**Tamale**: ''We started (cabbage) farming many years ago with our parents here. We depend on it. We had to change from wastewater to piped water due to our inability to access water anymore from the drains. Our colleagues are fortunate to have the wastewater still because it makes crops bigger in size and they look fresher and broader than ours. Meanwhile the prices of the crops are the same. We have to pay a monthly water bill while they do not pay anything".

**Moving out of poverty**: For peri-urban farmers, dry season vegetable irrigation adds 40-50% of cash to their normal income especially as significant parts of their rain-fed maize and cassava harvest are consumed by the household. Without this additional income, cash availability might actually be less than US$ 100 per year. Around Kumasi, about 60,000 people are benefiting from dry-season irrigation (Cornish and Lawrence, 2001). However, only a minority of peri-urban farmers shift to year-round vegetable farming (e.g. tomatoes in the Akumadan area). There are three reasons for this: the importance of maize and cassava for home consumption (mentioned by 52% of the farmers interviewed); the lower price of vegetables in the rainy season (40%); and the increased risk of pest attacks (8%). But those farmers who move to urban areas and take the risk take a remarkable step to overcome poverty. As shown in Table 4.2, urban vegetable farmers can double the maize-cassava income of their rural colleagues and move over the poverty line of one US$ per capita.

**Individual food supply:** In Accra and Kumasi, the surveys showed that in each city about 600,000 residents from all income categories benefit from their backyard gardens (IWMI, unpubl.). These gardens can be very small (e.g a few plantains). The cultivation for subsistence purposes mainly relieves the household of its necessary budget allocation for foodstuff. Thus backyard gardening does not play a key role in household livelihood strategies regarding food supply, but is part of it and reduces to a limited extent households' vulnerability to food crisis. However, those who have more space and larger gardens or chicken coups, might also sell surpluses. In contrast to backyards, open-space cultivation of vegetables is usually for the market. This is especially the case for exotic vegetables while farmers who specialize in traditional vegetables might also consume a part of their produce.

**Urban food supply**: At the macro level, the contribution of urban agriculture to the Gross Domestic Product will be small, but the importance for certain commodities, as lettuce, cabbage, milk and poultry products might be substantial, especially if we consider up- and downstream activities (Cofie et al., 2003; Drechsel et al., 2006b). Nugent (2000) reported that urban agriculture can meet large parts of the urban demand for certain kinds of food such as fresh vegetables, poultry, potatoes, milk, fish and eggs. The proximity of production to consumption reduces traffic, (cold) storage and packaging, and related costs.

Emphasising the contribution of open-space urban agriculture to urban food supply in Kumasi, Table 4.3 shows that the demand for vegetables (like lettuce or spring onions) as well as fresh milk is nearly completely covered by inner-urban production. Food items like tomatoes, garden eggs and cassava as well as eggs and poultry meat are derived from the peri-urban area while staples, such as cocoyam, plantain, maize and rice come from rural areas or via import to the city markets in Kumasi. Another vital part of Kumasi's urban and peri-urban agriculture is poultry production, which is practiced by people from all social sectors. Vegetable farmers in and around Kumasi benefit from this, as it offers them access to cheap but high-quality organic fertilizers (Drechsel, 1996, Drechsel et al, 2000).

**Table 4.3:** Contribution of rural, peri-urban and market-oriented urban agriculture to urban food supply in Kumasi (Drechsel et al., 2006b).

| Food item (examples) | Kumasi Metropolitan Area (%) | Peri-urban Kumasi (%)* | Rural and import (%) ** |
|---|---|---|---|
| Cassava | 10 | 40 | 50 |
| Maize | < 5 | 5 | 90 |
| Plantain | < 5 | < 10 | 85 |
| Yam | 0 | 0 | 100 |
| Cocoyam | < 2 | < 10 | 90 |
| Rice | 0 | < 5 | 95 |
| Lettuce | 90 | 10 | 0 |
| Tomatoes | 0 | 60 | 40 |
| Garden eggs | 0 | 60 | 40 |
| Onions | 0 | 0 | 100 |
| Spring onions | 90 | <10 | 0 |
| Poultry/eggs | 15 | 80 | < 5 |
| Livestock | 5 | 10 | 85 |
| Fresh cow milk*** | >95 | < 5 | 0 |

* Using a 40 km radius from the city center.

** Mainly rice, onions and part of the livestock are imported. *** KNUST farm production.

**Contributions to other urban development objectives.** Urban farming can have substantial contributions to the city beyond the provision of livelihoods and food. These include among others contributions to flood control, land reclamation, land protection, resource recovery (from waste), urban greening and biodiversity etc. (see also table 11.1 in chapter 11). These contributions might be more important for some authorities than the food production per se but have not been quantified and assessed so far. An example is that urban open-space farming protects unused land from squatters and uncontrolled waste dumping, thus saves expenditures on land maintenance and waste collection (Anku et al., 1998).

## 4.4 Externalities

When assessing the benefits of open space vegetable production to the society, there are also a number of possible negative externalities, which should not be ignored. A related checklist of environmental criteria was compiled by Anku et al. (1998). Examples are:

- the potential impact of polluted irrigation water on farmers' and consumers' health;
- the potential impact of pesticide use on farmers' and consumers' health
- soil nutrient depletion through frequent harvests and/or water pollution by farmers through the (over)use of manure, fertilizers and pesticides;
- stream siltation and eutrophication through erosion from cultivated slopes;
- increased urban malaria through the creation of mosquito breeding grounds

**a) Health impact through pathogens in irrigation water.**

Although there is ample evidence of irrigation related crop contamination with pathogens (see Chapter 9) an economic assessment of its health impact in Ghana is still missing. A major challenge in addressing this issue is that farmers and consumers might be exposed to a variety of similar or even higher pathogen-related risk factors (poor sanitation, lack of potable water, etc.), which make it difficult to value an individual risk factor, especially if the concerned persons do not perceive and record any particular problem (see Chapter 10). This corresponds with a related study in Ouagadougou, where perceived health records of 500-600 farmers and non-farmers were practically the same (Gerstl, 2001). However, the potential risk group is larger. As shown in chapter 5, every day more than 200,000 urban dwellers consume in Accra's streets lettuce produced with polluted water. As the amounts of the salad supplements are very small, the risk of infections due to pathogens is much higher for the consumer than any health risk due to pesticide accumulation (Amoah et al., 2005b).

**b) Health impact through pesticide misuse.**

A pilot assessment of the misuse of pesticides on farmers' health was attempted by KNUST-IWMI in the tomato producing area of Akumadan, Ghana (Gyiele, 2002b). The town of Bechem with dominantly traditional staple crop farming was used as control. Sources of data were farmers, hospitals/health posts, pharmacy/chemist shops and traditional medicine practitioners (herbalists). Health records from Jan 2000 – May 2001 were analysed from about 10,000 persons per study area. In addition, about 170 farmers have been interviewed and 200 samples of tomato fruits analysed for pesticide residues.

In Akumadan, the annual pesticide usage is estimated at 500 tons of which 4% are organochloride compounds with residues found in water, soil and in human body fluids such as breast milk (Ntow, 2001). Despite many campaigns promoting *Integrated Pest Management* (IPM), only a minority of the farmers (16%) tested these including biological pesticides. However, these farmers often add chemical pesticides to these extracts for increased potency of the mixture (Okorley et al., 2002). Also “pesticide farmers” mix cocktails of two or more chemicals and often use their fingers and mouth to test the resulting potency (Danso et al., 2002b).

Restricted chemicals in use are, for example, Endosulfan (100% of the farmers interviewed), Carbofuran (82.5%) and Polytrine (81.7%) as well as Ridomil plus/Ridomil (Metalaxyl) (75.8%). Farmers also confirmed to administer Lindane in their spray mixture. Other pesticides used are Karate, Dithane, Unden, Thiodan and Actellic, which were applied singly or as a cocktail. Misuse and overuse are very common (Ntow, 2001; Gyiele, 2002b; Okorley et al., 2002; Ntow et al., 2006).

**Table 4.4:** Comparison of prevalent symptoms between Akumadan and Bechem farmers

| | **Akumadan (n=120)** | | **Bechem (n=60)** | | |
|---|---|---|---|---|---|
| **Symptoms** | **Frequency** | **Percent** | **Frequency** | **Percent** | **Difference** |
| Headache | 120 | 100 | 46 | 77 | 23 |
| Burning sensation in eye | 88 | 73 | 10 | 17 | 56 |
| Weakness | 84 | 70 | 28 | 47 | 23 |
| Fever | 114 | 95 | 35 | 58 | 37 |
| Watering eye | 87 | 73 | 6 | 10 | 63 |
| Blurred vision | 43 | 36 | 7 | 12 | 24 |
| Dizziness | 80 | 67 | 16 | 27 | 40 |
| Nausea and vomiting | 82 | 68 | 10 | 17 | 51 |
| Cold/breathlessness/chest pain | 21 | 18 | 6 | 10 | 8 |
| Heart problems | 12 | 10 | 6 | 10 | 0 |
| Confusion | 3 | 3 | 0 | 0 | 3 |

Source: Gyiele (2002b)

It was observed that because of lack of records, farmers could not give offhand information on the type of health reaction they have experienced in the past. However, common symptoms such as headache, nausea, vomiting, cold, weakness, chest pain etc. were significantly higher for Akumadan farmers compared to farmers in Bechem where pesticides are not used (see Table 4.4). The most common symptoms in Akumadan were headache 100% (77% for Bechem), fever 95%, burning sensation in the eye 73%, and general body weakness 70%. Comparing on percentage difference basis burning sensation in the eye, watering eye, nausea and vomiting for Akumadan are 56%, 63% and 51% higher than for Bechem.

Other symptoms – often discussed in public - are impotence in men and infertility in women (Mensah et al., 2001). However, only 17% of the farmers saw a corresponding relationship. Farmers associated bending and other strenuous activities with tomato production as likely causes of female infertility.

High rates of self-medication are common in the study areas and most farmers consult chemical sellers (60%) in mild to moderate cases while 15.8% rely on herbalists. Persistent ailments are usually believed to have a spiritual origin and are usually taken to the herbalist too. Herbalists are contacted in Akumadan 2-3 times as often as in Bechem. As such, hospital records only reflect severe cases and underestimate the full extent of cases. The same applies to routine health statistics submitted to and published by the Ministry of Health. To bridge this gap, additional assessments from herbalists were compared with farmers' testimony.

Death, as a result of pesticide poisoning, is rare. However, 16% of the farmers knew of people who had died from pesticide poisoning (occupational exposure), while 100% experienced convulsion and fainting after spraying or knew people who suffered these symptoms after pesticide application.

The methods used for the economic assessment at the farmers' level were:

- Cost of medical treatment;
- Opportunity cost of labor i.e. absence form farming activities due to pesticide poisoning; and
- Cost of drugs for treating minor illnesses.

Considering these three approaches, the annual costs summed up to US$ 125 per tomato farmer (Gyiele, 2002b). With farm sizes under tomato cultivation ranging mostly from 0.3 ha to 2.0 ha, it becomes obvious that smallholders in particular have to pay a significant share.

These costs were compared with the gains from pesticide use compared to a pesticide-free tomato production based on IPM principles and biological pesticides. Some initial comparisons showed that the annual difference from using agro-chemicals vs. IPM could range between zero and more than US$ 2000 on hectare bases, depending on the kind and frequency of pest attacks. In other words, when there was no or little attack, both systems achieved the same yields and returns, while under severe attack the IPM farmers were apparently at higher risk of gaining less than those using pesticides. If confirmed, then this risk factor would not encourage the adoption of IPM, also under consideration of additional medical costs (assuming farmers perceive the relationship). Urban farmers confirmed this by stating that despite lower costs, IPM is simply too cumbersome and risky for them, compared to spraying “plant medicine”.

A quantification of food-chain related pesticide uptake and cost assessment for the consumer was not possible in the frame of this study. But as shown above (see a)), the potential impact will be significantly smaller than through pathogen contamination.

**c) Health impact through increased urban malaria.**

In comparison with rural areas, West African cities are relatively **malaria**-free due to general water pollution. The malaria vector *Anopheles* needs very clean water for breeding. Adaptations of the vector to less clean water could however occur as reported from Accra by Chinery (1984). In a malaria study on a 15 ha urban farming site in Accra with 77 man-made shallow water reservoirs filled with either tap water or polluted water, either water pollution or natural predators and other known competitors (tadpoles) effectively controlled larval development (Miah, 2004). Nevertheless, studies conducted by IWMI in Kumasi and Accra (Afrane et al., 2004; Klinkenberg et al., 2005) showed that in some cases, significantly more mosquitoes were caught and/or more children were affected in communities around irrigated farming sites than non-farming sites. However, as urban agriculture is often practiced in urban lowlands or other greener areas, which might generally offer more resting and breeding grounds for mosquitoes than other city areas, an explicit link with local *farming* activities could not (yet) be established in these cases. A preliminary economic assessment of the additional health expenditure was based on a comparative study of urban areas with and without open-space farming considering treatment costs and working days lost. The analysis showed that on average, for all age groups in the city, sites with urban agriculture increase the risk of malaria attack by 0.22 attacks per person during a period of 6 months. In other words, every fourth to fifth person in the vicinity of irrigated urban agriculture will have malaria one time more than if he/she were living in a pure urban area. With a typical malaria treatment cost of US$ 1.0 per case, an urban household in the vicinity of urban agriculture will spend an extra amount of 0.22 US$ x 6.6 household members for malaria treatment, i.e. 1.45 US$ over the observation period.

In addition, about 0.5 extra days will be lost per adult person in communities with urban agriculture than in those without. Under consideration of the average estimated household income, the number of working household members and the unemployment rate, the loss will cost the household another one dollar. In total, 2.45 US$ was attributed to each household over the 6-months period as extra malaria related expenditure in urban communities with open spaces used for irrigated urban agriculture (Gyiele, 2002b).

**d) Environmental impacts.**

In view of **water pollution** through fertilizers and pesticides, Gyiele (2002b) and Bower and Tengbeh (1995) concluded that the observed or likely contribution from urban smallholder farms is insignificant in view of the general pollution by the city. This could be different in rural areas where agriculture might be the only source of pollutants. In the tomato producing area of Akumadan, Ghana, with frequently reported pesticide overuse, pesticide residues in streams and sediments were however low, but monitoring of the build-up of residues was recommended (Ntow, 2001). A willingness-to-pay study (for safer drinking water instead of stream water) did not show much awareness for water pollution in this area (Gyiele, 2002b).

The risk of **stream siltation** will depend on the original vegetation cover along the streams and the cultivation practices of the farmers. It is possible that the year-round vegetable beds support soil conservation, increase infiltration and reduce run-off and erosion, thus contribute positively to flood control and urban drainage. On the other hand, studies in Harare, Zimbabwe, concluded that seasonal maize cultivation on slopes increased erosion. This led to a discussion of stream siltation and eutrophication through fertilizer use in urban farming (Bowyer-Bower et al., 1996; Mawoneke and King, 1999).

Irrigated vegetable production is one of the few forms of sedentary agriculture in West Africa where shifting cultivation is still the dominant land use system. However, with up to 10 lettuce harvests per year, soil nutrient mining is severe forcing farmers to provide continuous nutrient input. Especially on sandy soils, urban farmers enter into a vicious cycle of applying high rates of nutrients, which keep leaching out due to high rates of irrigation. As the irrigation water also contains nutrients and as the urban vicinity offers access to different waste resources, costs related to nutrient inputs can remain low. In and around Kumasi, for example, the poultry industry is very strong and farmers pay mostly for the transportation of poultry manure, but not or very little for the manure itself (Drechsel *et al.* 2000). Thus, the related costs to vegetable farmers appear relatively lower than in rural areas where the most economic way to address soil nutrient depletion is still shifting cultivation (Table 4.5).

**Table 4.5:** Externalities due to soil nutrient leaching in and around Kumasi

| System | Maize-Cassava intercrop | Year-round vegetable production |
|---|---|---|
| **Cost assessment** | The 2-year rental of a new plot is about US$10-50/ha depending - among others - on its proximity to the city, and accessibility. | Nutrient losses account for only US$10/ha/year if replaced with cheap poultry manure. Mineral fertiliser would increase the replacement costs tenfold. |
| **Costs per year** | US$5-25 | US$10 |
| **Percentage of net income** | Up to 10% | Up to 1 % |

Source: Drechsel et al. (2005)

## 4.5 Conclusions

Urban farmers are able to cultivate all year round, which provides them with an earning capacity that is at least twice higher than that of their rural counterparts. This offers opportunities to move out of poverty. Open space urban farming also contributes substantially to the perishable food requirements of Ghanaian cities. This is partly because food flow from outside is constrained due to lack of cold transport and storage facilities available in less developed countries. Thus urban farming saves energy, transportation, storage and packaging costs. There are also a number of other possible benefits, such as flood control and land reclamation, which have not been quantified so far. On the other hand, there are different negative externalities, which can fluctuate widely with changing conditions, spatially and temporarily. Some of them (like water pollution) relate, however, more to the general challenges of urbanization and poor sanitation than to the farming practices per se.

Examples of externalities were given for farmers (pesticide misuse, nutrient depletion, wastewater exposure) and the society (malaria risks through irrigated urban farming). The data indicate that medical treatment related to the use of pesticides can be a significant cost factor for farmers. This, however, is not a typical problem of urban and peri-urban agriculture but of any farming system using pesticides. An assessment of the likely health impact of polluted irrigation water on farmers and consumers is still lacking. Based on the amounts of lettuce consumed, it can be assumed that the potential impact (and costs) for the society due to irrigation related pathogens is much higher than the possible impact of pesticide overuse.

# 5. Quantification of marketing channels for lettuce[1]

*This chapter provides qualitative and quantitative information on the distribution pathway of lettuce produced in Kumasi and Accra from the farm to the consumer. The data show the contribution of irrigated urban farming and the size of the beneficiary group, which is also the group at risk from crop contamination.*

## 5.1 Background and objectives

On the background of contaminated vegetables from urban agriculture, the objective of this chapter is to present the different lettuce distribution channels and to categorize the groups of sellers and consumers, in order to identify entry points and target populations for risk reduction programs. To get an impression of the dimensions of the lettuce market and its consumer groups, an attempt was made to estimate the total amount of lettuce produced and the size of lettuce consuming population.

## 5.2 Details on surveys

In Accra, six central markets (CM) and five neighborhood markets (NM) were visited, whereas in Kumasi the three existing main markets (Central Market, Railway Market and Asafo Market) and 12 neighborhood (or community) markets were included in the survey. On the markets, dealers who sell lettuce were interviewed. Whenever a customer was met buying lettuce from one of these dealers, they were also interviewed. This procedure allowed the determination of the relative importance of each customer group. For each market, general information was collected from dealers. These include the average price of lettuce heads/sacks and the total number of wholesalers and retailers on that particular market.

In addition to these activities, several urban vegetable farms were visited, both to interview farmers and to meet with dealers who buy and harvest lettuce on the farms. Further, a number of samples of the sacks used to carry the harvested lettuce to the markets were weighed.

To assess the functionality and importance of national trade with lettuce, the major transition points where lettuce was sent to or received from other cities were visited.

[1] This chapter was in large parts contributed by Manuel Henseler and is based on a study carried out in a project of the CGIAR Challenge Program for Water and Food.

In order to follow the distribution chain of lettuce, it became necessary to carry out a further survey among fast food sellers. As part of this study, 133 and 244 stands were visited in Accra and Kumasi respectively. In Accra, 83 fast food vendors who served lettuce at that time were interviewed while in Kumasi, 144 fast food vendors were equally interviewed. Likewise, 161and 212 fast food customers were interviewed for Accra and Kumasi, respectively. In addition, 34 fast food stands were also visited in five different suburbs of Accra, in order to assess the origin of their lettuce, to discover their washing habits and to calculate the average weight of lettuce in one fast food meal. Therefore, interviews were carried out with the sellers and average size salad portions were purchased. The salad samples (N=20) were taken to the laboratory, where the lettuce was sorted out and weighed (Henseler et al., 2005). Chemical analyses were already carried out in a more comprehensive survey (Amoah et al., 2005, 2006b). Based on the statistics of Accra Municipality and Ghana's Food Research Institute, the number of fast food sellers in Accra selling food known for its lettuce supplement was estimated. About 90 fast food vendors in different parts of the city were visited at different times in a day and the absolute number of people who buy food with lettuce per day (in contrast to other food or the same but without lettuce) were recorded.

**Definitions** (used for this survey)**:**

-*Wholesalers* were defined as dealers who buy large quantities and concentrate on one or very few sorts of vegetables. However, distinction between wholesalers and permanent retailers is often not easy as they often show mixed behaviour (also crop- and season-dependent).

-*Permanent Retailers* have a permanent stand on a market to display and sell their produce.

-*Independent Vegetable Dealers* have a permanent stand but are not located on the official market.

-*Mobile Retailers* do not have a permanent stand but rather roam around with their produce or temporarily install themselves at certain sites.

-*Fast food stands* are stationary street food vendors that sell ready made food. This survey concentrated only on stands selling fried rice, plain rice, jollof rice, so called waakye rice and fried eggs. Traditional "*chop bars*", who serve so called kenkey, fufu, banku etc. were not included, as they do not contain lettuce. [for information on these dishes please see, for example: www.ghanaweb.com/GhanaHomePage/food/ ]

## 5.3 Marketing channels and food flows

### Traditional marketing structures

Wholesale marketing of exotic vegetables, which are *produced in peri-urban areas,* takes place at certain distribution points on specific days during the week. In Kumasi, for example, traders from the city and distant traders from Accra, Cape Coast, Obuasi and Takoradi-Sekondi come for business. The presence of traders from beyond Kumasi can influence market prices as they make better offers (Cornish and Aidoo, 2000). Farmers send their produce to various distribution points relatively early in the morning (normally by 5.30 am), where wholesalers, retailers and hawkers converge to purchase these vegetables. In addition to the three main markets in Kumasi – Central Market (Kejetia), Asafo and Sofoline- there are other small sale points located at strategic points within the city. Once the local market has been satisfied on these two days and the distant traders are gone, the market for exotic vegetables on any other day is small and prices highly erratic (Cornish et al., 2001). A significant proportion of the exotic vegetables *produced in the city* is sold at the farm gate (i.e. directly to wholesalers or traders).

While many sectors of agriculture in Ghana are being financed either by the government or external aid, urban farmers specialize in market production and can only rely on self-financing (usually to start the business) or market women who can provide funds for the purchase of input (especially seeds and chemicals). These women can be 'middlemen', wholesalers or actual market sellers. They visit the urban farms and reserve beds of vegetables in advance, thus financing the venture. The contract is verbal. The price per bed depends on the season, crop, and the size of the bed (approx. US$1.4-3.6 per bed). Farmers are not allowed to sell the vegetable to any other person. The total amount of money received may differ from the agreed figure as demand and supply might have changed during the growing period. All the farmers complain about this dependency on the traders.

When interviewed, vegetable wholesalers in Kumasi stated categorically that they preferred going to the farms within the city to buy fresh vegetables without having to pay intermediate and transportation costs to middlemen. If the type and quantity they need could not be acquired on the farms, the rest is procured from the distribution centers (see Figure 4.2). Common bottlenecks of this system are:

- poor price information;
- low number of farmers associations and limited capacity to lobby;
- lack of cold transport and storage (inadequate transportation);and
- lack of safe water and hygiene in markets for handling of produce.

### Alternative marketing strategies

There are examples of urban farmers who have broken from this dependency. A case in point as reported by Danso and Drechsel (2003) is a small group of 5-7 farmers within the "La" area in Accra who farm around a more or less treated wastewater pond, which belongs to the Military Authority of the adjoining "Burma camp". There is no formal agreement between these farmers and the authorities. Farmers regularly complain about water shortage during the period of discharge because its caretaker uses the wastewater from the pond for aquaculture.

There are two senior farmers in the group: one supervises crop production, while the other markets the vegetables. Also, there are 3-5 junior members and these are in charge of bed preparation, cultivation, watering of crops, spraying of pesticides and harvesting of produce. The marketing manager is responsible for input supply and marketing of the produce and all the necessary farming information concerning production techniques and marketing strategies. He has a long history in trading of non-agricultural commodities from Nigeria to Ghana, but has never worked as a farmer before he started cultivation in the La area.

At peak production, each of the 3-5 laborers is supposed to have up to 100 beds under cultivation. According to the Marketing Manager, their cropping pattern depends completely on the demand for a particular product at a particular time. He has studied the market in order to know when to produce what to meet demand peaks and has come up with a corresponding commodity chart:

| **Crop** | **Cropping period** |
|---|---|
| Lettuce | March – April |
| Cabbage | April – June |
| Sweet pepper | August – November |
| Spring onions | September – December |

Source: Emmanuel Opare, pers. communication.

As many vegetables are grown in short rotation (e.g. lettuce can be cultivated 9-11 times a year) flexibility counts a lot. A typical cropping pattern is: onions, green pepper, lettuce, which is rescheduled every three months.

Marketing of the vegetables is carried-out in two ways: a greater portion of the produce is sent to certain vegetable markets in Accra while the remaining is sold on-farm per bed. During high demand periods, the marketing manager purchases from other producers at different sites in order to improve his gains but also to provide sufficient produce to meet the sellers' demands. Thus, he is not only bypassing middle-men but also taking over their function.

The leaders pay themselves a monthly wage of US$57 each and US$29 each to the other five members. A simple input-output calculation carried out by the farmers indicates that there is a quarterly net profit of US$286 excluding the monthly wage. This is used to buy the necessary input for the next cropping. In addition, these farmers manage to have a special budget, which is used only when there is loss in production or a member of the group has a problem (family, health, funeral, etc).

### 5.4 Food flows

The analysis of the interviews with lettuce farmers, dealers and their customers allowed compilation of information on lettuce marketing channels into flow charts (Figures 5.1 and 5.2). The charts visualise the flow from the sources of lettuce (top), through its distribution pathways (center) to the target groups, who finally buy the lettuce on the market (bottom).

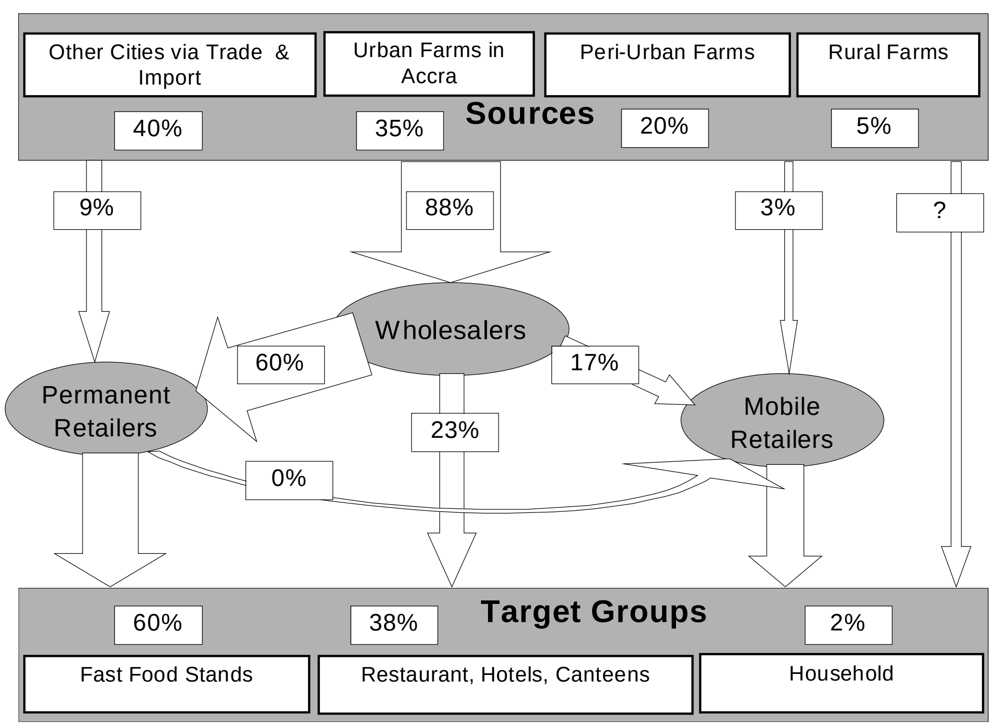



**Figure 5.1:** Flow chart of lettuce distribution in **Accra** (Henseler et al., 2005).

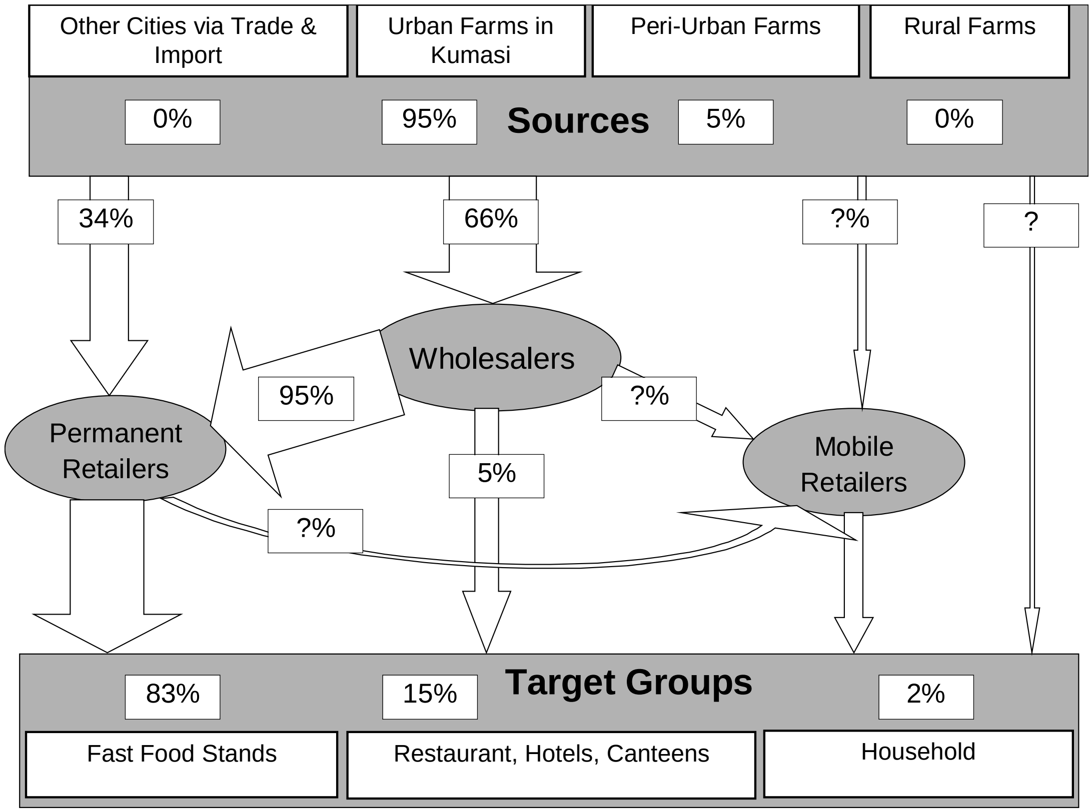



**Figure 5.2:** Flow chart of lettuce distribution in **Kumasi** (Henseler et al., 2005).

### National Trade and Import of Lettuce

The major sources of lettuce in Accra are urban farms in Accra and other cities (Figures 5.1 and 5.2). *Trade and Import* means in most cases lettuce harvested at farms from urban Kumasi. In a few cases Aburi and Koforidua in Ghana and Lomé in Togo were mentioned as sources. A large fraction of the lettuce coming from these cities is organised by a small group of 7-10 female wholesalers. They bring their produce (5-10 sacks each) in public buses (1.1 USD fee per sack) or lorries to Accra's Agbogbloshie market and sell it there for 16 to 39 USD (depending on the season) to other wholesalers and retailers. Agbogbloshie market therefore plays a crucial role in lettuce distribution in Accra. One of such sacks weighs in average 50 kg (wet weight). Sacks used for sales within Kumasi are smaller and are carried on metal pots (average of 30 kg lettuce per sack). These sacks are sold in Kumasi for 3 to 13 USD, depending on the season. Some wholesalers in Kumasi bring their produce to local bus stations where they sell it to other wholesalers. These carry the lettuce in lorries or buses to Accra, Takoradi/Tarkwa, Cape Coast and other cities in Ghana (Figure 5.3). Lettuce from

Togo is transported with lorries that carry also other vegetables, including carrots and spring onions.

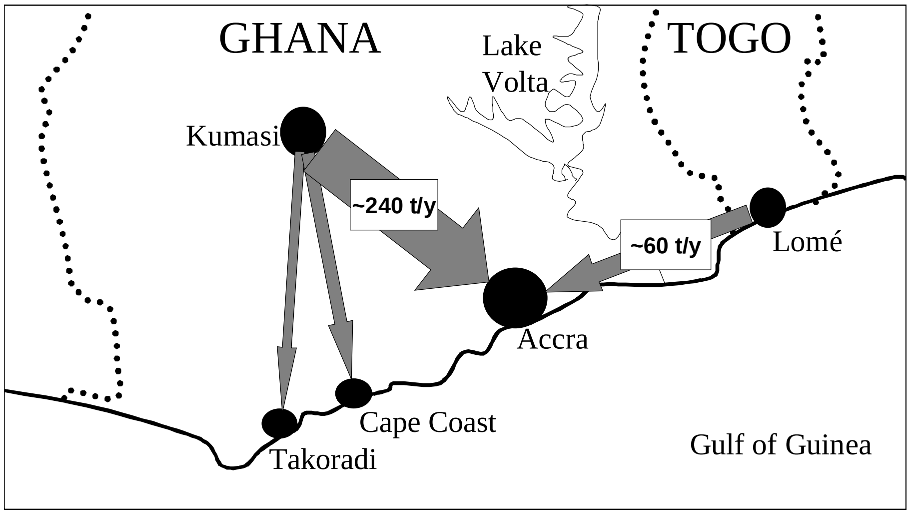



**Figure 5.3:** Import and national trade of lettuce in Ghana.

On market days (Mondays and Thursdays), approx. 50 sacks are brought to Agbogbloshie market, mostly from other cities. On Tuesdays, Fridays and Saturdays, less lettuce (approx. 5 sacks) arrives, whereas on Wednesdays and Sundays, the local supply is allowed to dominate the market and hardly is any lettuce brought to Agbogbloshie from other cities. Based on these numbers, a total of over 300 t of lettuce per year is brought to Agbogbloshie market from these sources. There are probably also smaller markets in Accra for the wholesale of lettuce.

#### Lettuce from Urban and Peri-urban Farms

In Kumasi, 95% of the lettuce came from urban farms. In Accra 35% were from urban sources within Accra, whereas a reasonable amount (approx. 20% of total lettuce on the market) also came from peri-urban farms. Rural farms obviously contribute very little to lettuce supply in the two cities, probably due to its easily perishable nature. Since the lettuce brought from other cities has its origin mostly in urban farms, it is assumed that this source ("irrigated urban agriculture") accounts for about 70% (in Accra) and 95% (in Kumasi) of the total lettuce sold on the cities' markets.

The importance of the different sources of lettuce certainly varies during different seasons. During the major dry season in Accra (November to April), more lettuce is brought from other cities. The shares of the different external sources (i.e. Kumasi and Lomé) again depend on the climatic conditions obtaining in those areas. The present survey was conducted at a time, when Accra had a dry weather, whereas Kumasi was already in its rainy season, which could explain the large share of externally grown lettuce on Accra's market. The situation during other periods would have to be assessed in a repetition of this survey in different seasons.

**Lettuce Distribution Pathways**

In both investigated cities, the major distribution pathway is from farm gate to wholesalers, from wholesalers to permanent retailers and from retailers to the final target groups (Figures 5.1 and 5.2). Based on the information gathered on the markets, an estimation of the number of lettuce dealers in the two cities was made. Assuming there are 7-8 central- and 43 neighborhood markets in Accra (modified from De Lardemelle, 1996), a total number of 40 wholesalers and 400 permanent retailers was calculated (excluding *Independent Vegetable Sellers*). Due to the outstanding importance of the Agbogbloshie Market in vegetable trade, this market was considered as a separate type of CM. For Kumasi, based on the 3 larger and 18 neighborhood markets, about 20 wholesalers and 160 permanent retailers were estimated. In Kumasi, hardly were there any *Independent Vegetable Sellers* found.

The importance of mobile retailers is uncertain and difficult to determine, as they are hard to spot. In Accra, 21 of them were found during this survey, whereas in Kumasi no mobile retailers were spotted at all.

**Total Amount of Lettuce traded in Accra compared to Kumasi**

The total amount of lettuce handled and purchased in the two cities was extrapolated based on amounts, the stratification of traders and number of traders. An alternative assessment was based on areas and production figures.

The total lettuce production during dry season in urban and peri-urban Accra ranges between 900 and 1000 t/y. Another 300 t/y are added from other cities summing up to approximately 1250 tons of lettuce per year purchased and consumed in Accra.

For Kumasi, it can be calculated on the basis of cultivation area and information on productivity that about 1000 t of lettuce is produced per year. The market turnover was estimated as 850 t/y. Since large quantities of lettuce produced on Kumasi's urban farms are transported to Accra and other cities without ever going to Kumasi markets, this difference seems to be justified. Further, it agrees with the figure calculated by Leitzinger (2000), who estimated a total lettuce consumption of 615 t/y in Kumasi. His survey was based on interviews on household-level. It can be confidently expressed that nearly all lettuce actually consumed in Kumasi is also produced there.

### 5.5 Customers and consumers

The largest client of the lettuce marketing chain are the fast food sellers, buying 60% of the total lettuce in Accra and a greater 83% of the lettuce in Kumasi. Restaurants, hotels and canteens buy 38% of the total lettuce traded in Accra and 15% in Kumasi. Private households in Accra and Kumasi rarely purchase lettuce, making up for only 2% of the total lettuce sold on the assessed markets. This reflects the fact that lettuce is not part of the traditional Ghanaian diet. It is certainly possible that especially upper class households buy lettuce rather from *independent vegetable dealers* or from *supermarkets*, which were not covered in this present survey. However, there are only very few supermarkets (all in Accra) that sell fresh vegetables. A rapid assessment in two typical (upper class) suburbs showed that the share of households would still remain in the 2-4% limit when compared with the quantities bought by fast food sellers, canteens and restaurants.

**- Fast food stands**

Almost all fast food stands purchase their vegetables from markets, i.e. not at farm-gate. In fast food stands, lettuce is normally mixed with other vegetables like cabbage, carrots and onions, with cabbage and carrots also mostly coming from urban farms. The content of lettuce in the offered meals varies. Most fast food stands serve lettuce as a side dish along with fried rice, plain rice, so-called waakye rice or with fried eggs; in few cases also with jollof rice or bread.

Sizes and appearances of the stands vary. Most commonly, they consist of a square shaped wooden box with a small opening in the front to sell the dishes. Other stands simply have a table and a few pots or thermo-boxes for the food. The (home) ready-made salad is usually stored in plastic plates and sometimes covered with cellophane foil.

Dr. P. Johnson of Ghana's Food Research Institute (NRI/DFID/FRI, 2000) estimates from field surveys that there are approximately 15,000 street food vendors in Accra. According to AMA statistics gathered from different suburbs, about one third of the registered vendors sell food known for its salad (lettuce and/or cabbage) supplement mostly from urban agriculture.

A survey among 90 sellers from this group showed that on average 50 units per fast food seller are sold with a salad component per day. This gives a total of about 250,000 units or fast food consumers; certainly a rough estimate. About 60% (or 150,000 meals) of these units contain lettuce, the others only cabbage and other vegetables.

Alternatively, we estimated the number of fast food consumers by considering the total amount of lettuce traded on Accra's markets (950 t/y), and extracting the fraction that goes to fast food stands (60%) and dividing it by the average weight of the lettuce in one fast food dish (12g), about 130,000 fast food meals with lettuce are sold per day. Combining both assessments, it seems that about 130,000-150,000 units of lettuce are served per day.

Under additional consideration of cabbage and spring onions, it can be assumed that in Accra everyday, probably more than 200,000 people consume uncooked vegetable outside their household. If we consider also canteens and restaurants another 80,000 beneficiaries from urban agriculture are possible. However, this large group also comprises the part of Accra's population at risk of food contamination.

Although sellers claim to wash their vegetables with tap-water, the washing methods and procedures described by them are in most cases not sufficient to secure decontamination of lettuce according to laboratory test by IWMI (Amoah, unpublished). It is therefore not surprising that salad from street food vendors was found to be contaminated with pathogens (Mensah et al., 2002). A perception study conducted in Kumasi (Olsen, 2006) shows, however, that street food vendors are convinced that they have eliminated risks by their practices of washing lettuce. For health campaign to be effective it is important to target these beliefs of risk-control and eradicate the misunderstanding of safe practices related to washing of lettuce, safe food temperatures etc.

**- Consumers**

Street food containing lettuce is available in the areas of all income groups, with relatively more frequent lettuce supplement in low-income areas. Customers are mostly males (70%) and buy 3-4 times a week. Like the typical urban dweller, most live in low-class (50%) and middle-class (ca. 38%) areas, and often work in the small-scale private sector, but can also be businessmen as well as students. Some of the fast food with lettuce supplement belongs to the cheapest food available in town attracting the poor and their dependants, as stated by Essamuah and Tonah (2004).

Consumers translate their general risk awareness into decisions by selecting food vendors they have personal trust in through the physical appearance of their stand and food.

## 5.6 Conclusions and strategies for improved hygiene

The survey has confirmed that the majority of the lettuce coming to urban markets has their origin in urban farms. Many of them have only access to contaminated water for irrigation. While there should be the awareness of the potential health risks to consumers, it is also important to realize the important role of this new and growing economy to the city's food supply. In Accra, at least 200,000 people benefit everyday from vegetables produced in urban agriculture. Both benefits and risks should therefore be taken into account when intervention strategies are discussed.

It has been shown that although more direct pathways exist, the majority of lettuce distribution from farm gate to customers runs through the urban markets.
Further, this survey has identified the fast food sellers as the major customer group of the lettuce market. In order to reduce the consumers' health risk resulting from contaminated lettuce, it is pertinent to address fast food sellers through health campaign. Also, restaurants and canteens, which sell a reasonable fraction of the total amount of lettuce produced in the two cities, should be included in such programs. Although they often have better infrastructure for hygienic preparation of raw-eaten vegetables than dealers in markets or fast food sellers, it also depends on the applied washing method in order to ascertain that the lettuce is thoroughly clean of bacterial load. Since most restaurants and canteens are registered, they should be easier to access and control than street vendors.

Vegetable dealers and street food vendors could be approached through the activities of extension agents, including units from MoFA (Ministry of Food and Agriculture), AMA (Accra Metropolitan Assembly) and other government bodies. MoFA's programs directed to vegetable sellers and market infrastructure have already been launched and are still ongoing. Different existing programs should be coordinated and focus on the health risk of raw-eaten vegetables. MoFA's extension services should also be involved in health implementation activities directed at farmers and street food sellers.

A good entry point for intervention programs could be found in the already existing associations. Various vegetable sellers associations and the so-called Maggi© Fast Foods Association of Ghana would be suitable networks to access the described target groups. Their organisational structures should be strengthened so that they can be used for training purposes or as platform for information exchange with government bodies. Unfortunately, many vegetable dealers and fast food sellers are not yet members of the existing associations.

A legal framework, consisting of a set of by-laws (Laryea, 2002), to regulate the hygiene standards in markets and food stands is existent, although it might be better adapted to reality. But the law enforcement, which would be the task of AMA health department, is unsatisfactory due to lack of resources for the task force and the ignorant attitude of dealers and sellers. Since many fast food sellers are not registered and do not have permanent stands and are not members of any association, it is particularly difficult to approach them or control their movement. A health campaign broadcasted through radio, TV or newspapers could reach households, fast food consumers and restaurants, and thus increase the pressure on vegetable dealers and fast food sellers to comply with the recommended hygiene standards.

# 6. Sanitation and urban wastewater management

*This chapter discusses key sanitation and wastewater management issues in Ghana and their relevance to urban agriculture. It reviews common wastewater concepts and describes the domestic wastewater disposal and treatment facilities in Ghana's main urban centers and how they are managed. The chapter is based on local literature, interviews with relevant stakeholders and observations made by visiting the urban centers.*

## 6.1 Review on wastewater concepts

### 6.1.1 Wastewater types and terminologies

Due to limited industrial development, d*omestic* effluent and urban run-off contribute the bulk of wastewater generated in Ghana. Domestic wastewater usually contains *greywater (sullage),* which is wastewater from washrooms, laundries, kitchens etc. and can also contain *blackwater,* which is generated in toilets. Blackwater might contain besides urine and faeces/excreta (together sometimes called nightsoil) also some flush water. The mixture is termed as *sewage* if it ends up in a sewerage system or *septage* if it ends up in a septic tank. Figure 6.1 shows a schematic diagram that summarizes the different types of wastewater.

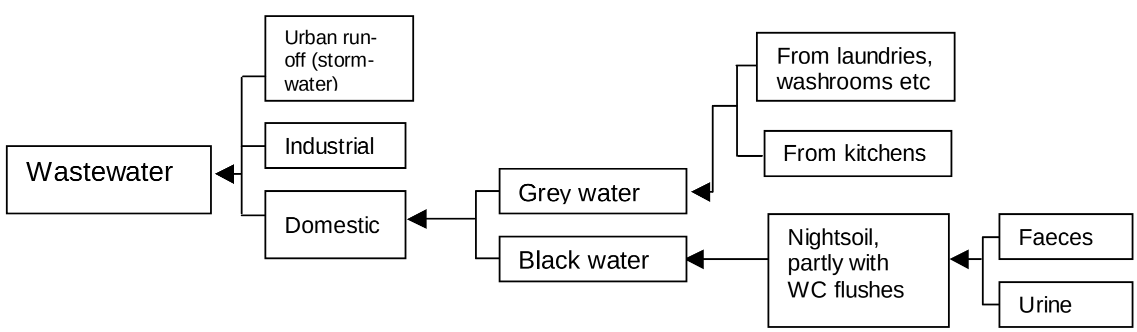



**Figure 6.1:** Typical types and terminologies used for wastewater in Ghana

Faecal sludge refers to all sludge collected and transported from on-site sanitation systems by vacuum trucks for disposal or treatment (Strauss *et al*. 1997) and differs slightly from conventional wastewater as its quality is subject to high variations due to storage duration, temperature, technology and performance of septic tanks etc. Table 6.1 shows the wide differences in the characteristics of faecal sludge and wastewater. The figures combine results of studies in Accra/Ghana, Manila/Philippines and Bangkok/Thailand. Box 6.1 explains some of the indicators used in this book.

**Box 6.1:** Key indicators of water quality

- **Electrical Conductivity** (EC) indicates the salt content
- **Total Dissolved Solids** (TDS) comprise inorganic salts and small amounts of organic matter dissolved in water
- **Suspended solids** (SS) comprises solid particles suspended (but not dissolved) in water
- **Dissolved Oxygen** (DO) indicates the amount of oxygen in water
- **Biochemical oxygen demand** (BOD) indicates the amount of oxygen required by aerobic microorganisms to decompose the organic matter in a sample of water in a defined time period
- **Chemical oxygen demand** (COD) indicates the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant
- **Total coliforms** (TC) is encompassing faecal coliforms as well as common soil microorganisms, and is a broad indicator of possible water contamination
- **Faecal coliforms** (FC) is an indicator of water contamination with faecal matter. The common lead indicator is the bacteria *Escherichia coli* or *E. coli*.
- **Helminth** analysis looks for worm eggs in the water
- **$NH_4$-N** and **$NO_3$-N** show dissolved nitrogen (Ammonium and Nitrate, respectively)
- **Total Kjeldhal Nitrogen** is a measurement of organically-bound ammonia nitrogen
- **Total-P** reflects the amount of all forms of phosphorous in a sample

**Table 6.1:** Characteristics of faecal sludges and sewage from tropical countries

| | **Faecal sludge** | | **Sewage** |
|---|---|---|---|
| | **High strength** | **Low strength** | |
| Source | Public toilet or bucket latrine sludge | Septage | Tropical countries |
| Characterization | Highly concentrated, mostly fresh; stored for days or weeks only | Low concentration: usually stored for several years; more stabilized | |
| Chemical oxygen demand (COD) (mg/l) | 20,000 – 50,000 | <15,000 | 500 – 2,500 |
| COD/BOD* | 5:1 -10:1 | 5:1 -10:1 | 2:1 |
| $NH_4$-N (mg/l) | 2,000 – 5,000 | <1,000 | 30 – 70 |
| Total solids (%) | ≥ 3.5 | < 3 | < 1 |
| Suspended solids (mg/l) | ≥ 30,000 | ≈ 7,000 | 200 – 700 |
| Helminth eggs (no/ l) | 20,000 – 60,000 | ≈ 4,000 | 300 – 2,000 |

**Source:** Strauss *et al*. (1997) and Mara (1978).

### 6.1.2 Disposal and treatment methods

Wastewater disposal taking place at the point of waste production like within individual houses without transportation is termed as *on-site disposal* while in *off-site disposal*, there is a transportation element. On- site methods include dry methods (pit latrines, composting toilets), water saving methods (pour-flush latrine and aqua privy with soakage pits and methods with high water rise (flush toilet with septic tanks and soakage pit, which are not emptied). Off- site methods are bucket latrines, pour-flush toilets with vault and tanker removal and the conventional sewerage system. Conventional sewerage systems can be combined sewers (where wastewater is carried with storm water) or separated sewers.

Wastewater treatment can also be done on-site or off-site. An example of on-site treatment is with septic tanks. There are three broad levels of treatment: primary treatment where gross particles and objects, sand, grit, suspended solids are removed. Secondary treatment is the removal of organic matter and tertiary treatment is when nitrogen compounds and phosphorus compounds and pathogenic microorganisms are removed. The treatment can be done mechanically like in trickling filters, activated sludge methods or non-mechanically like in anaerobic treatment, stabilization ponds etc. The major treatment methods found in Ghana are highlighted as follows.

**Stabilization ponds:** this is a low-technology treatment process; basically a shallow body of wastewater contained in an earthen basin (lagoon). It usually has 4 or 5 ponds of different depths with different biological activities taking place in each, hence their names (anaerobic, facultative and maturation ponds). The first pond, anaerobic pond, is mainly a pre treatment step acting as settling tanks with anaerobic degradation of organic matter, like faeces. In the facultative ponds[1], organic matter is further broken down to carbon dioxide, nitrogen and phosphorous by using oxygen produced by algae in the pond. Maturation ponds are aerobic systems used as post treatment to facultative ponds, to further reduce organic matter and pathogenic microorganisms before disposal into natural water bodies. Such ponds are in Asafo (Kumasi) and Tema Community Three, as well as in Legon staff village, Achimota AMA and Teshie Nungua AMA.

[1] Most plants in Ghana have two facultative ponds.

**Trickling filter:** it is made up of a round tank filled with a carrier material (volcanic rock, gravel or synthetic material). Wastewater is supplied from above and trickles through the carrier material covered with a biofilm, with living bacterial matter responsible for degradation of organic matter. The effluent of a trickling filter contains sludge washed from the carrier material and is removed by means of a secondary filter. This method is widely used in Accra, like at Burma Camp, the Nsawam Prison and in Kumasi at the University of Science and Technology (Akuffo, 1998).

**Activated sludge:** it is based on the principle that intense wastewater aeration forms flocs of bacteria (activated sludge), which are capable of thorough degradation of organic matter and could easily be separated by sedimentation. A part of the activated sludge is recycled to maintain the concentration of active bacteria in the tank. The system consists of an aeration tank with mechanical mixers and the system exists in various forms i.e. conventional installation, oxidation ditches, carrousel process and processes aimed at biological nitrogen and phosphorous removal. Most larger hotels in Accra like La Palm, Labadi and Golden Tulip or the 37 Military Hospital use this method.

## 6.2 Domestic wastewater disposal and treatment in Ghana

Urban wastewater management is based on domestic or municipal wastewater. Most industrial activities in Ghana are evident in urban centers along the coastline like Tema, Accra and Takoradi and they dispose off their wastewater directly to the ocean. According to the Global Water Supply and Sanitation Assessment 2000 Report, 63% of Ghanaian population has improved sanitation facilities with countries like Niger and Benin having less than 25%. While most countries in the West African sub-region show a very high disparity in the provision of sanitation services between rural and urban areas like in Senegal (94% urban, 48% rural), Benin (46% urban, 6% rural), Ghana seems to have a good balance (62% urban, 64% rural). However, an inter-regional analysis for Africa shows that West Africa has a very bad sanitation coverage (48%), Central Africa has the worst (29%) while North Africa has the best (74%) followed by South Africa (63%) and East Africa (62%) (WHO/UNICEF, 2000).

### 6.2.1 Disposal facilities

The population and housing census carried out in Ghana in 2000 analyzed waste disposal facilities in three categories; the kind of toilet facilities being used, means of solid waste disposal and means of liquid waste disposal (Ghana Statistical Service, 2002). Figure 6.2 shows the kinds of toilet facilities[2] that the population used.

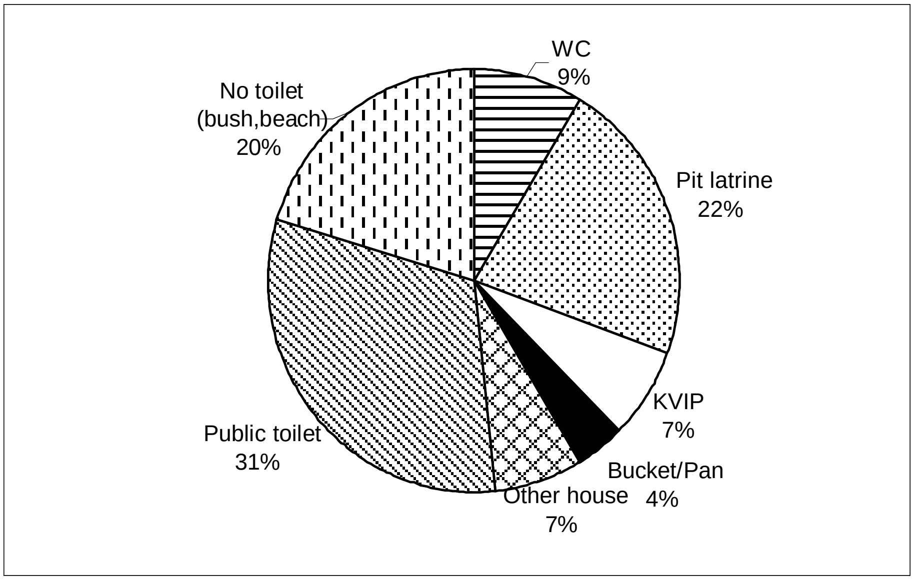



**Figure 6.2:** Kinds of toilet facilities used (Data from Ghana Statistical Service, 2002).

Pit latrine is more prevalent in rural areas and the wastewater is unavailable for use. Water closet (WC) and Kumasi Ventilated Improved Pit latrines (KVIP) are not common in households in most regions, possibly because of the cost of construction and the need for piped water in using the WC. Many households countrywide however use public toilets reflecting the absence of toilet facilities in many dwelling places. Quite striking though is that more than 20% of the households in Ghana have no toilet facilities, with the percentage increasing to about 70 for the three northern regions.

On liquid waste disposal[3], about 38% of Ghana's population throw it on the streets or outside, 21% directly throw it in the gutters, 35% in the compound and 1% in other places. Only 5% of the population dispose their liquid waste through sewerage networks connected to treatment plants as shown in Figure 6.3. All officially recorded sewerage systems were in urban areas, mainly Tema, Accra and Kumasi. A smaller study carried out in Accra estimated that about 12% of the population throws it on the streets or outside, 53% directly into gutters, 20% in the compound.

[2] Toilet facilities here mainly carried blackwater.
[3] Liquid waste here mainly refers to greywater.

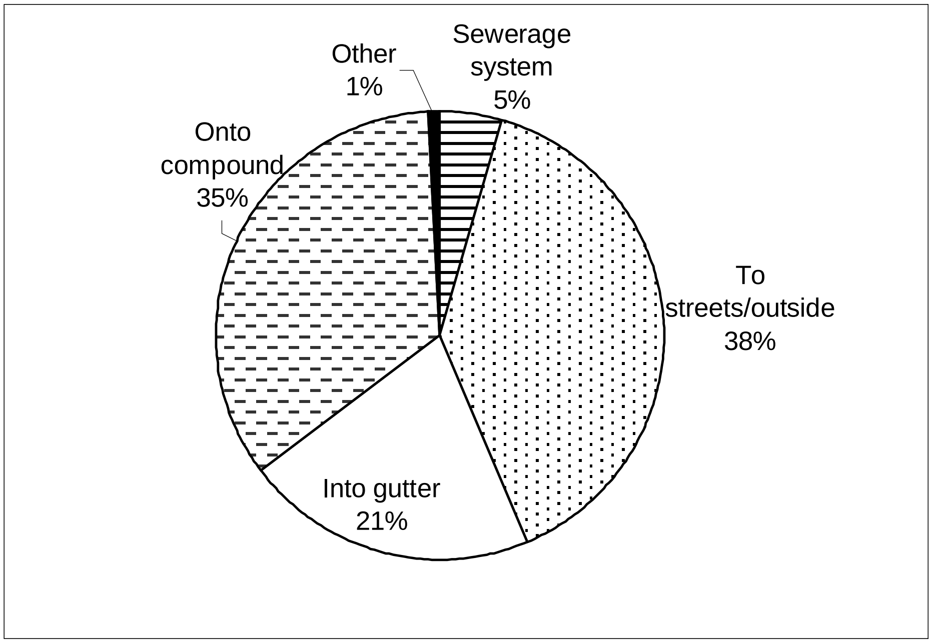



**Figure 6.3:** Means of liquid waste disposal (Data from Ghana Statistical Service, 2002).

### 6.2.2 Treatment facilities

Industrial wastewater treatment in Ghana is minimal. Some industries and abattoirs carry out some primary treatment. Most of the treatment facilities in Ghana are for treating faecal sludge and sewage. Sewage treatment systems receive wastes from the sewerage system while faecal sludge treatment plants are fed by trucks carrying waste from septic tanks, public toilets etc. Following a monitoring survey by Ghana's Environmental Protection Agency (EPA) on the number, status, treatment methods and distribution of both faecal sludge and sewage treatment plants in Ghana (EPA, 2001), a follow up survey was carried out by this study to crosscheck some of the information obtained. Figures 6.4 and 6.5 summarize the information of both sources:

More than half of all treatment plants in Ghana are in the Greater Accra region, mainly in the capital city of Accra and port city of Tema. Two regions (Brong Ahafo and Upper West) have no treatment plants at all. The stabilization pond method is the most extensively used with almost all faecal sludge and large-capacity sewage treatment plants using the method. Most trickling filters and activated sludge plants recorded have a low capacity and belong to private enterprises like larger hotels. Less than a quarter of the treatment plants are operational (Figure 6.5).

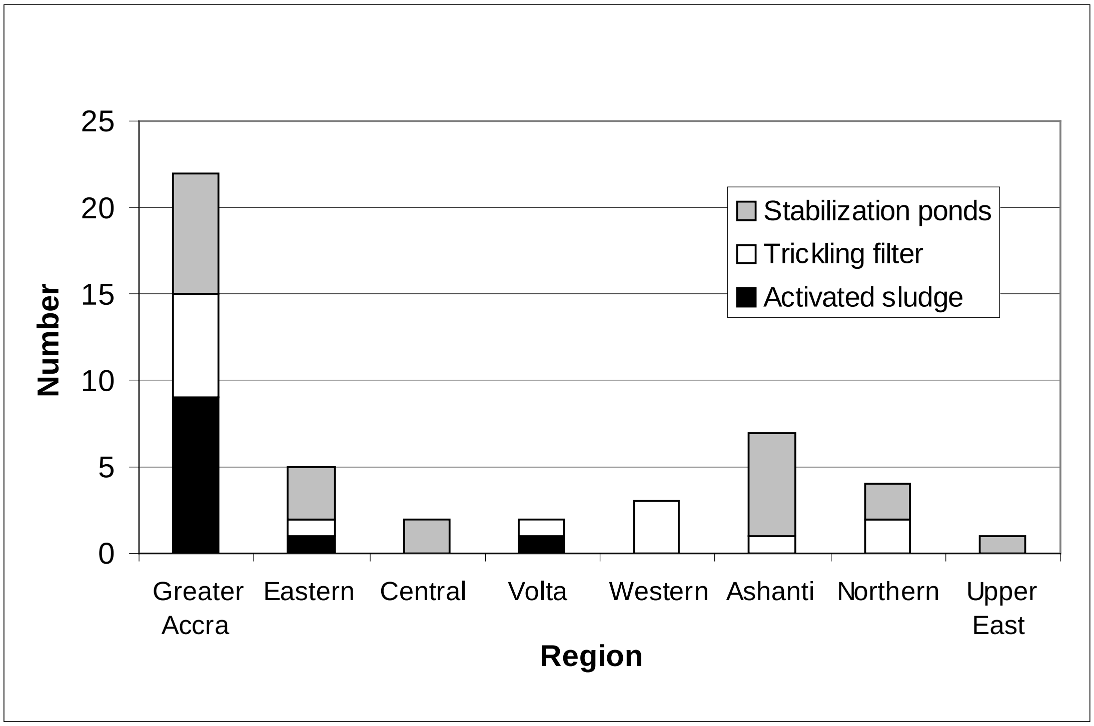



**Figure 6.4:** Regional distribution and design of wastewater treatment systems in Ghana

No precise figure can be given on the percentage that meets the EPA effluent guidelines and the capacity of these, but indications show that hardly any of the plants is meeting them (Akuffo, 1998).

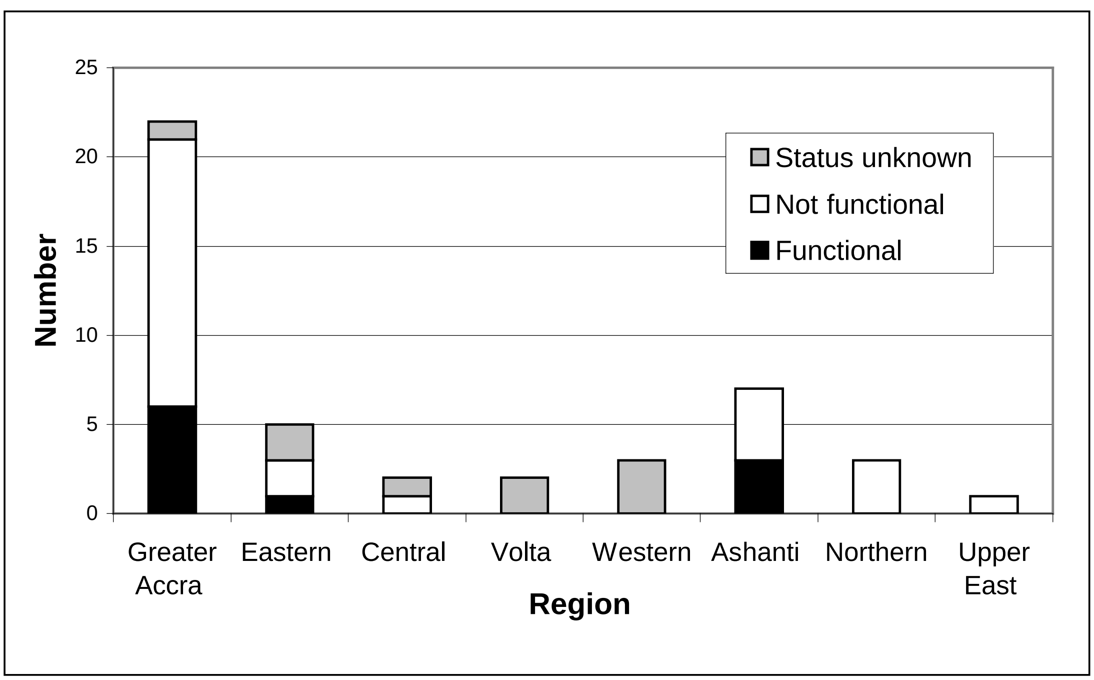



**Figure 6.5:** Status of wastewater treatment plants in Ghana (2001)

## 6.3 Kumasi as a case study

### 6.3.1 Background information

Kumasi, the capital of the Ashanti region is the second largest city in Ghana. It has a population of about one million people with an annual growth rate of 5.9% (Ghana Statistical Service, 2002). The city covers an area of 22,300 ha but only 5,575 ha are developed. Four main streams (Daban, Sisa, Wiwi and Subin) flow through Kumasi city, with the Subin originating from and cutting through the city center. The streams join downstream the Oda River. Quite characteristic of the drainage system in Kumasi is a concrete drain that was superimposed on the Subin River to avert flooding in the city. This has now turned into a 'solid and liquid waste highway' due to the dumping of all sorts of wastes in the drain.

### 6.3.2 Volumes and sources of wastewater

**Domestic wastewater:** Most residents of Kumasi (about 38 %) use public toilets. There are about 400 public toilet facilities in Kumasi, equipped with either facilities to flush and a holding tank or KVIP latrines with 2 pits per latrine (used alternatively) or one pit per latrine. The use of double pit latrine has not proved successful: As the pits were filling up faster than expected, the sludge retention time in the previously used pit became too short to allow sludge stabilization. About 120,000 people use bucket (pan) latrines. However, it is being phased out because of its less hygienic nature. Another 26 % of the population use household water closet (WC) linked to septic tanks and seepage pits. Septic tanks perform well in areas where there is sufficient space for a drain field but most of the existing septic tanks overflow to surface drains due to undersized or non-existent drain fields. Only 8 % of the population are connected to a sewerage system while the rest of the population have no toilet facilities at all (See Figure 6.6).

**Industrial wastewater:** Kumasi being an inland city is not highly industrialized. Thus industrial wastewater is not significant in quantitative terms. The principal generators of industrial wastewater in Kumasi are the two breweries, a soft drink bottling plant and an Abattoir. Together, they generate about 1,000 $m^3$ of effluent daily, all of which end up in the city's drains without treatment. Light industrial activities in the so called "Suame Magazine" suburb and sawdust from the sawmills also generate significant amounts of waste oil and leachate respectively which add to environmental pollution (Simon et al., 2001).

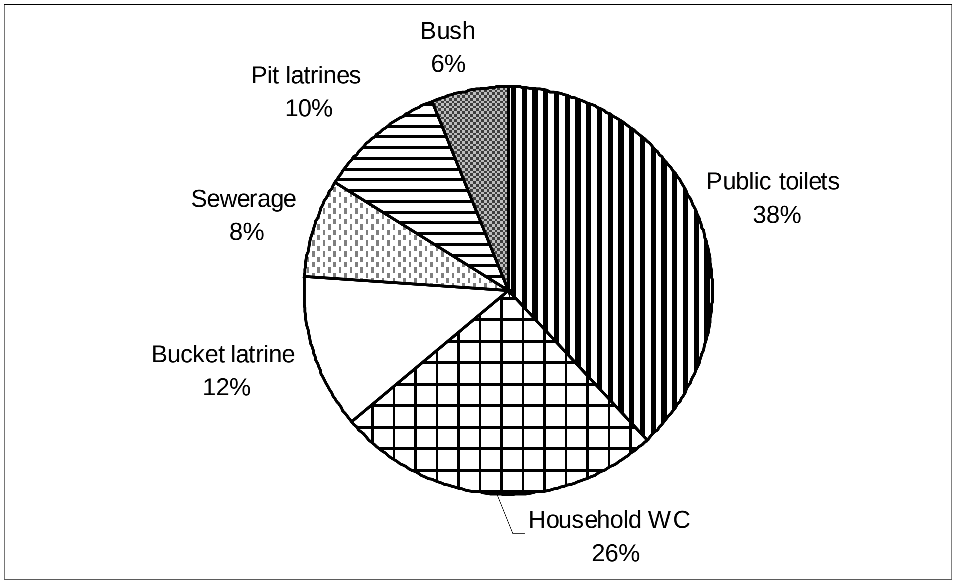



**Figure 6.6:** Means of domestic wastewater in Kumasi

### 6.3.3 Disposal and treatment of domestic wastewater

**Sewage treatment plants**: Five separate small-scale sewerage systems currently exist in Kumasi. There are two conventional systems at a local university (KNUST) and one connecting the Komfo Anokye Teaching Hospital (KATH), City Hotel and the central parts of the 4BN Army barracks. There are two satellite systems at Ahinsan and Chirapatre suburbs and one simplified sewerage system at Asafo suburb. However, both of the conventional systems are not in operation.

The KNUST plant was designed as a trickling filter system and had an inflow of about 390 $m^3$/day but has been under rehabilitation [and out of order] for more than 10 years now and raw sewage from KNUST is discharged to a 'wetland' linked to River Wiwi, where urban farmers practice vegetable farming. Greywater mainly from students' hostels and staff quarters (250 $m^3$/day) runs in open gutters to nearby streams (Wiwi and Sisa).

Asafo's simplified sewerage network was built in 1994 in a high population density suburb of Asafo. The plant has 4 stabilization ponds and can serve up to 20,000 people but only 60% of the people are connected (1.2% of the Kumasi population). The ones not connected say that they cannot afford the connection fee. It is usually in good working condition. Its effluent (Table 6.2) is discharged into a nearby stream-turned-wastewater drain called the Subin drain.

**Table 6.2:** Effluent quality of Asafo sewage treatment plant

| ----------------------------------Effluent quality ------------------------------------ | | | | | | | |
|---|---|---|---|---|---|---|---|
| **pH** | **EC (µs/cm)** | **$NH_4$-N (mg/l)** | **$NO_3$-N (mg/l)** | **DO (mg/l)** | **SS (mg/l)** | **TC x $10^6$ (MPN/100ml)** | **FC x $10^4$ MPN/100ml** |
| 7.5 | 722 | 50.13 | 16.0 | 8.47 | 0.33 | 4.15 | 9.15 |

Source: Keraita et al. (2002a)

The two satellite plants are at two low-cost housing estates of Chirapatre and Ahinsan. They were built in the late 1970s. They were equipped with a sewer network and communal septic tank systems for black water. Chirapatre had six communal septic tanks for a population of 1800 inhabitants and Ahinsan five for about 1500 inhabitants. Sewer lines were blocked and septic tanks were in a bad state of maintenance. Both schemes have been replaced with two sewerage networks with waste stabilization pond treatment methods. *Greywater* (effluent from bathrooms and kitchens) is discharged into the drainage system.

**Faecal sludge treatment plants**: until a few years ago, there has not been any proper treatment plant for faecal sludge in Kumasi. A temporary treatment facility with design capacity 144 $m^3$/day was built south of Kaase in 1999 (Leitzinger and Adwedaa, 1999). It was soon overloaded with up to 500 $m^3$/day (Table 6.3) and faecal sludge flowed into the Sisa River (see Figure 7.1) without any treatment. However, having no alternative, the Kaase plant was used until 2003, when another 200 $m^3$/day capacity plant started being used at Buobai. The use of the Buobai plant was stopped due to conflicts with the community. Since March 2004, the local authority is operating a second faecal sludge treatment plant at Dompoase with a design capacity of 300 $m^3$/day of faecal sludge and 300 $m^3$/day of leachate from the nearby landfill. The actual inflow of sludge is about 240 $m^3$/day of the 500 $m^3$ collected per day by on-site systems.

**Table 6.3:** Quality of wastewater at Kaase Faecal sludge treatment plant

| | **EC (µS/cm)** | **BOD (mg/l)** | **COD (mg/l)** | **$NH_4$-N (mg/l)** | **$NO_3$-N (mg/l)** | **Total P (mg/l)** | **Helminths (No/l)** |
|---|---|---|---|---|---|---|---|
| Influent | 37,300 | 14,090 | 43,543 | 1,948 | 59 | 319 | 787,837 |
| Effluent | 23,000 | 3,250 | 5,807 | 1,653 | 104 | 399 | 7,388 |

**Source:** Leitzinger and Adwedaa (1999).

### 6.3.4 Institutional aspects of wastewater management in Kumasi

The Kumasi Metropolitan Assembly (KMA) is responsible for wastewater management in the city. Currently, it engages more in the promotion and establishment of active involvement of communities and the private sector in more direct services like collection and haulage of faecal sludge, operation and maintenance of the facilities (public toilets, sewerage systems, treatment systems), collection of user charges etc. KMA has a sanitation strategic plan for Kumasi with recommendations for each type of housing area in the city based on the characteristics of these areas as well as the preference of the user, and willingness and ability to pay. The plan recommends the use of simplified sewerage in high population density areas, latrines in the medium-density areas and WCs and septic tanks in the low-density areas. The construction of new treatment plants and public sanitation facilities in markets, schools and light industrial areas was encouraged, while existing public bucket latrines were phased out.

The KMA has by laws addressing environmental sanitation (KMA, 2000). Liquid waste collection and treatment by service providers is governed by regulations. KMA and the Environmental Protection Agency (EPA) are the two bodies responsible for certifying any treatment plant that is constructed in Kumasi. They also address city drainage and pollution control. With increasing water pollution in Kumasi, many people attribute it to the failure of KMA to collect, treat and dispose of wastewater efficiently. EPA, the government body with the corresponding monitoring and prosecution mandate has limited resources, hence lacking the basis for any legal suit. In addition, government institutions like hospitals, learning institutions etc also contribute to water pollution, making the prosecution of individuals or private establishments a farce.

## 6.4 Situation in Accra and Tamale

In Accra-Tema, there are about 22 sewerage systems and sewage treatment plants serving institutions and hotels, but – as mentioned above – only a few are operating and maintained in accordance with designers’ intentions (Akuffo, 1998; EPA, 2001). These plants serve in total about 5-7% of Accra’s population (Figure 6.7). The largest plant, which started operations in 2000, works with an upflow anaerobic sludge blanket (UASB). The plant can handle about 16,000 $m^3$/day but receives less than 5000 $m^3$/day due to the small size of the sewerage. After a one-year test run the plant was handed over to the Municipality and broke partially down in 2003/4. The sewage was consequently directed into the ocean.

Faecal sludge treatment plants in Accra are no better. The main plants at Achimota with dumping rate of about 250 $m^3$/day; Korle Gonno (50 $m^3$/day) and Teshie-Nungua (80 $m^3$/day) are badly maintained or out of order. Untreated faecal sludge ends up being disposed of in nearby streams (Achimota, Teshie) or in the seashore, as is the case at Korle Gonno, also called "Lavender Hill". Currently, more than half of Accra's collected faecal sludge is dumped into the ocean.

Like in Kumasi, greywater is mostly transferred through storm water gutter into drains and streams. Accra's major wetland, the Korle Lagoon, receives 'fresh' water through the Odaw stream, which is the main urban storm water drain with a catchment area covering more than 60% of the city. Due to Accra's limited sanitation infrastructure, the Odaw and the lagoon receive a vast amount of wastewater as well as solid waste (Biney, 1998; Boadi and Kuitunen, 2002).

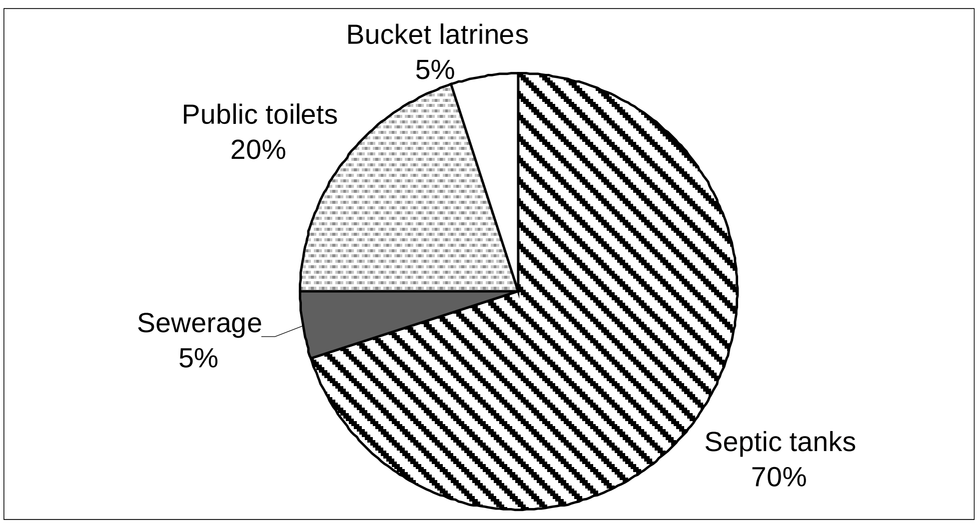



**Figure 6.7:** Means of nightsoil collection in Accra

In Tamale, there is no conventional public sewerage system. The two private treatment plants that were in existence (Kamina barracks and Tamale hospital at Kokuo) are not functional. From a survey conducted in 100 households in Tamale (Asare, 2002), 37% had individual household toilet facilities (in which 15% were using WCs, 6% KVIPs and 16% bucket latrines). Fifty one percent (51%) were using public toilets while the rest (12%) had none (see Figure 6.8).

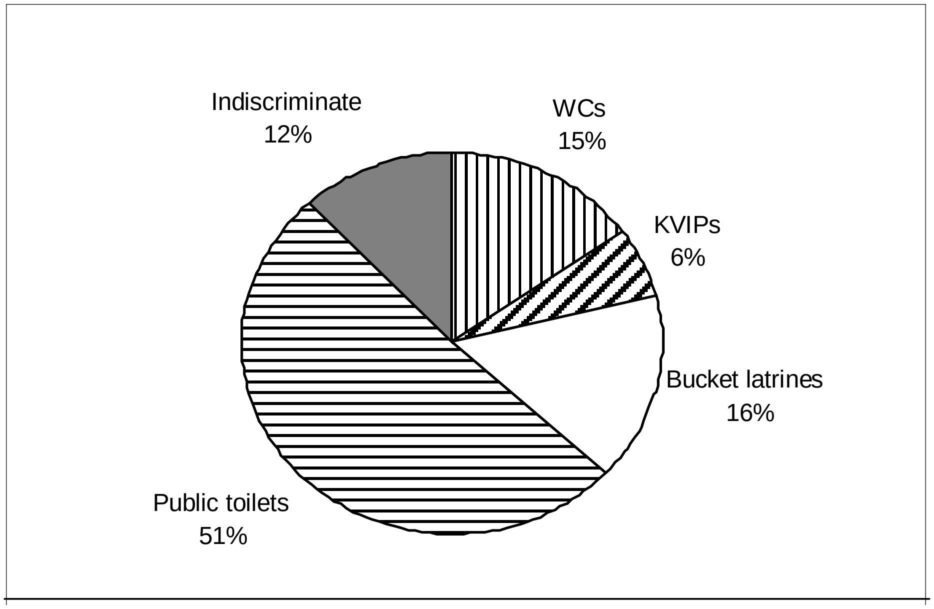



**Figure 6.8:** Means of nightsoil collection in Tamale

The records of the Municipal Sanitation Unit (MSU) in Tamale show that average volume of faecal sludge generated annually is 30,600 $m^3$. About 83% of this is collected by the MSU and disposed of on wetlands and on farms in more than ten informal locations in and around the city. Though the MSU has no official reports on farm delivery of this waste, the suction truck drivers reported that during the dry season, farmers do request for faecal sludge to be discharged on their lands (see Chapter 8). Individual households, particularly those who use bucket latrine, dispose of the remaining 17%. A first sanitary landfill has recently been developed which should absorb besides solid waste also faecal sludge.

## 6.5 Applicability of conventional wastewater treatment systems

Efficient wastewater treatment and controlled use as evident in most high and middle income countries like Israel, Tunisia, Jordan etc have proved worthwhile in reducing the health and environmental risks associated with wastewater irrigation. However, in Ghana, as in most low-income countries, especially in sub-Saharan Africa, there is virtually no sanitation infrastructure. For efficient collection and treatment of wastewater, much investment is needed, which is not available. The little funds available in these countries are used for more prioritised sectors like provision of food, water supply, medical care and education.

Gijzen (2001) estimated the period of time needed to meet the European Union's (EU) effluent standards by a number of low and middle income countries, assuming that 1.5% of the GNP could be invested in sewers and treatment facilities (Table 6.4). The table shows that this time frame exceeds by far the economic lifetime of the treatment plant (20 – 30 years) and in many cases even that of sewers (50-60 years). For the implementation of conventional wastewater collection and treatment in developing countries to reach EU standards is therefore unrealistic.

**Table 6.4:** Estimated period of time needed to meet EU effluent standards at an investment level of 1.5%

| **Country** | **Population** (Million) | **GNP/capita** (US $/capita) | **Cos**t to meet EU standards (US $ / capita) | **Time** needed at 1.5% GNP per year (Years) |
|---|---|---|---|---|
| Bulgaria | 8.5 | 2210 | 3755 | 113 |
| Egypt | 60 | 1030 | 4000 | 259 |
| India | 935 | 335 | 3750 | 746 |
| Kenya | 29.2 | 290 | 4500 | 1034 |
| Mexico | 92.1 | 2705 | 3750 | 92 |
| Poland | 38.3 | 1700 | 1230 | 48 |
| Romania | 23.2 | 1640 | 1422 | 58 |

**Source:** Gijzen (2001).

Other than cost implications, laying sewerage systems, especially in densely populated areas seems economically unjustified. For example in Accra, the UASB treatment plant built near the Korle lagoon cannot operate to its full capacity. This is because the area is densely populated such that making sewer connections would mean rebuilding whole suburbs, which has not only economic but also social consequences.

## 6.6 Conclusions and Recommendations

Urban wastewater management in Ghana is the responsibility of local municipal authorities and is mainly concerned with domestic wastewater, as there are only few industrial activities and these are often along the coastline. The use of public toilets, latrines and open defecation are the forms of sanitation available in most Ghanaian cities with very limited sewerage networks (<5%). Statistics show that 63% of Ghanaians have access to improved sanitation facilities, but the distribution is poor with more than 70% of the population in the northern part of Ghana having no access to sanitation facilities. Wastewater treatment has an equally low coverage. Of the 42 plants in Ghana, more than half are in Accra and most of them, especially the public ones with larger capacity, are not or only partially functional.

There is more to be done to reduce wastewater production, improve sanitation infrastructure and enhance appropriate disposal strategies. The applicability of conventional sanitation and waste collection treatment and disposal systems is questioned as the financial and institutional resources and efficiency required alone for their maintenance are beyond the means of most municipalities. The World Bank currently supports solid waste management and its privatization in many West African countries. It is highly recommended that similar efforts be extended to the wastewater challenge. Town and city planning should develop corresponding realistic – decentralized - scenarios in close collaboration with the private sector and the research community to address for example the challenges of non-point source pollution. Special emphasis for immediate action should be given to those currently developing suburbs at the fringes of Accra and Kumasi where there are still opportunities to lay the ground for future sanitation infrastructure, which opportunities have been missed too often in the past.

# 7. Water quality in and around the cities

*This chapter presents findings from a study done in Kumasi, aimed at assessing the water quality in water bodies in and around the city, especially those used for irrigated agriculture. Physiochemical and microbiological parameters were measured. Data obtained from previous monitoring were also reviewed and are presented for comparison. Some references have been made to Accra and Tamale.*

## 7.1 Key indicators

The quality of water applied has implications for crop and soil productivity and consumers' health. The FAO and WHO guidelines on quality of irrigation water are the basis for national guidelines in many countries. Where domestic wastewater is the main source of water pollution, the two main indicators from the health perspective are Faecal Coliforms (FC colonies/100ml) and Helminth eggs (eggs/100 ml). These and other indicators, like BOD, are briefly explained in Box 6.1 of the previous chapter.

Limits to these parameters depend on the types of crops grown. For vegetables likely to be eaten raw, the irrigation water should in the ideal case have less than $1x\ 10^3$ faecal coliforms per 100 ml and ≤1 nematode egg per litre (WHO, 1989, 2006).

## 7.2 Sampling sites and methods

Fourteen sampling sites used for irrigation were selected in upstream and downstream locations of Kumasi along the major streams and rivers (Figure 7.1). These locations correspond in part with those used before by Cornish et al. (1999) and McGregor et al. (2002). Besides the major streams, two shallow wells close to streams were also sampled. Water samples were collected and taken for analysis in accordance with standard methods of water quality sampling and analysis (APHA, 1989). Parameters analysed included pH, Electrical Conductivity (EC), Ammonium- Nitrogen ($NH_3$-N), Nitrate – Nitrogen ($NO_3$-N), Phosphates ($PO_4$-P), Potassium (K), Faecal coliforms (FC) and Total coliforms (TC). The choice of parameters depended on their agricultural significance and ability of local labs to analyse them. A total of seven samples were collected from each site at 2-4 week intervals. These were done over a one-year period from the beginning of February to the end of June 2002, covering both dry and wet seasons. Rainfall data was taken from the nearby Kumasi met station.

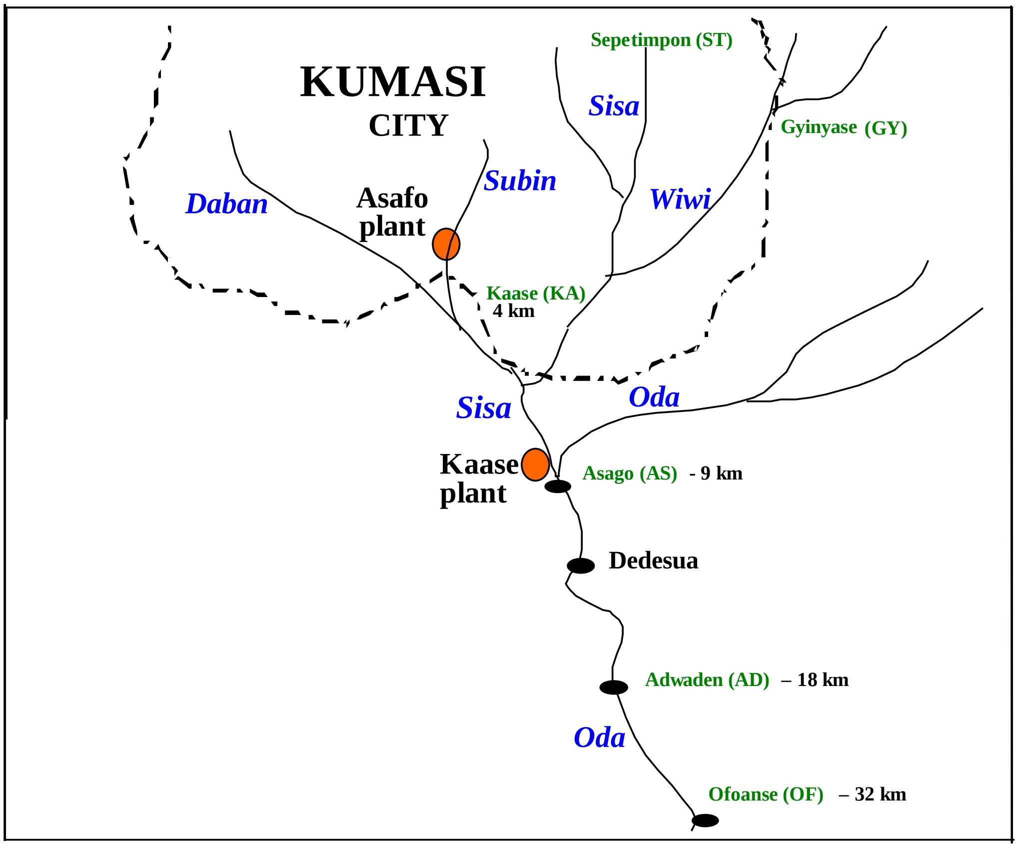



**Figure 7.1:** Stream network in and around Kumasi and some water sampling sites

## 7.3 Changes in water quality along the main streams

The Subin river, which originates from the heart of Kumasi and serves as storm water – cum wastewater channel (see Chapter 6), is heavily polluted by faecal and total coliforms, and shows low dissolved oxygen and high conductivity. This probably reflects the night soil dumping, direct disposal of domestic and all kinds of wastes from the urban areas. Animal skin dressing and piggery activities between the main wastewater source and the Subin River substantially prejudice pollution effects of source effluent on the river. Wastewater from the source shows a fairly consistent trend of high values in conductivity, turbidity and coliforms.

Many people rely on the stream and its tributaries for their domestic use (few have pipe-borne water) and for irrigation. The changes in water quality in streams in and around Kumasi are evident, and complaints have been coming from users, especially in Asago Village, 9 km from the city center, just downstream of the Kaase faecal treatment plant where the Sisa enters the Oda river.

The pH levels had few variations, ranging from 6.8 –7.2, which are in the normal range for irrigation water. The salinity levels were also low (EC <1 dS/m) and decrease downstream. Also, there is a significant difference in $NH_4$ between upstream and downstream (Figure 7.2) and there is a typical decline of the nutrient levels with increasing distance from the city (Figure 7.3). Compared to normal poultry manure application in vegetable production, the fertilizer effect of irrigation water is in general insignificant along the Subin and Sisa (Drechsel et al., 2005).

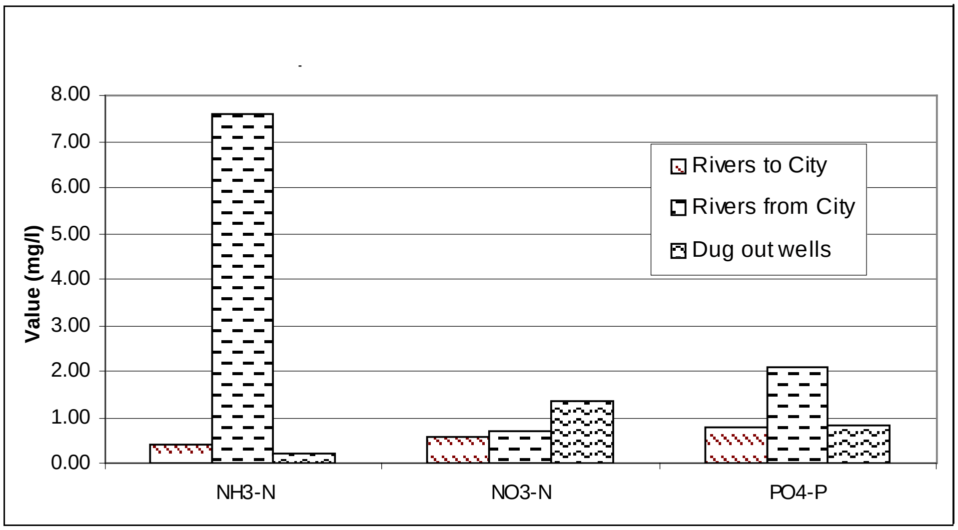



**Figure 7.2:** Comparison of average nutrient levels at different sampling locations

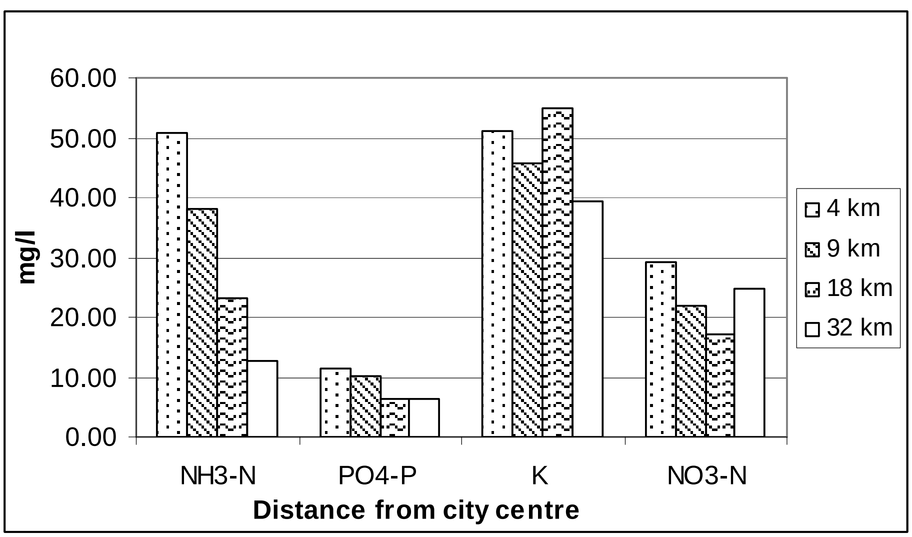



**Figure 7.3:** Variations of chemical parameters in downstream Kumasi

Microbiological pollution also followed the same declining trend with increasing distance from the city (Figure 7.4). For instance, total coliforms as indicator of faeces dropped from $3.5*10^{10}$ counts 4 km away from the city center to $1.7*10^{8}$ counts 18 km downstream. The same was observed for faecal coliforms. High coliform and $NH_3$-N in downstream water bodies could be associated with lack of adequate sanitation facilities and non-functional sanitation infrastructure, especially the Kaase faecal sludge treatment plant. It is worthwhile to note that in contrast to nutrient levels, the pathogen contamination of the stream remains high (more than $10^{6}$/100 ml) even 32 km downstream of the city, which is a serious health concern to users of this water source.

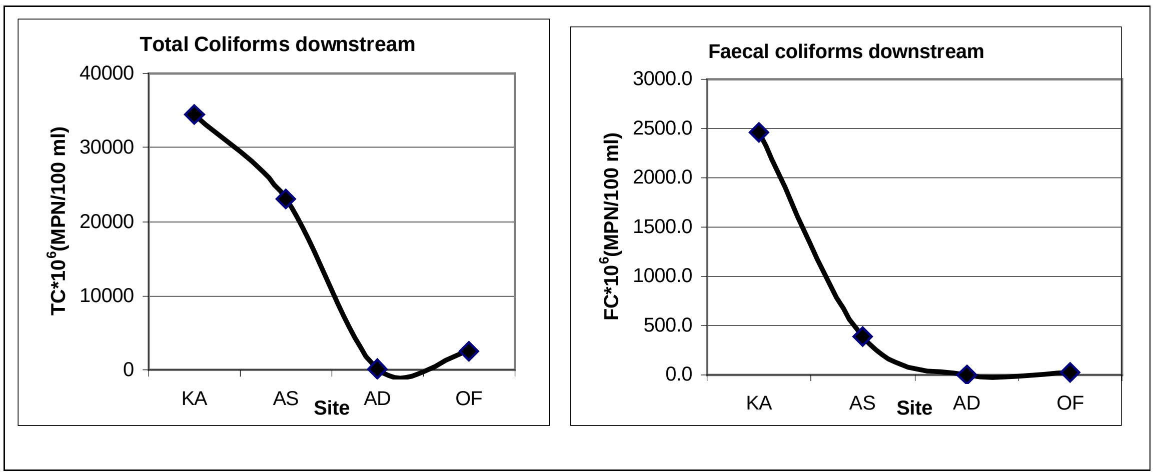



**Figure 7.4:** Changes in coliform levels downstream

Industrial wastewater is not significant in quantitative terms in Kumasi as there is limited industrial development mainly because Kumasi is an inland city. The main generators of industrial wastewater in Kumasi are the two breweries, a soft drink bottling plant and the abattoir generating a total of about 1000 $m^3$ of effluents daily which also end up in the city's drains and nearby streams (Simon et al., 2001, Keraita, 2002). There are light-industry activities, which generate significant amounts of non-collected waste oil and leachate.

Heavy metal contamination remains localized. In most cases, the stream metal levels do not exceed common norms in and around Kumasi (McGregor et al., 2002; Cornish et al., 1999; Mensah et al., 2001). The situation can be different in Ghana's rural gold mining areas, or, for example, in the cities of Kano (Nigeria) or Ouagadougou (Burkina Faso), which are known for their tanneries and water contamination e.g. with Chromium (Drechsel et al., 2006a).

## 7.4 Seasonal variations of coliform levels

Figure 7.5 shows the influence of rainfall on coliform levels at two locations, both downstream of Kumasi monitored over a 6-month period. There is a general increase in levels of faecal coliforms after the first rains and this continues for about two months before the levels start decreasing. In general, there was a bit of correlation between rainfall and coli counts, but more data should be collected over many seasons to clearly establish the relationship. Faruqui et al. (2004), for example, mention the effects of “laundry days” and “Friday prayers” on stream water quality. This piece of information can be used to advise water users to avoid or to be more cautious when using water from these sources at particular times of the day, week or season to reduce negative health impact.

There was no significant trend in the variation of the nutrient load across the seasons. $NO_3$-N levels increased almost immediately after the first rains and as the rains continued, the levels decreased over the next three months after which they remained constant. The immediate response can be attributed to mineralization processes of organic debris starting with the first rains and the highly soluble nature of nitrates.

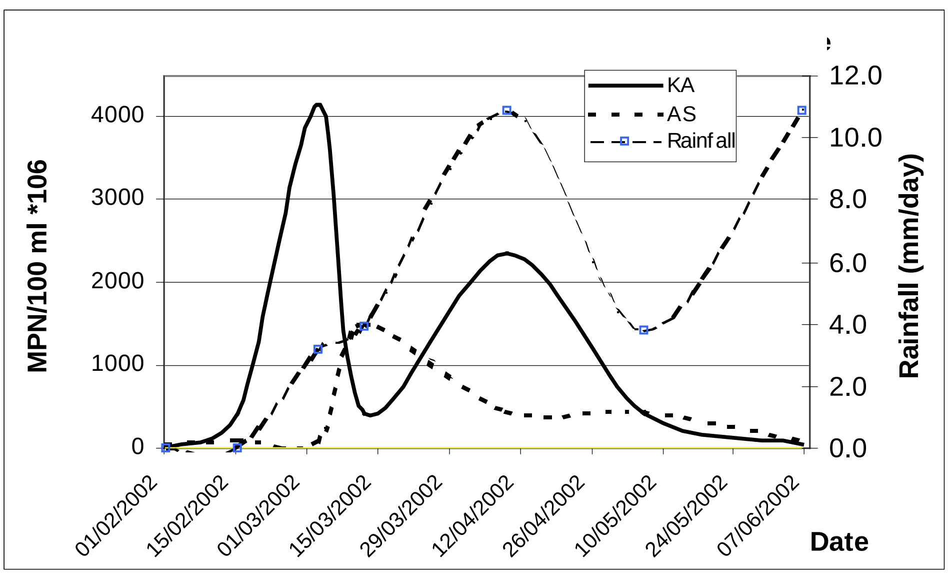



**Figure 7.5:** Faecal coliform changes over seasons

Figure 7.6 is derived from Cornish et al (1999). The authors monitored stream water quality over the dry-wet season interface over one-month in February/March, 1999. This showed also an increase in the $PO_4$-P levels for about two weeks after the onset of the rains.

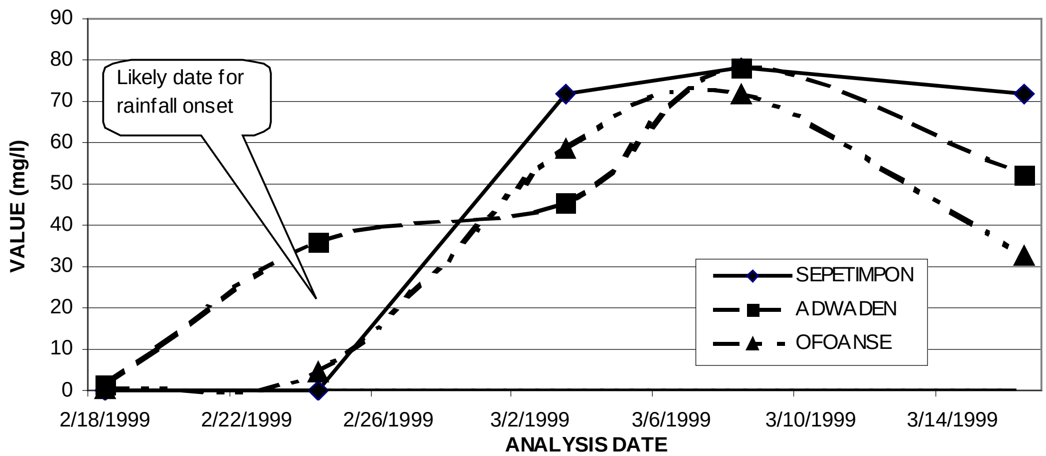



**Figure 7.6:** $PO_4$-P variations on dry-wet season interface (Cornish et al., 1999)

Water quality monitoring by Ghana's EPA between 1999 and 2001 showed high variations in contamination levels (McGregor et al., 2002). This underlines that the conclusions drawn are only indicative and therefore subject to verification after longer measurement periods. The need for regular monitoring is evident.

### 7.5 Water quality in vegetable farming sites

Amoah et al. (2005, 2006b) sampled irrigation water (specifically for coliform levels) in the main urban farming sites in Accra and Kumasi. In Accra, faecal coliform levels ranged from $10^1$-$10^7$/100 ml (Table 7.1). The lower values were recorded in Dzorwulu where farmers use pipe water stored in shallow wells. Farming sites in Korle-bu, La and Marine Drive where farmers use water from urban drains for irrigation recorded the higher values. Previous studies carried out in Accra (Armar-Klemesu et al., 1998; Sonou, 2001, Zakariah et al., 1998) also showed that there are hardly any unpolluted water sources available for irrigation. The worst case is the highly populated drainage basin of the Odaw river/Korle Lagoon, which covers more than 60% of Accra. Its year-2000 BOD load has been estimated as 132,000 kg/day (Biney, 1998).

In Tamale, the highest level of faecal coliform levels was recorded at Kamina, where farmers use a broken down sewage pond for irrigation purposes. However, most of the vegetables grown here are traditional ones, which are eaten cooked and may pose less or no risks to consumers. Figure 7.7 shows the levels in other sites. Like in Accra, water in Tamale is scarce and farmers have no choice other than to use water from storm water drains polluted with domestic wastewater (Abdul-Ghaniyu et al., 2002).

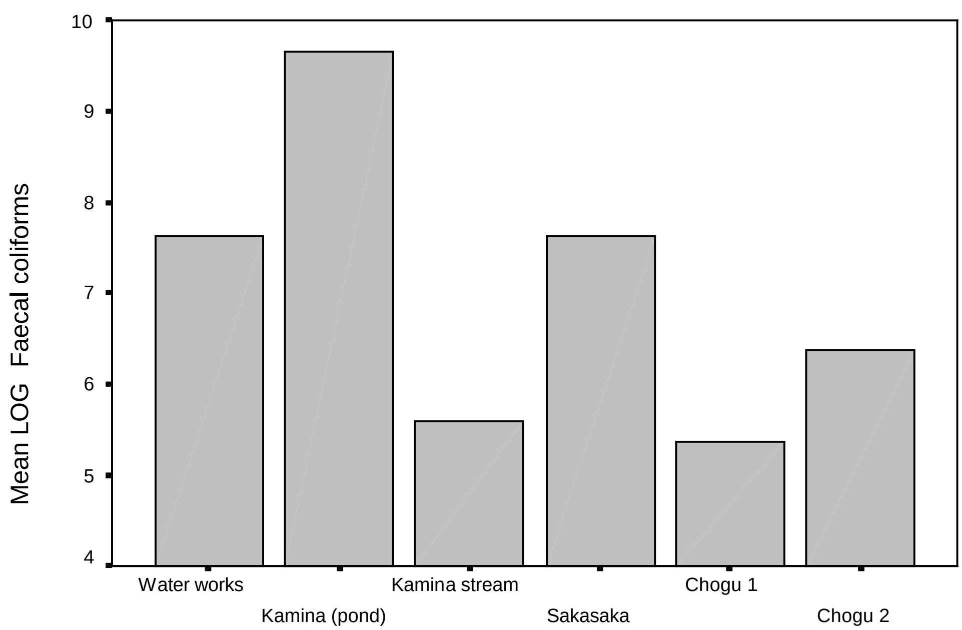



**Figure 7.7:** Faecal coliform levels in main urban vegetable farming sites in Tamale (Amoah, unpubl.)

Shallow wells (dugouts close to streams) had in general better quality water than the streams, but showed in many cases relatively high coliform levels of $10^6$/100 ml. These were associated with water entering the wells and the extensive use of (fresh) poultry manure in vegetable farming. Cornish et al. (1999) observed the same phenomenon that shallow wells do not always offer a cleaner water source than streams and rivers and recommended improvements to avoid run-off entering the wells.

As mentioned in the previous section (7.4), the analysis of heavy metal concentrations in streams used for irrigation in and around Kumasi did not show any alarming values. The same seems to apply to Accra as preliminary data provided by Mensah et al. (2001) indicate.

**Table 7.1:** Water quality and crops on selected urban farming sites in Accra and Kumasi

| Location | Sources and quality of irrigation water | Crops |
|---|---|---|
| Marine Drive, Accra | Faecal coliforms (FC) up to $10^{6-7}$/ 100 ml; Electrical conductivity (EC): 0.7-1.1 ds/m; irrigation with watering cans | Lettuce, green pepper, spring onions, cucumber etc. |
| Dzorwulu, Accra | 1. River Onyasia with contributions of wastewater from neighbouring settlements (FC up to $10^{5-6}$/ 100 ml); irrigation with watering cans<br>2. Piped water; irrigation with drag hoses or watering cans (FC< $10^{1}$ / 100 ml); | Lettuce, cucumber, Cabbage, Cauliflower, onion, Chinese cabbage, spring onions, radish, spinach etc |
| Korle Bu, Accra | Drain water from hospital staff houses and shallow wells (FC up to $10^{8}$ / 100 ml); irrigation with watering cans | Lettuce, cabbage, spring onions, ayoyo, alefu, etc |
| La, Accra | Wastewater from the Burma Camp barracks, partially treated (FC still up to $10^{6}$ per 100 ml); Irrigation of okra, maize and other tall crops by furrows; irrigation of vegetables by watering cans around the last treatment pond | Cabbage, lettuce, sweet pepper, okra, maize etc |
| Gyinyase 1 Kumasi | Stream water and shallow wells (Total Dissolved Solids (TDS): 1840 mg/l, pH: 7.5); irrigation with watering cans | Green pepper, lettuce, cabbage, spring onions, Ayoyo, Alefu |
| Gyinyase 2 Kumasi | Streams, shallow wells, which are partly enriched with run-off (TDS: 1160 mg/l; pH: 7.1). Irrigation with watering cans and furrow | Lettuce, cabbage, spring onions, green pepper, carrots |
| Georgia Hotel | Pipe borne water, irrigation with drag hose, watering cans, sprinklers. | Spring onions, cabbage, Ayoyo, cauliflower, Alefu, green pepper |

Source: Gbireh (1999), updated and modified

## 7.6 Conclusions and recommendations

In Ghana, the industrial contribution to water pollution is generally low. Streams in and around Kumasi contain diluted domestic storm and wastewater with pH, EC, heavy metal and nutrient levels in the acceptable range. However, levels of faecal and total coliforms were very high, all being above $10^{6}$/100 ml even as far as 32 km downstream of the city center, which could pose health problems to users. The situation is similar in other main cities of Ghana like Accra and Tamale. High levels of faecal contamination are mainly due to inadequate sanitation facilities in the city which leads to poor sanitation practices like open defecation, and broken down sanitation infrastructure. This also affects wells used for drinking water (Kyei-Baffour et al., 2005).

A seasonal variation in coliform levels and nitrate nitrogen linked to the rainy season was observed. However, the studies were not sufficiently detailed to verify these observations.

As water quality continues to deteriorate, especially in urban water bodies, it is pertinent to counteract and improve the situation. In view of limited private and public resources to mitigate nonpoint source pollution through improved infrastructure, educating the public about the dangers of indiscriminate solid and liquid waste disposal should be institutionalised and not depend on projects. The target group should include school children as successfully demonstrated by McGregor et al. (2006).

# 8. Irrigation practices

*This chapter describes the different irrigation methods and technologies used by farmers, understanding the factors for their choices and how they are being used. Seventy farmers were interviewed in Kumasi accompanied by focus group discussions in Accra and Tamale and field observations on all study sites. The chapter also describes the use of black water (faecal sludge) in Northern Ghana*.

## 8.1 Sources of irrigation water

As described in Chapter 6, sources and quality of irrigation water vary between piped water and raw wastewater. Most common is, however, the use of stream and drain water, highly polluted with domestic grey water. A brief overview of some key features in Accra, Kumasi and Tamale is presented here:

In **Accra**, the main source of irrigation water is urban drains[1]. The contents of these drains vary from raw wastewater as in Korle-Bu to storm water diluted wastewater as in Marine Drive, though this changes with seasons. In Dzorwulu, a polluted stream (Onyasia) is used in combination with pipe-borne water. Other than using a big drain that runs through Accra's La area, a few farmers there also use partially 'treated' wastewater' from the maturation pond of the stabilization pond treatment system belonging to the Burma military camp. Other farmers in La use piped water.

In **Kumasi**, polluted rivers and streams are the main sources of water for 70 % of the farmers. None of the farmers interviewed used (raw) effluent directly from the source or a sewage treatment plant. A very few cases (n< 5) were recorded where farmers, because they have no choice, use wastewater from drains[1]. There is an extensive use of shallow dug wells on valley bottoms (27%), especially in the urban area. Of the 70 farmers interviewed, more than 75% said that they use the source of water that is accessible and reliable. Piped water is not only expensive but is unreliable and in any case inaccessible to most farmers.

In **Tamale**, with no perennial stream and a long dry season, water is scarce. Some farmers end up using drain water. In areas like Kamina, farmers use wastewater from a broken sewage treatment plant and others at "Waterworks" use water from a water supply dam, which has

[1] These drains carry all sorts of storm- and wastewater including grey water and black water.

been abandoned due to water pollution. The agricultural use of faecal sludge in Tamale does not concern vegetables and targets its nutrient value, not the water (see chapter 8.5).

## 8.2 Irrigation methods and technologies used

Watering cans, buckets, motorized pumps with hosepipe, surface and sprinkler irrigation methods, as described below, are being used in the study areas.

### 8.2.1 Watering cans

This is the most common irrigation method used in all the study areas (Keraita et al., 2002b, 2003a). It is also the most precise one for fragile leafy vegetables. Farmers use watering cans to fetch and manually carry water from a water source, mostly shallow dug wells, streams or dugouts, to the fields, followed by watering of crops through the spout or shower head of the can (see Figure 8.1) making it an overhead irrigation method. In many cases, farmers carry two watering cans at a time. As men dominate irrigated urban farming, it is rare to see a woman with two watering cans. In peri-urban areas, where women are more common, they seem to prefer water fetching and application with buckets, often transported as head load. One watering can as used in Ghana has a capacity of 15 litres of water.

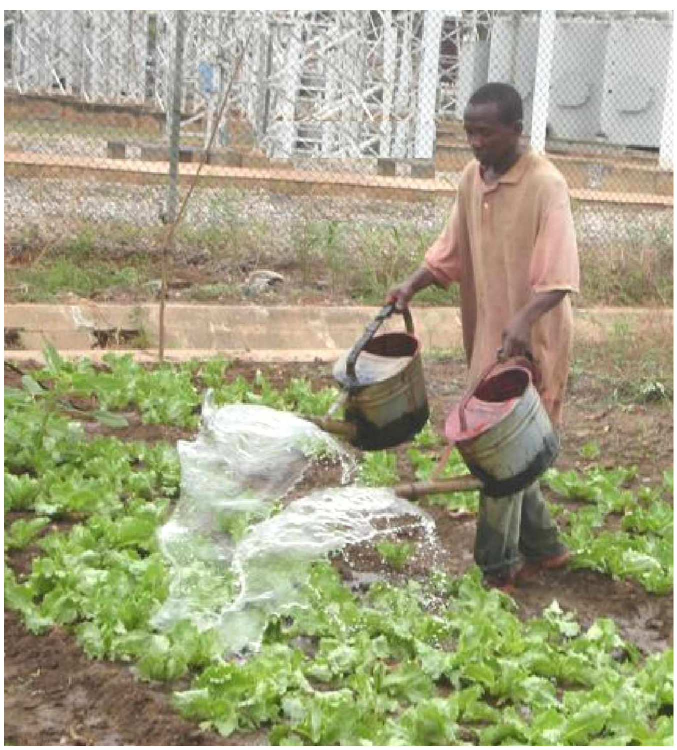


**Figure 8.1:** Lettuce irrigation with watering cans in Accra

Almost all farmers in the valley bottom of urban Kumasi use watering cans. Most of them have shallow dug wells on their farms and even for those who have to fetch water from streams, the distance is usually short (10-15 m). Previous studies (Keraita, 2002, Cornish et al., 2001) showed that farmers closer to water sources tend to over-irrigate in absolute crop water requirements. However, farmers are trying to keep their leafy vegetables fresh, thus irrigation is just wetting the soil surface and evaporation losses are significant.

### 8.2.2 Bucket method

In this method, bowls and buckets are used to fetch water, usually from a stream/river or dugout. It is then manually carried to the fields where it is either applied directly or put in a drum to be applied later. This practice mostly involves women and children carrying buckets as 'head loads' and is commonly done in the peri-urban areas. Here male farmers can easily involve family members and take advantage of the traditional role of women and children in transporting water. Farms are comparatively further from the water source than the ones where watering cans are used, but normally are less than 50 m. The manner of watering (overhead or to the roots) is determined by crop height and type. Farmers using buckets and watering cans come in contact with water mainly by stepping in it while fetching, or water splashing on them while carrying and during watering. Crop contamination is very high due to the combination of crops with large surface area and overhead application (Figure 8.1).

### 8.2.3 Motorized pumps

Motorized pumps are mostly seen in peri-urban areas, but also increasingly in Accra. A small motor pump is placed temporarily near a water source, usually the bank of a river or a big stream and water is pumped through rigid plastic pipes or semi-flexible pipes which are connected to a flexible hosepipe at the end. Farmers use the hose to apply water to their crops either overhead or near the roots on the surface. In other cases, pumps helped to reduce transport ways: water was pumped into a dugout from where water was fetched with cans.

In many cases where motorized pumps were used in Ghana, there were massive water losses with many pipes of inappropriate size or leaking. Farmers finally end up flooding fields along the pipelines and at the point of irrigation. More than one farmer is needed for the operation (e.g. one pumping, one irrigating). Irrigators are often fully wet as they try to fix the pump, pipes and direct the hose for irrigation. The fields are usually adjacent to the water sources and the pipes could be as long as 300 m. Due to the high velocity of water from the pipes, watering can be done overhead even for tall crops like mature garden eggs. As the water pressure and the hose would damage leafy vegetables, usually only taller growing and stronger vegetables are irrigated in this way.

Though the total amount of water applied per season using this method was high (5 litres/second), the distribution and uniformity of application was poor. Pumps are hired from the ‘wealthier’ farmers for a constant fee per day (US$3-5/day in 2000). In order to make maximum use of their money on the day of hire, farmers end up over-irrigating the areas most accessible to the feeder hose, leaving other areas of the field under-irrigated. In Dedesdua, a village in peri-urban Kumasi, to reduce costs, farmers on average irrigated once in three weeks (for a 120 day crop growth period) instead of once a week. This was equivalent to 5-10 hires over the 120-day period instead of 20 hires, which is a considerable saving for the farmer. They felt that this was sufficient for the crops but in reality such long cycles could affect crop productivity.

### 8.2.4 Surface irrigation

Some form of surface irrigation, mainly furrow is being practiced in La in Accra. La farming area is a comparatively wider open space with a topography that allows for furrow irrigation. The source of water is a drain that runs from the nearby military camp to its treatment plant. Farmers have constructed an open weir and diversion channel to irrigate their plots downstream by furrows (fruity vegetables), or they divert water into dugouts from where they can fetch with a watering can (leafy vegetables). During the dry season, farmers raise the water level in the drain with sand bags and divert the water in a main canal, which conveys the water to the plots. Furrow irrigation can reduce crop contamination since crops are grown on ridges, but exposure to farmers is as high as with water fetching from streams and drains.

### 8.2.5 Sprinkler irrigation

This method was seen in a few sites (behind Georgia Hotel in urban Kumasi and Dzorwulu in urban Accra). In both cases, the sprinkler system is connected to a pipe borne water source. Low cost materials were used, like bamboos as sprinkler risers etc.  These systems are the portable type and farmers in Dzorwulu combine them with the watering can method. The fields were reasonably large but the crops grown were the same as in the other areas. In this case, irrigation water has both on and off farm effects (aerosolised particles) on crops, farmers and the environment.

### 8.3 Water and land productivity

Leafy vegetables, which are the most commonly grown crops in irrigated urban agriculture, have higher and more regular crop water requirements compared to more traditional crops. According to Agodzo et al. (2003) irrigation water requirements of most vegetables grown in Ghana vary between 300 and 700 mm depending on the climatic conditions and crop species. As the extension service has limited training to support informal irrigation, farmers have learnt over time when and how much water to apply to their crops. When asked a question like "how do you know the amount of water to apply?" most urban farmers indicated that it was from 'hands-on-experience' mostly using soil and weather as indicators (see Figure 8.2). Generally, most farmers irrigate in the mornings and evenings, saying that at these times "*it is cooler so we can more easily carry the water-load*" which corresponds well with periods of low evapotranspiration rates, allowing other jobs during normal working hours (8am to 5pm).

Not all farmers can afford to buy irrigation equipment, like motorized or electrical pumps. However, neighborhood arrangements enable farmers to hire pumps on affordable terms. At Dedesua, in Kumasi, for instance, most farmers only pay for the fuel of a local motor pump. Payment can also be made on flexible terms such as paying after selling the crop or by providing labor for the pump owner. Some farming sites have farmers associations to exchange labor and irrigation equipment.

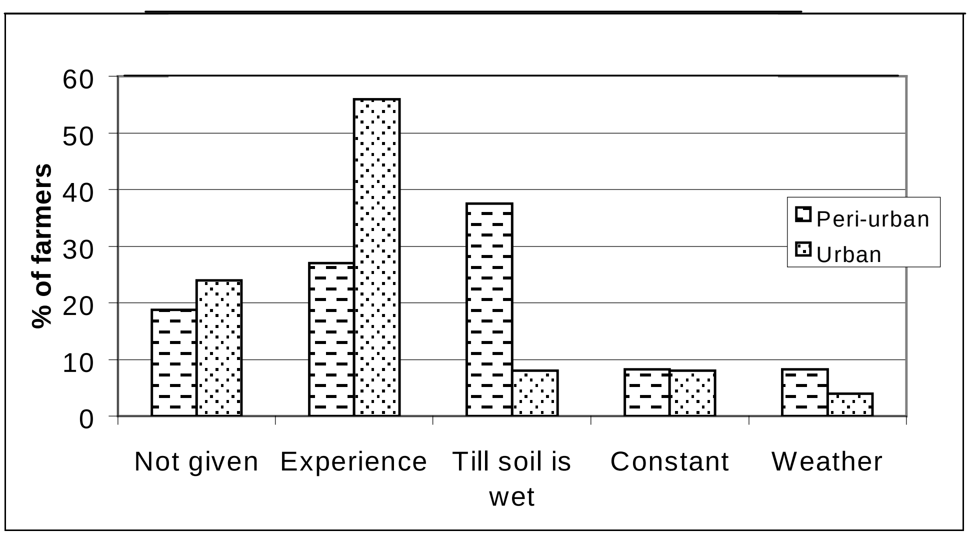



**Figure 8.2:** How farmers know the amount of water to apply

From field monitoring of water use, some farming sites in and around Kumasi showed a tendency towards over-irrigation in the urban areas by one-third of the irrigation water requirements and under-irrigation of the same magnitude in the peri-urban areas. Urban farms are much smaller (on average one-seventh) than peri-urban farms and farmers predominantly use watering cans for irrigation. Urban farmers achieve a more uniform spatial water distribution, though, because of the watering cans, and their irrigation intervals, which are regular. Peri-urban farmers use either buckets or motor pumps connected to water hoses. Peri-urban farmers have irregular irrigation intervals and poorer water distribution, especially those using hosepipes. As only a few peri-urban farmers own a pump, they wait for long periods before irrigating their farms 'queuing to hire a pump'. Subsequently it is quite common among these farmers to apply as much water as they can when the pump is available. The bucket method is laborious and depends on availability of women and children. This too contributes to irregular watering.

A good overview on tomato, garden egg, pepper, okra and onion production and yields in Ghana was provided by Nurah (1999), but few studies have been conducted on the productivity of vegetables common in Ghana's cities. Indicative studies on urban lettuce and cabbage production show typical production levels ranging between 20-35 tons/ha (lettuce, fresh weight) and about 40 tons/ha (cabbage) per crop. With e.g. 5 lettuce crops and 3 cabbage cops per year, the annual output is significant. Some variations across cities and seasons have been observed. For example, production levels in Kumasi are generally higher (10-20%) than in Accra, probably due to better soils except under excess rainfall, when levels start declining in Kumasi's inland valley bottomlands. Production during the wet season is higher in both cities than during the dry season. Preliminary calculations of water productivity under the *Challenge Program on Water & Food* project CP38 show a typical range of 6-9 $kg/m^3$ for lettuce grown in Kumasi, and about 8 $kg/m^3$ for tomatoes. However, the lettuce values could also be lower as calculations did not consider the period when seedlings are in the nursery bed (Keraita, unpubl.).

## 8.4 Options and constraints to technology change

Having to spend a significant share of time on irrigation (see Chapter 4) farmers desire less laborious and cheap irrigation methods that can reduce their workload. However the continued use of arduous methods of irrigation in urban agriculture, even when newer technologies are available, raises the question of the reason why these are not more widely used.

In Accra, farms are often found along streams and drains, and are at best tolerated by the authorities. The transport distance for the watering can is usually short enough to favor labor over capital input. Watering cans allow more flexibility, one-man-usage, and are less sensitive to bad water quality and solids. Moreover, they allow "soft" water application protecting young vegetables on their beds. All these are good reasons to avoid investment in pumps and hoses. In addition, there are differences in the related input markets (also for pumps and hoses) between Francophone Togo and Anglophone Ghana as well as in their practices and their promotion. EnterpriseWorks, for example, started promotion of treadle pumps in most Francophone countries of West Africa between 1995 and 1999, while corresponding activities in Ghana only started in 2002.

A comparison with neighboring Lomé, where farmers cultivate high value crops for export on poor quality beach sands using motorised pumps, shows that there is a combination of factors involved, which goes beyond the higher investment and maintenance costs of such technologies. Farmers in Lomé have access to larger plots, and the city authorities accept them (Figure 8.3). In many cases, tenure agreements exist. This security favors investments, for example, in tube wells and multiple storage ponds, i.e. transport saving technologies, which are necessary to maximize the profits from larger plots.

**Figure 8.3:** Watering can irrigation with well and storage reservoirs in Togo. Further reservoirs are visible in the background.

Thus it becomes again obvious that technology promotion has to consider a variety of local conditions, both biophysical and socio-economic. Shallow wells and watering cans may be the most appropriate technology, for example, in Kumasi's inland valleys. The demand for treadle or motor pumps might, however, rise on upland sites, and in Accra, especially where farmers can share one pump and the water sources are not too close. Treadle pumps might be tried where groundwater is available between 1 and 7 meters or the walking distance between field and water source is more than 50 m. If the pump is not mobile, the farm site needs facilities to secure the pump overnight as farmers might live far from their fields. Wherever there is better water quality than in drains, low-cost drip irrigation technologies like bucket-kits and drum-kits, could be tested. The authorities might support especially those changes, which could reduce the health risk associated with using polluted water, like storage (sedimentation) reservoirs.

## 8.5 Faecal sludge as a source of nutrients

Farmers in Tamale and other northern parts of Ghana use faecal sludge in agriculture (Owusu-Bennoah and Visker, 1994; Cofie et al., 2005). Sludge is disposed of on farms during the dry season, allowed to decompose and mixed with the soil at the start of the rainy (farming) season. Generally, men are responsible for the acquisition (from septic trucks) and application of faecal sludge on farms. This is because men generally own the land due to the traditional set-up as there are no women fields.

Cofie et al. (2005) conducted interviews with 100 farmers using faecal sludge in Tamale and Bolgatanga (another urban center in northern Ghana). Half of the farmers were using tractors for land preparation, while the rest used hoes and bullocks. The average farming area is about one ha and though some farmers claimed to have been using faecal sludge for more than 25 years (Gumani community in Tamale), an average of about five years of use was recorded. Many farmers own land with less than 20% farming on family or hired land. About 63% received faecal sludge from the local assemblies' tankers, though they could wait for 1-3 weeks before delivery after making an unofficial request. Four out of five farmers said that they used faecal sludge to increase crop yields and improve fertility, however up to half of them experienced social constraints in its use.

### 8.5.1 Methods for sludge application

Methods of sludge application have been derived from the experience and understanding of the farmers. Over the years, farmers in Tamale have taken advantage of the climatic conditions (see Chapter 2) to develop a safe method of faecal sludge application in their fields. The high temperatures lead to effective drying of the discharged sludge and allow the sludge to be handled easily while integrating it into the soil. Moreover the health risks associated with use of faecal sludge are reduced, as most microorganisms contained in the sludge die in high temperatures. By the start of the first seasonal rains (usually in April), most of the sludge is completely dry and ready for use. Most farmers grow cereals (maize and sorghum) on the fields fertilised with faecal sludge, i.e. **not** vegetables. Two main methods are used (Asare et al., 2003):

**i. Surface spreading**: this involves discharging faecal sludge at various points (accessible to the septic emptier) at random on farmers' plots. This is done during the dry season (October – December). By the end of the dry season (February-March), the faecal sludge applied becomes very dry. Farmers then gather and redistribute this material evenly on the field, before cultivation.

**ii. Pit method**: pits are dug on farms and rice and maize straw is placed at the bottom of the pit. Faecal sludge is then poured into the pit, which is large in size and can take several trips of the conveying truck. Layers of bran and straw are placed in between subsequent trips. The process is repeated until the pit is full. This is left to compost for months. Before the cropping season starts, the pit is emptied and the dry mixture of faecal sludge and straw is applied evenly on the field. The pit method is not as widely used as the surface spreading method because it requires quite high quantities of crop residues in combination with the faecal sludge.

### 8.5.2 Nutrients supplied through faecal sludge application

From farmers' experience over the years, five trips of the suction truck of $4.5m^3$ are used to fertilise one acre of land (0.4 ha). Farmers apply an average of 56 $m^3$/ha. Through this practice, significant amounts of plant nutrients in terms of nitrogen (N), phosphorus (P) and potassium (K) are returned to the soil, and in addition the organic matter level is gradually built up. Based on the average concentration of nutrients in human excreta as reported by Drangert (1998), estimated amounts of N, P, K and carbon in the applied sludge are presented in Table 8.1. This estimate does not consider loss during sludge storage in septic tanks and the amount lost in the field beyond the reach of plants. Based on the current sludge application rate by farmers, about 550 hectares of land can be fertilised annually using the faecal sludge that is generated in Tamale municipality alone at the current collection rates. In fact, because there is no sanitary sludge storage facility near Tamale, trucks dump the sludge in natural depressions around the city. The new landfill site with sludge sedimentation ponds will not benefit farmers and reduce a viable option for resource recovery towards a closed nutrient loop.

**Table 8.1:** Estimated amount of nutrients applied in faecal sludge by Tamale farmers

| *Nutrient* | Total in human faeces (kg) | Total in $m^3$ | Amount applied (kg/ha) |
|---|---|---|---|
| Nitrogen (as N) | 4.5 | 8.2 | 459 |
| Phosphorus (as P) | 0.6 | 1.1 | 61 |
| Potassium (as K) | 1.2 | 2.2 | 121 |
| Carbon (as C) | 11.7 | 21.3 | 1183 |

**Source**: Calculated after Drangert (1998) based on the nutrient concentration in human feaces per person-year. Density for faecal sludge is taken as 0.55 kg/$m^3$

### 8.5.3 Farmers' views on constraints for faecal sludge use

Among the same set of farmers interviewed by Cofie et al. (2005), 74% expressed that they had no problem with using faecal sludge in agriculture. Those who noticed problems complained of foul smell and health issues like itching and foot rot, with very few saying that it attracted public mockery. The major constraints are highlighted below. The interviews were carried out before the new treatment ponds near Gbalahi were put in place:

§ Bad odor is a deterrent to its application on farms. Farmers are not allowed to use sludge in the city because of the odor.

§ Farmers who have fields near large concentration of houses are unable to use faecal sludge to improve soil fertility. Faecal sludge use is more in peri-urban areas.

§ Negative attitude of other people towards the use of human waste. For farmers on hired land, it is a common situation that landowners do not allow them to use sludge on their lands despite its positive effects on soil fertility. Some people also shun the consumption of crops cultivated with faecal sludge.

§ There is excessive weed infestation after the application of faecal sludge.

§ Land for farming is scarce around the Tamale Municipality.

§ Inability of the suction truck drivers to send faecal sludge to fields that are too distant from the city.

Like in Accra's faecal sludge treatment plant in Teshie-Nungua, Tamale's new sanitary landfill site at Gbalahi has the provision to use settled sludge to enrich composted solid waste. However, besides differences in quality, this would require that farmers organize and pay for compost transport. The current system of sludge dumping on farmers' fields appears more like a win-win situation (which could also enhance the lifetime of the stabilization ponds) as long as the environmental and health risks are under control. An alternative form of co-composting is under test in a Buobai near Kumasi. Due to the availability of cheap poultry manure, farmers' demand is, however, low (Cofie et al., 2006; Danso et al., 2006).

## 8.6 Conclusions and recommendations

Streams, drains and nearby shallow dug wells are the most common sources of irrigation water. Watering cans are predominantly used with good reasons, but make the task arduous. Motorised irrigation (pump and hose) is easier but is not recommended for every crop and sometimes results in poor distribution of water over space and time.

Much could be done to improve irrigation efficiency - not only where water is scarce, like in Tamale, but also where irrigation consumes too much labour and gives extra burden to women. However, there are no specialized extension services offered to irrigating farmers. Changing of irrigation methods and promoting new technologies however is complex and depends on both biophysical and socio-economic conditions, as comparison with the situation in Lomé has shown. In general, a lot still needs to be done at farm level to improve water and land productivity and also reduce the health risks associated with the use of (usually diluted) domestic (grey) wastewater. Such measures may include raising awareness levels of farmers, improving irrigation scheduling and efficiencies, and changing irrigation methods and technologies for safer ones (see Chapter 12).

Black water (sludge, nightsoil) is used not for irrigation purposes but for the nutrient content in peri-urban areas of Northern Ghana. Farmers either spread it on their fields in the dry season or stabilise it in pits before application. In principle, the sludge is dry and does not contain pathogens by the time the cereals are grown. Farmers did identify certain constraints to its use like odor, excessive growth of weeds and negative attitudes of others towards faecal sludge as a source of nutrients. However, the system appears as a suitable and low-cost option for safe nutrient recovery from urban waste.

# 9. Quality of vegetables in urban markets[1]

*This chapter shows results obtained from analyzing samples of vegetables taken at farm gate and from selling points in Accra, Kumasi and Tamale. Due to the common practice of irrigating with polluted water, the focus was on the microbiological quality of the vegetables using faecal coliforms as main indicator. In addition, some information is provided on helminth contamination, heavy metals and pesticide residues.*

## 9.1 Sampling and analyses

Where overhead irrigation with polluted water is common, like in Ghana, consumers of irrigated crops are at risk, especially if it concerns crops which are consumed uncooked. On the pathway from farm to fork, crops pass through various hands and it is important to analyse post-harvest contamination. To get a complete picture, pesticides and heavy metals also have to be considered. However, compare to wastewater irrigation, pesticide use is not a particular characteristic of urban and peri-urban agriculture.

This first study on pathogens was conducted over three months, October to December 2002. A total of 180 vegetable (*lettuce, cabbage and spring onion)* samples were collected from nine major markets and twelve specialized individual vegetable and fruit sellers in Accra, Kumasi and Tamale. On each market, samples were collected under normal purchase conditions, from three randomly selected sellers. A minimum of three composite samples (*each containing two whole lettuces*), three bunches of spring onions (*each containing two bunches*) and three cabbages were collected, put in sterile polythene bags and transported on ice to the laboratory where they were analyzed immediately or stored at $4^{o}$ C until analysis within 24-48 hours. Samples from individual sellers were collected in the same way.

The second pathogen survey addressed 886 randomly selected farmers, sellers (wholesalers and retailers) and consumers/food vendors of irrigated lettuce in both cities. Over a period of 12 months from May 2003 to April 2004 a total of 1296 lettuce samples were collected at different entry points from farm to the final retail outlet. Twice every month, at least three composite samples (*each containing two whole lettuces*) from each selected farm site were randomly collected just before harvesting by a wholesaler. The wholesaler was followed to the wholesale market where another sample from the same original stock was colleted before being finally sold to a retailer. At the final retail point, three composite samples were again

[1] This chapter is in large parts an extract from the forthcoming PhD thesis by Philip Amoah (IWMI-KNUST).

sampled after vegetables had been displayed on the shelves for at least two to three hours, which is a typical turnover period at the retail point.

The samples were analyzed quantitatively for total and faecal coliform (Most Probable Number method) and helminth eggs according to standard procedures (APHA, 1989, Schwartzbrod, 1998). Faecal and total coliform populations were normalised by log transformation before analysis of variance (ANOVA). Results of analysis are quoted at $p < 0.05$ level of significance (5%). For details of the pathogen analysis see Amoah et al. (2006b, 2007). Pesticide analysis considered *lindane*, e*ndosulfan*, *lambda cyhalothrin*, c*hlopyrifos* and p,p'-DDT. Sample peaks were identified by their retention times compared to the retention times of the corresponding pesticide standard obtained from the International Atomic Energy Agency (IAEA). The ability of the laboratory used (Water Research Institute, Accra) to identify these substances has been verified by cross-tests in Ghana and Europe. For details of the analysis see Amoah et al. (2006a). Heavy metal sampling and analysis were carried out in an independent project by the Department of Soil Science, University of Ghana, Legon.

## 9.2 Coliform counts

Table 9.1 shows the faecal coliform contamination levels of lettuce at different entry points starting from farm to the final retail outlet. Irrespective of the irrigation water source, mean faecal coliform levels exceeded the recommended standard. There were no significant differences in the average lettuce contamination levels at different entry points (farm, wholesale market and retail outlet). Also the analysis of individual samples followed from farm to retail on the various sampling dates confirmed that the contamination of lettuce with pathogenic microorganisms does not significantly increase through post-harvest handling and marketing (Amoah et al., 2006b). This is good news as the hygienic conditions, including washing habits, clean display and handling of food as well as availability of sanitation infrastructure on market sites is not very supportive. Only 31% of the markets in Accra have a drainage system, 26% have toilet facilities and 34% are connected to pipe-borne water as shown by a survey some years ago (Nyanteng, 1998). While it appears as if the initial contamination on- farm is so high that it hides any possible post-harvest contamination, the latter also remains less significant in those cases where lettuce was irrigated with piped water, thus making it significantly less contaminated. These results question earlier statements, for example by Armar-Klemesu *et al.* (1998)[2].

Another interesting result was that on-farm crop contamination also takes place under irrigation with piped water. Sources of contamination in these cases included the already contaminated soil (FC levels of 1 x $10^4$ $10g^{-1}$ in the upper 5 cm) and the frequent application of improperly composted (poultry) manure (Amoah et al., 2005; Drechsel et al., 2000).

**Table 9.1:** Mean faecal coliform contamination levels of lettuce at different entry points along the production - consumption pathway of lettuce (Amoah et al., 2006b)

| City | Irrigation water source | Statistics | Log faecal coliform levels (MPN* $100g^{-1}$) | | |
|---|---|---|---|---|---|
| | | | Farm | Wholesale market | Retail |
| Kumasi | Well (n=216) | Range | 3.00 - 8.30 | 3.10 - 8.50 | 3.20 - 7.00 |
| | | Geometric mean | 4.54 | 4.44 | 4.30 |
| | Stream (n=216) | Range | 3.40 – 7.10 | 3.60 – 7.20 | 3.50 – 7.20 |
| | | Geometric mean | 4.46 | 4.61 | 4.46 |
| | Piped water (n=216) | Range | 2.30 – 4.80 | 2.60 – 5.30 | 2.40 – 5.10 |
| | | Geometric mean | 3.50 | 3.69 | 3.65 |
| Accra | Drain (n=216) | Range | 3.40 -6.00 | 3.00 - 6.80 | 3.00 - 6.50 |
| | | Geometric mean | 4.25 | 4.24 | 4.48 |
| | Stream (n=216) | Range | 3.20 - 5.70 | 3.10 - 5.90 | 3.20 - 5.50 |
| | | Geometric mean | 4.22 | 4.29 | 4.37 |
| | Piped water (n=216) | Range | 2.90 - 4.70 | 2.90 - 4.80 | 2.80 - 4.50 |
| | | Geometric mean | 3.44 | 3.46 | 3.32 |

* MPN, Most Probable Number;

### 9.2.1 Faecal coliform levels in vegetables in Accra

In Accra, lettuce, cabbage and spring onion samples were taken from Makola, Agbogbloshie, Dome and Kaneshie markets and from some individual sellers. In all markets and selling points, lettuce had the highest levels of faecal coliforms population (Figure 9.1). Agbogbloshie is the main depot for vegetables from within and outside Accra, where vegetables are not washed as they are mainly sold to other vendors who are expected to wash them before selling (Figure 9.2).

[2] However, the often-cited statement of the authors that contamination of vegetables in markets was higher than at farm gate was later amended. At farm and market, the levels appeared comparable, which could also mean no further contamination.

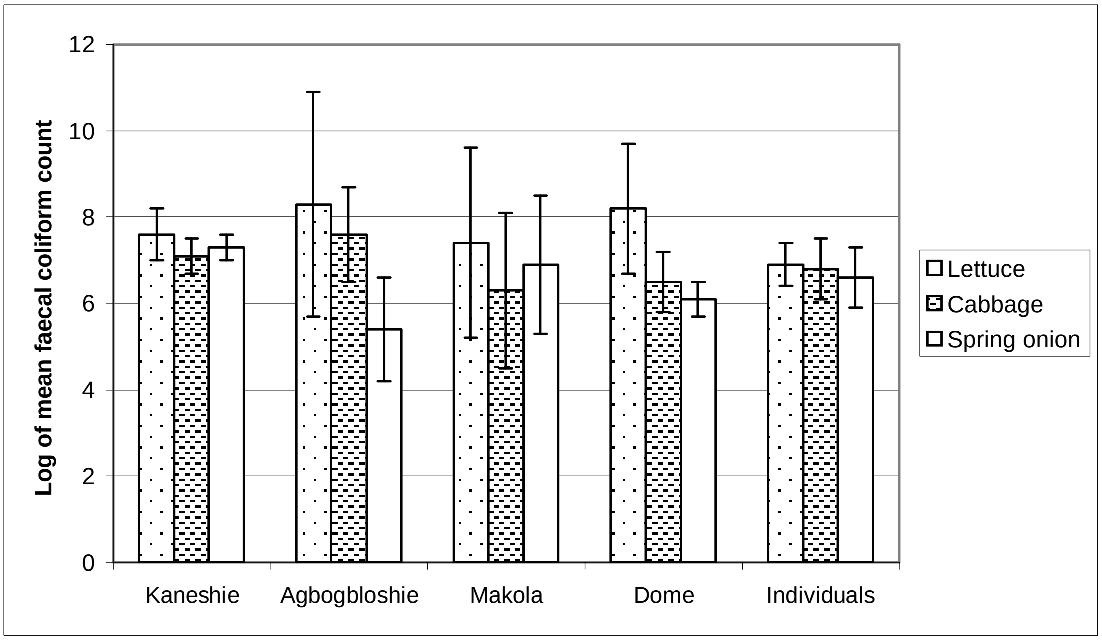



**Figure 9.1:** Faecal coliform populations on selected vegetables from some markets in Accra.

**Figure 9.2:** A section of Agbogbloshie market showing vegetables displayed on the ground.

For both cabbage and lettuce, there were no significant differences in either faecal or total coliform levels when comparing these vegetables across markets. The same applies to spring onions, except higher levels in Kaneshie than Agbogbloshie.

### 9.2.2 Faecal coliform levels in vegetables in Kumasi

In Kumasi, vegetable samples were collected from three markets (‘White’ (opposite Post Office), Asafo and Central) and from some individual sellers. Samples collected from individual sellers had less contamination compared to the formal markets (Figure 9.3). However, these levels are still higher than the International Commission on Microbiological Specification for Food (ICMSF) recommended levels of $1 \times 10^3$ 100 $g^{-1}$ fresh weight[3]. Mensah et al. (2001) observed that on the smaller “White” markets where (expatriate) consumers asked frequently about produce quality, the sellers changed the water to wash their produce more often than on other markets and reduced indeed the pathogen level.

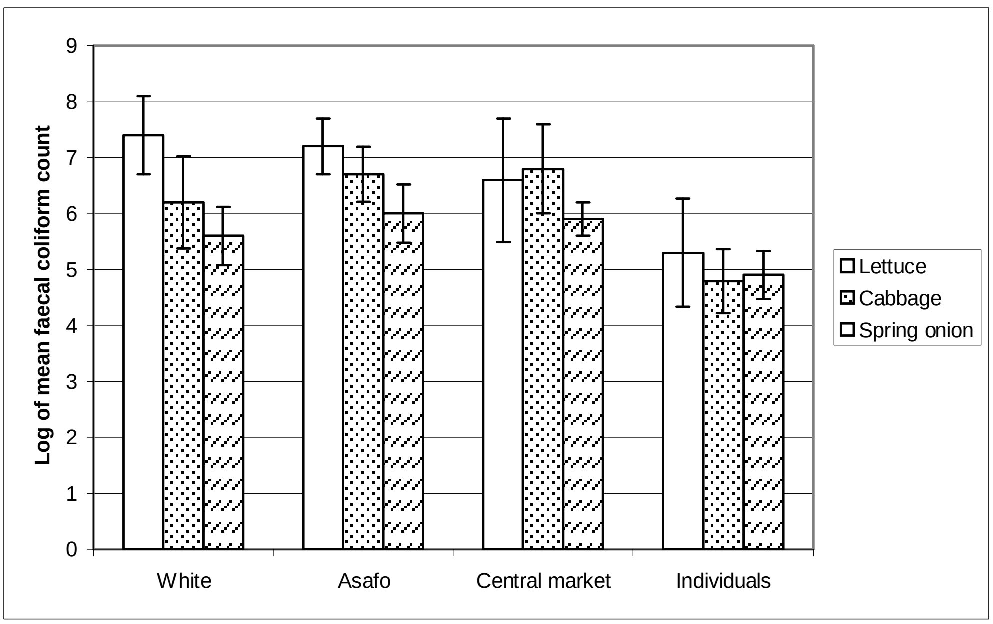



**Figure 9.3:** Faecal coliform populations on selected vegetables from markets in Kumasi.

[3] Ready-to-eat foods are considered to be of "acceptable" quality in England if they contain <100 *E. coli* per gram wet weight (i.e., $<10^4$ per 100 g) (Gilbert *et al*., 2000). This guideline value is used in many other countries, including Australia, Canada and New Zealand. Since lettuce is a common component of many ready-to-eat foods, it makes little sense for the wastewater used to irrigate lettuce to be treated to a higher quality than is required of the lettuce itself (WHO, 2006).

### 9.2.3 Faecal coliform levels in vegetables in Tamale

Tamale has few vegetable markets and selling points, as it has a smaller population compared with Accra and Kumasi. Sampling was done in two markets (Aboabo and the main market), while some samples were also taken from individual sellers. Faecal coliforms ranged from 4.0 x $10^5$ to 7.5 x $10^8$ while total coliforms were between 1.5 x $10^7$.and 1.6 x $10^{10}$ (see Figure 9.4) There was no significant difference in both total and faecal coliform counts for the three vegetables across markets.

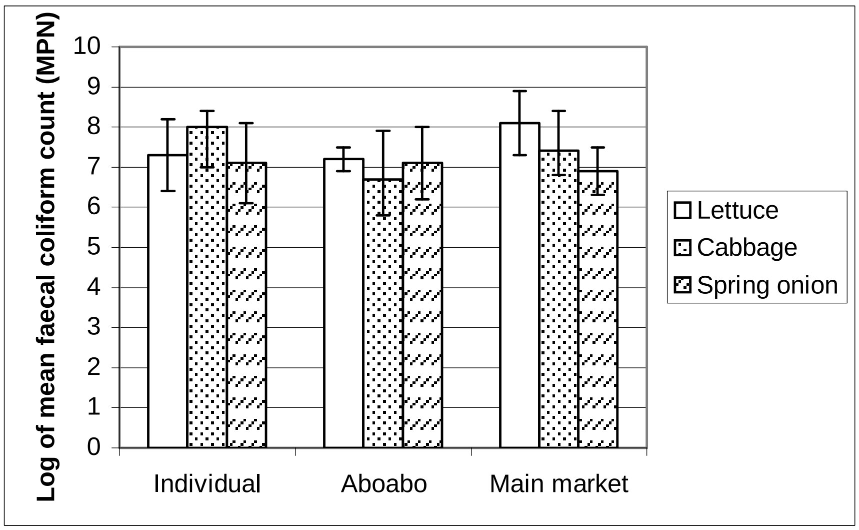



**Figure 9.4:** Faecal coliform populations on selected vegetables from some markets in Tamale

### 9.2.4 Inter-city comparison of the total and faecal coliform levels in vegetables

Lower levels of both total and faecal coliform populations were recorded for vegetable samples from Kumasi compared to those from Accra and Tamale (Figures 9.5 and 9.6).

The reason for this could be both on-farm and post-harvest handling of crops. Previous studies done in Kumasi (Cornish et al. 1999, Keraita et al. 2002b) show that many farmers use shallow wells along the streams with better water quality for irrigation compared with Accra and Tamale where water from urban drains is mostly used. There is no scarcity of water in Kumasi and vegetables are washed on the farms (though with the same irrigation water), before they are taken to the market.

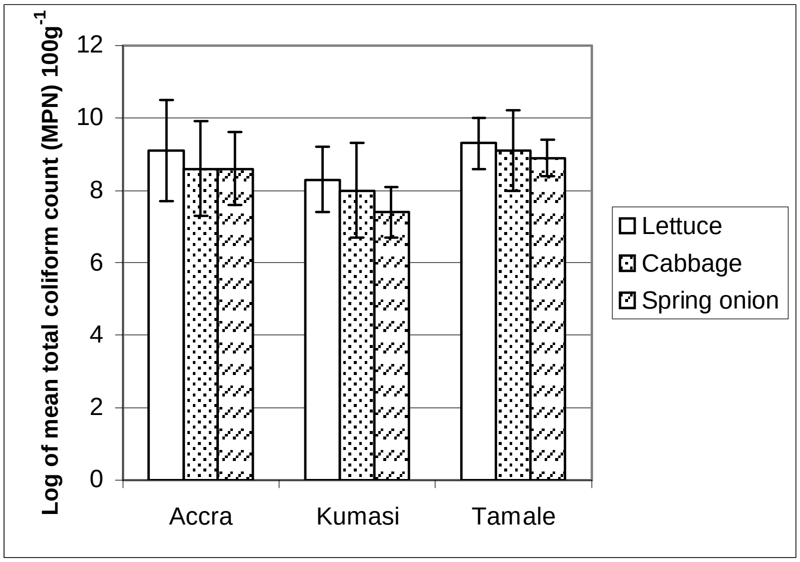



**Figure 9.5:** Total coliform levels in vegetables from Accra, Kumasi and Tamale

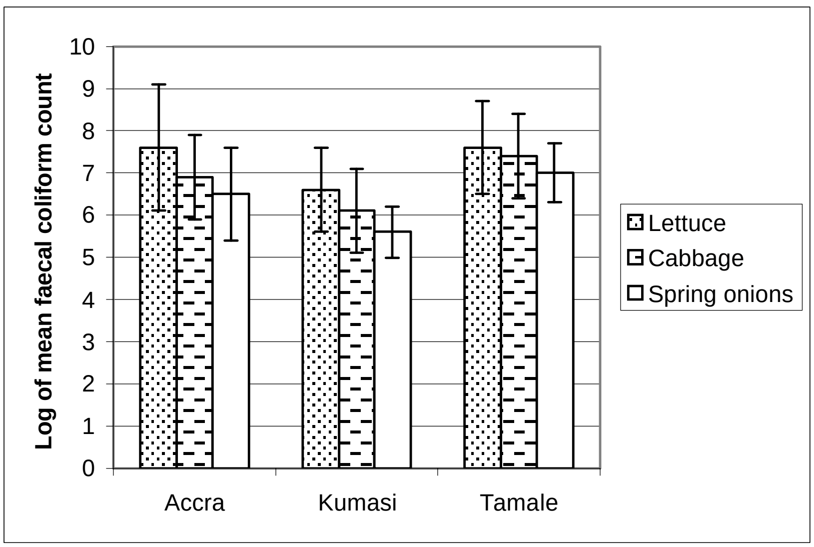



**Figure 9.6:** Faecal coliform levels in vegetables from Accra, Kumasi and Tamale

### 9.2.5 Inter-vegetable comparison of total and faecal coliform levels

Among the three vegetables, lettuce showed the highest level of contamination both in faecal and total coliform (Figure 9.7) with contamination levels ranging between $10^6$ and $10^{11}$ for total coliforms and between $10^3$ and $10^9$ for faecal coliforms. These contamination levels are in line with recent studies on food contamination conducted in Accra (Akpedonu, 1997, Abdul-Raouf et al., 1993).

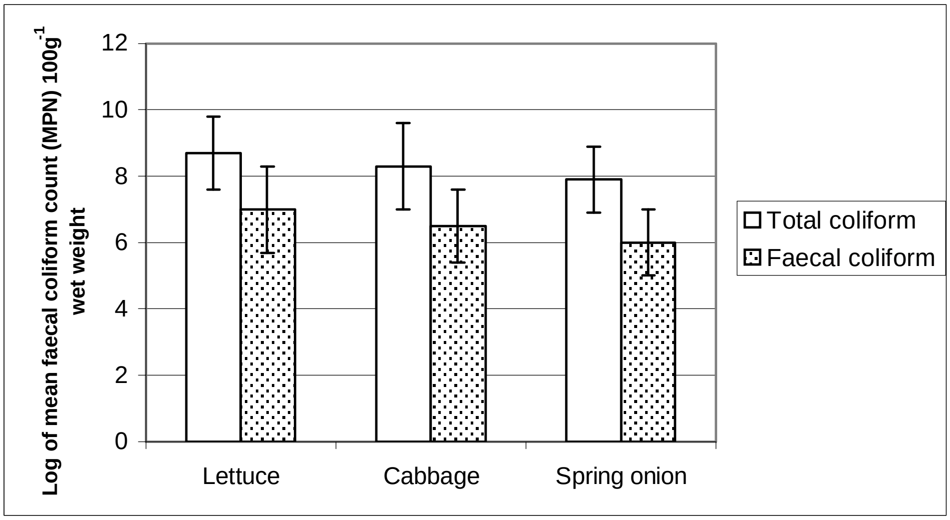



**Figure 9.7:** Faecal and total coliform populations on selected vegetables

The differences were significant for faecal coliform counts, which could be attributed to the larger leave surface of lettuce offering a larger contamination surface. This foliage also protects microorganisms against exposure to environmental factors and prolongs microorganism survival (Shuval et al. 1986, Armon et al. 1994).

## 9.3 Helminth eggs

Table 9.2 shows helminth populations from the vegetables analyzed. The eggs identified include *Ascaris lumbricoides, hookworm, Trichostrongylus, Schistosoma heamatobium and Trichuris trichiura. Strongyloides stercoralis and* nuaplius larvae were observed but not included in the counts. *S*. stercoralis had a high occurrence and was observed in all samples. *A. lumbricoides* was the most predominant among all the other organisms and was observed in 85% of the contaminated vegetables. This could be attributed to the high level of persistence of *A. lumbricoides,* hence high survival time. The presence of helminths, particularly *A. lumbricoides,* on the vegetables could pose a serious problem because of their high infective dose and low host immunity. For a better assessment of the potential threat it is required to determine egg viability. It can be assumed that many of the eggs found in streams and irrigation water are old and no longer viable.

**Table 9.2:** Mean helminth egg population on selected vegetables in Ghanaian markets

| Vegetable | No. of samples | Average number of eggs/g |
|---|---|---|
| Lettuce | 27 | 1.14 a |
| Cabbage | 32 | 0.42 a |
| Spring onion | 26 | 2.74 b |

*The mean difference is significant between a and b at the 0.5% level.*

As shown in Table 9.2, cabbage had the lowest counts of helminth eggs and spring onions the highest ($p<0.05$). The high helminth egg count in spring onion is surprising considering the low surface area of the leaves compared with lettuce and cabbage.

## 9.4 Heavy metals

In 2006, the University of Ghana started a pilot assessment of heavy metals in crops, water and soils on different urban vegetable production sites in Accra. The data so far available show that in the water, soil and crop samples at all the study sites (Marine Drive, Korle Bu, GBC, Dzorwulu and Alajo) the concentrations of Cadmium were well below international limits. However, the concentrations of lead in lettuce were in general above the standards. The major source of lead in the urban environment is usually traffic. A detailed and final evaluation of the variations in the concentrations of these and other metals in the different materials at the respective sites will be available soon (Dowuona, 2006).

## 9.5 Pesticides

The results on pesticide residues showed that vegetable producers in Ghana use a wide range of chemicals to control insects, fungi and other pests. Some of the used pesticides are restricted in application or even banned in Ghana. These include Lindane, Endosulfan, Karate (Lamba cyhalothrin), Chlorpyrifos and DDT. These chemicals have very powerful biologically active ingredients, which are highly toxic and persist in the environment posing a serious threat to the health of producers and consumers. This notwithstanding, farmers indiscriminately use them to cultivate vegetables. Observations revealed that majority of the farmers who apply these chemicals do not perceive the health risks (see also Chapter 4 for pesticide use on tomatoes in peri-urban areas) or give it less importance than the risk of losing the harvest.

Only lettuce was selected for the pesticide residue analysis due to financial constraints. Chlorpyrifos (Dursban) was detected in 78 % of the lettuce samples, which corresponds with a report by Okorley and Kwarteng (2002) who stated that Dursban is among the most widely sold pesticides in the central region of Ghana. Lindane and Endosulfan are among the pesticides restricted for the control of certain pests, like on cocoa and coffee. As shown in Table 9.3, Lindane, Endosulfan, and DDT were, however, each detected on 33% of the vegetables, showing how weakly these restrictions are enforced. All concentrations exceeded allowed standards.

**Table 9.3:** Percentage of lettuce showing pesticide residues.

| Name of Pesticide | Percentage of lettuce with pesticide residues |
|---|---|
| Lindane | 31 |
| Endosulfan | 33 |
| Endosulfan | 3 |
| Lambda cyhalothrin | 11 |
| Chlorpyrifos | 78 |
| DDT | 33 |

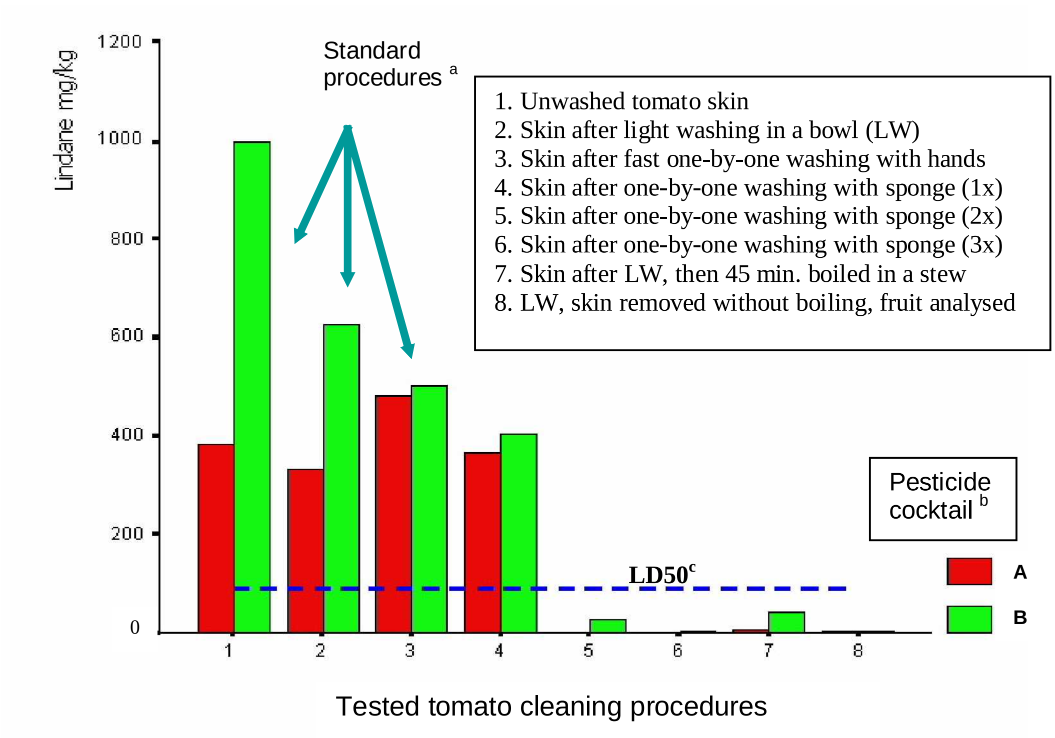
Our laboratory analysis showed that washing of food before eating can reduce or eliminate much of the pesticide residue, except when e.g. Lindane is used (Figure 9.8). In our case study, tomatoes from two farms (A and B) were analysed. On Farm A, they were treated with a cocktail of pesticides three weeks before harvesting while on Farm B they were still treated on the same day of harvesting with a similar cocktail. The cocktails were farmers' choice:

Farm A Diathane, Thionex, Kocide, Lindane

Farm B Diathane, Thionex, Kocide, Topsin, Karate, Lindane

Tomato cleaning was carried out under normal kitchen conditions in Ghana 72 hours after sampling with a number of treatments (see Figure 9.8).

With a melting point over 100°C, even boiling could not remove Lindane. In contrast, the tomato skin cracks when boiled and the pesticides in the water enter the fruit body. The safest way for consumers is to wash the fruit several times or to use only peeled tomatoes (Figure 9.8). An alternative could be to remove hydrophobic chemicals with soap, which was, however not tested due to the expected unfavorable local perception of the resulting taste.




a. Standard washing procedures in Ghanaian households

b. Two different "cocktails" of pesticides applied on two farms (A and B)

c. $LD_{50}$ (lethal dose of lindane is >88 mg per kg bodyweight)

**Figure 9.8:** Effect of various forms of washing on the reduction of lindane residue concentrations on tomato skin. Source: Boadi, Abaidoo, Drechsel (unpublished)

## 9.6 Conclusions and recommendations

Both faecal and helminth contamination of vegetables (*lettuce, cabbage and spring onion*) produced and marketed at various selling points in Accra, Kumasi and Tamale exceeded the ICSMF recommended levels. Faecal contamination was about twice higher than the ICSMF recommended level of $10^5$ faecal coliform/g fresh weight. Helminth contaminations were also high (0.42 – 2.74 eggs $g^{-1}$).

Results showed that except for piped water, all other sources of water used by urban farmers for irrigation showed FC levels exceeding common guidelines for unrestricted irrigation. The study identified the farm as the main point of microbiological lettuce contamination. Despite poor sanitary conditions in markets, post-harvest handling and marketing did not affect the farm-gate contamination levels. Although lettuce irrigated with piped water had the lowest FC counts, contamination levels can still exceed common standards suggesting contamination through manure and the already contaminated farm soils, with post-harvest contamination being again the comparatively lower risk factor.


**Figure 9.9:** Awareness creation for appropriate pesticide removal in Ghana (Source: IWMI)

Comparing vegetables, it was observed that lettuce had the highest levels of faecal contamination, which is to be expected because of its open leaf structure. However helminth eggs were surprisingly higher in spring onions in spite of lower area to volume ratio. Cross-market comparisons within cities showed in general no significant differences in contamination from faecal coliforms for lettuce and cabbage. Thus there is no particular market which could be recommended for the purchase of safe produce. This also concerns supermarkets. However, there was a tendency to safer produce where - based on consumers' demand - sellers changed the water they use to refresh their crops more often than in other markets.

Comparisons among cities showed that in general, the quality of vegetables in Kumasi was better than that in Accra or Tamale. This may be indicative of the water source (often shallow wells near streams) or better post-harvest handling (washing of vegetables still on farm) practices.

The main question of the authorities is where intervention should be placed to reduce health risks for consumers. The results suggest that during the sampling period post harvest contamination was not a major contamination source in contrast to contamination on farm. However, most sellers wash (or refresh) different vegetables before selling them with the same water again and again. This water could easily contaminate relatively cleaner vegetables. Thus, it is not sufficient to address only farm practices.

To reduce the health risk associated with the consumption of contaminated lettuce, it is evident from the study that the problem should first be tackled at the farm level through safer agricultural practices. This, however, is not as easy as often recommended. Changes in irrigation methods, timing and types of crops might not be possible for the farmers (Drechsel et al., 2002). Therefore, other options are currently under investigation in two projects of the Challenge Program on Water for Food. First trials by IWMI show that especially helminth counts can be reduced significantly with simple measures on farm, while it requires good washing practices at home to minimize the bacterial contamination. Thus, it will always be necessary to wash the crops in addition, also in view of heavy metals and pesticides. Kitchens of fast food sellers particularly should be addressed in a related campaign as shown in Chapter 5. Among food sellers, awareness of food safety is generally high and more than 90% of the food vendors and consumers wash salad, however, individual methods vary largely and seldom meet the required standards as our tests showed.

The same applies to the removal of pesticides. Many farmers use restricted and even banned pesticides for vegetable production resulting in residue much higher than the recommended thresholds. In fact, pesticides are considered as plant medicine and the perception of human health risks is very low (Danso et al., 2002b). Despite sufficient legislation, monitoring of pesticides residue on food is virtually non-existent in Ghana (Clarke et al., 1997). Alternative forms of pest control require more participatory technology development and skills training to become competitive (Okorley et al., 2002). Risk reduction should, however, also focus on households to create demand for safer crops and to educate about appropriate washing procedures. Figure 9.9 shows a related example.

# 10. Perceptions of stakeholders

*This chapter presents perceptions of vegetable farmers, sellers of exotic vegetables, consumers of such vegetables and local authorities/officials on urban open-space vegetable farming and irrigation with polluted water sources in Ghana. In all, over 1000 vegetable consumers, 150 vegetable sellers, 24 city officials and over 140 farmers took part in the study in Accra, Kumasi and Tamale. It also presents Accra's first Vision on urban and peri-urban agriculture.*

## 10.1 Data collection

When dealing with wastewater irrigated vegetable production, the manner in which different stakeholders perceive it (or not) provides important insights on their priorities and motivation to deal with these issues. In a typical farming situation in urban Ghana, the key stakeholders involved are the farmers and their families, the market sellers who earn an indirect living from the sale of the produce, the consumers who may or may not be aware of the source of their consumables, the local authorities/officials who have the responsibility of regulating the practice, especially if polluted water sources are used, and the media with the power to influence opinions. Assessing their views and perceptions is a sensitive exercise.

Data used in this study were collected mainly through field interview with 1100 vegetable consumers (400 each in Accra and Kumasi and 300 in Tamale) and 150 vegetable sellers (50 each in Accra, Kumasi and Tamale) using semi-structured questionnaires. Consumers were sampled on suburb basis to cover an entire city with all the different social and economic groups. Only sellers of exotic vegetables (e.g. lettuce, cabbage, carrot, cucumber, and green pepper) were interviewed, as the vegetables they sell are the main ones grown in urban areas with irrigation. Sellers were chosen at random (affected by their willingness to participate) from selected markets (both big and small) spread across each city. Twenty-four city officials (15 in Accra, 5 in Kumasi and 4 in Tamale) were interviewed as part of this study. Information on farmers' perceptions was obtained from two separate complementary field surveys. In one survey, which focused on farmers' identification and ranking of farm constraints, 60 and 49 urban open-space vegetable farmers were interviewed in Accra and Kumasi respectively while in the other survey (focused on farmers' perceptions of urban agriculture and wastewater irrigation), 138 open-space vegetable farmers were interviewed in Accra.

## 10.2 Perceptions of farmers

### General farming constraints

In all the cities, farmers encounter numerous constraints in producing vegetables (Box 10.1).

**Box 10.1:** Typical production constraints mentioned by urban open-space farmers in Kumasi, Accra, Takoradi and Tamale

- Marketing of produce: vegetable market women/sellers dictate produce prices at harvest.
- High cost of input (pesticides, farm tools, labor, fertilizer, etc.)
- Pest and disease threats to crops
- Inadequate amount of cheap soil inputs (compost, poultry manure, etc.)
- Lack of available land and tenure insecurity due to the increasing rate of urban development.
- High labor input (personal or paid) for watering of vegetables
- Dry-season access to (safe but cheap) water for irrigation
- Poor seed viability (lettuce, cauliflower, cabbage)
- Lack of capital funding sources: farmers have to fund themselves or make an arrangement with the market women to provide them with some advance payments for more production.
- Limited support by extension service (see chapter 11.2 for details)

Four of the constraints identified in the cities were labelled as more 'important'. These were farming input, water, crop disease, and marketing. Table 10.1 shows the percentage of farmers in Accra and Kumasi that identified each constraint as important. Majority of the farmers mentioned input as an important constraint. Water was the next constraint identified by the majority in Accra as important while in Kumasi, crop disease was the next important constraint identified by nearly half of the farmers.

**Table 10.1:** Key constraint identified as important by farmers

| Constraint | Accra (%) | Kumasi (%) |
|---|---|---|
| Marketing | 42 | 35 |
| Input * | 82 | 69 |
| Water | 75 | 53 |
| Crop disease | 48 | 55 |

*Seeds, fertilizer/manure, tools

Farmers specified the nature of each constraint as shown in Table 10.2. More than half (56%) of the farmers in Accra mentioned water shortage between December and March as the main problem associated with the available irrigation water sources. This was followed by water cost (24%) and quality (22%). Exceptionally for Accra, 11% of the farmers indicated that 'public criticism' of the sources of water they use for irrigation is the factor that makes water a constraint to urban vegetable production. In Kumasi, 'lack of adequate supply' throughout the year and dry season shortage were the main problems of irrigation water. Regarding input, between 47and 68% of farmers in the two cities complained of cost as the main factor, which makes it a constraint, followed by the quality of seeds available. On marketing of produce, 59% of farmers in Kumasi specified the exact problem as 'low seasonal demand' while 32% of farmers in Accra labelled the problem as 'no direct market access/cheap pricing of produce.' More than two-thirds of respondents in each city indicated that crop disease more often than not results in crop damage (or failure). This, they have tried to avoid by using various known chemicals (such as Lindane, Chlorpyrifos, Endosulfan, etc.) as well as local soap and other products, but have not succeeded.

**Table 10.2:** Specification of nature of 'important constraints'

| **Nature of constraint** | **Water (%)** | | **Input (%)** | | **Marketing (%)** | | **Crop disease (%)** | |
|---|---|---|---|---|---|---|---|---|
| | **Accra** | **Kumasi** | **Accra** | **Kumasi** | **Accra** | **Kumasi** | **Accra** | **Kumasi** |
| Lack of adequate supply | 2 | 45 | | | | | | |
| Public criticism | 11 | 0 | | | | | | |
| Conveyance | 2 | 31 | | | | | | |
| Quality | 22 | 0 | 20 | 26 | | | | |
| Cost | 24 | 8 | 47 | 68 | | | | |
| Shortage | 56 | 42 | 6 | 0 | | | | |
| Viability of seeds/expired chemicals | | | 27 | 20 | | | | |
| Lack of tools and equipment | | | 12 | 0 | | | | |
| Seasonal low demand | | | | | 28 | 59 | | |
| No direct market access/cheaper pricing of produce | | | | | 32 | 29 | | |
| Yield reduction | | | | | | | 31 | 22 |
| Crop damage | | | | | 12 | 18 | 69 | 78 |

The results of the average ranking of constraints to irrigated vegetable farming and the degree of importance of each constraint to all others are presented in detail in Table 10.3. None of the constraints was ranked on average as ‘most important’ in both cities. In Accra, water and input were ranked the same, as very important constraints but in Kumasi with easier water access in inland valleys, farmers ranked these two as only important. Crop disease and marketing were both ranked as important constraints in the two cities. Soil fertility, land, credit/capital, lack of extension services, crop theft, labor, etc., were all ranked as ‘less important’ in both cities. Regression analyses of the influence of education, experience (years cultivating), irrigation water source and type of land tenure on the mean ranking of constraints were done, but did not result in statistically significant ($p < 0.05$) relations.

**Table 10.3**: Ranking of constraints to irrigated urban vegetable farming

| Constraint | Mean Ranking | |
|---|---|---|
| | Accra | Kumasi |
| Input | 2.27 | 2.59 |
| Water | 2.27 | 2.99 |
| Crop disease | 2.87 | 2.80 |
| Marketing | 3.43 | 3.39 |
| Credit/capital | 3.80 | 3.61 |
| Soil fertility | 3.85 | 3.71 |
| Land | 3.87 | 4.00 |
| Crop theft | 3.90 | 3.84 |
| Lack of extension services | 3.97 | 3.39 |
| Expired chemicals | 3.97 | 4.00 |
| Labor | 4.00 | 3.76 |

Scale 1 to 4: 1=most important; 4 =less important

### Irrigation water source

About two-thirds (65%) of the 138 farmers interviewed in Accra expressed satisfaction with the sources of water they use. Their reasons for using such water were due to the many benefits they derived from the water. For such farmers, wastewater/urban runoff provide reliable water supply because flow is relatively continuous (mentioned by 36% of the farmers) and they do not pay for the water as some of the other farmers do, who are using costly pipe borne water (32% mentioned this). This in addition is often in short supply thereby making it an unreliable source. Less than 5% of farmers referred to nutrients in water as reason for its use; but generally, farmers do not give consideration to the nutrients present in wastewater. They use it mainly as a dry-season source of water, and apply poultry manure as a (often free) source of crop nutrients.

Ten percentage of the 138 farmers mentioned skin irritation/diseases and bad odor as the health risks associated with the use of their irrigation water. Majority of the remaining farmers (71%) were of the opinion that there has never been any actual risk to themselves or to the consumers. This is how many of them put it:

> *"Ever since I was born, my father has been doing this work [farming] and it is the same drain water [wastewater] we have been using with no health problem…"*

Similarly, in Kumasi, Keraita (2002) reported that only few farmers complained of having e.g. body rashes from the use of irrigation water. Their confidence in the low levels of risk also derived from no complaints coming from the consumers of their products:

> *"There is nothing wrong with the water [drain water]. Nobody [consumer] has ever complained of any disease after eating our vegetables"*

The rest (19%) hold dual opinions on the health issue. They indicated that they have not encountered any actual problems for themselves, and believe it is the same for the consumers. However, they also hold the opinion that the use of "wastewater" might potentially be associated with some diseases due to the presence of germs in the water and this might show up later on.

The low risk perception has to be understood in the context of farmers and consumers where both might have experienced from childhood other health affecting factors as poor sanitation, unreliable supply of potable water, daily malaria threat etc. To emphasize in this context a single factor is difficult and actual risk perception is likely to be very low.

In Accra, 19% of the farmers wear temporarily protective clothing, mainly boots and hand gloves, when irrigating or applying manure while 14% perceive that the use of protective clothing particularly boots retard work progress on the farm and that they work faster without such clothing. In Kumasi, 80% of the 71 farmers interviewed by Keraita (2002) were aware that wastewater had pathogens. However, the awareness was "passive" and did not result in the use of protective measures.

## 10.3 Perceptions of vegetable sellers

### Knowledge about source of vegetables

Sellers have different mechanisms for sourcing their produce. Some of them select their crops on the field and even harvest themselves, while others buy at distribution points where the source may not be known. In all, over 85% of the exotic vegetable sellers interviewed in each city were aware that their vegetables are produced from within the cities they live in.

### Benefits and problems of urban vegetable farming

Over two-thirds of the 50 vegetable sellers in each city mentioned the following as benefits of urban open-space vegetable farming (in no particular order):

- employment for farmers and sellers;
- easy access to fresh vegetables;
- reduced cost and time of transportation for sellers and;
- usually lower prices of vegetables (since transport costs are less);
- increased supply of vegetables on city markets (because of easy access);
- high profit through high turnover; and
- ability to supplement their family food (in case of traditional vegetables);

As a result of these advantages, sellers were supportive of agriculture within cities, and mentioned that city authorities should give it more attention.

Half of the sellers interviewed in Accra[1] and 8% in Tamale were aware of possible health risks associated with urban vegetable farming. When asked (those aware of risks) to specify the risks in question, 96% of such sellers in Accra and 50% in Tamale identified irrigation with polluted drain water as the main risk. They mentioned that this could infect consumers with diseases (through contamination of vegetables) without their being able to specify what type of disease. In Kumasi, 10% of the sellers were aware that there were some health risks without being able to specify the nature of it.

[1] This awareness might be a reaction to the fact that only in Accra the media targeted wastewater use followed by attempts of the authorities to prosecute farmers using polluted water for irrigation (see Drechsel et al., 2006a).

### Quality of vegetables

All sellers in Accra, Kumasi and Tamale are much concerned about the appearance of their produce, which includes its “quality”. Consumers buy only what looks proper, and anything short of this will mean loss of customers. However, “quality” of vegetables was in this context not associated with bacterial contamination levels. Vegetable sellers in all the three cities have common criteria for evaluating the quality of vegetables. This is mainly by observing and inspecting them. They look for the following: size, shape, freshness of leaves, color, firmness of leaves (particularly with cabbage), spots, dirt, holes, etc. Buyers use the same criteria (see below).

### Sources of water and its influence on purchasing

Over 70% of the sellers interviewed in each city were aware of the various sources of water being used by farmers cultivating vegetables in the cities. For the different cities the sources mentioned were the same as reported in the previous chapters. However, sellers were not specific about the quality of the various sources of water mentioned except for holding the general notion that pipe borne water has the best quality because it is treated water.

Between 20% and 50% of the sellers in the three cities said that they enquire about the geographical source of the crop. This was particularly so in Accra where 88% of the sellers indicated that sometimes consumers ask about the source of vegetables or the water used[2]. In Kumasi and Tamale, the situation is rather different with less than 20% of the sellers being sometimes asked about the source. Asking about the “source” is, however, not a direct indicator of risk awareness but can also be related to belief or experience that, for instance, carrots from Togo are better than those produced in Ghana without actually knowing the reason. In response to a direct question about what sellers think of vegetable production with “wastewater”, nearly all the sellers in the three cities replied as expected with negative opinions. According to them, this could bring diseases to consumers. Nearly 30% of sellers in Accra and Kumasi expressed the opinion that farmers involved in such practices should be stopped without any compromise.

When asked if they would offer higher price for vegetables produced with ‘good’ quality irrigation water (supposedly piped water), 76% of the respondents in Accra answered ‘Yes’, while only 14% and 28% in Kumasi and Tamale respectively, answered similarly. Sellers who were not willing to offer higher prices for vegetables grown with ‘good’ quality water

[2] However, no seller would reveal that the source might be an inner-urban place known for its bad water quality.

indicated that in practice this would result in selling vegetables at higher prices without having a corresponding demand. This reply appears to be a more thoughtful one (see also Danso et al., 2002b). Most sellers also hold the view that it is difficult to distinguish between wastewater irrigated vegetables and those grown with clean water. From the survey, it was gathered that sellers (mainly in Accra) use physical characteristics to differentiate between wastewater-irrigated vegetables and those grown with good quality water. However, the characteristics given ("slightly yellowish leaves", "generally not fresh", etc.) did not appear reliable, considering that 90% of the perishable vegetables are produced with polluted water, and actually do not show these characteristics.

## 10.4 Perceptions of consumers

### Knowledge about source of vegetables

Analysis of the survey results revealed that 60-94% of the consumers were aware that urban agriculture was a source of their vegetables (94% in Tamale, 80% in Accra and under 60% in Kumasi). Awareness is higher in Accra and Tamale than in Kumasi because in Accra and Tamale vegetable farming is done mostly in the core areas of the city, close to urban dwellings while in Kumasi many of the vegetable farms are located at the fringe around the local university.

### Benefits and problems of urban vegetable farming

Like vegetable sellers, consumers have a similar perception of benefits and potential problems of urban vegetable farming in Ghana. New arguments among the benefits were soil protection and savings in vegetable import and foreign currency. Also the risk perception was similar pointing at the possibility of diseases from the use of polluted water. Consumers also mentioned that some urban farmers use agro-chemicals wrongly, which could also have health implications.

On the question of how urban agriculture could be better organised, given the benefits mentioned, some of the consumers suggested that part of government lands should be set aside specifically for vegetable farming in the cities. They further mentioned that additional lands could be acquired in the peri-urban areas through negotiations with traditional authorities and farmers could pay a token fee to landowners.

### Quality of vegetables

The study revealed that a large majority of the consumers interviewed in each of the three cities are naturally concerned about the quality of the food they buy, including vegetables. Like with vegetable sellers, consumers also usually use standard characteristics such as color (greenish leaves represent good quality and yellowish represent bad quality), shape, cleanliness, freshness, no spots etc. to determine produce quality. The discussion held with sellers concerned the price, not the origin of the produce or the use of bad irrigation water or pesticides. Anyhow, it would be difficult to distinguish between likely contaminated and uncontaminated crops, and more than questionable if the seller would reveal any source which could reduce the market value of the crop.

### Sources of water and its influence on purchasing

Though the criteria for determining crop “quality” do not include pathogen contamination, many consumers (45% in Accra, 40% in Kumasi and 58% in Tamale) – if directly asked - thought it important to know where the vegetables were produced in order to avoid contaminated ones. When asked if they would buy wastewater-irrigated vegetables if they had a choice, 75-96% answered in the negative. Like sellers, consumers mentioned the contracting of diseases as the reason why they would not buy wastewater-irrigated vegetables. Others, however, were of the opinion that wastewater-irrigated vegetables could be cleaned adequately to remove any disease-causing organism. Consumers’ reactions as to what they would do in a scenario where all vegetables on urban markets were grown with wastewater were analysed too. Nearly 40% of the respondents in Tamale said they would clean vegetables adequately and use them instead of avoiding them. At least 30% would either cultivate vegetables themselves or buy from rural areas. Between 60 and 80% of the respondents in Accra and Kumasi pointed out that they would prefer stop buying vegetables from the market, though they could not point out where they would go for safer vegetables. About 20 to 40% mentioned that they would adequately clean such vegetables.

### Cleaning of vegetables

Cleaning vegetables at home is common. In a survey reported by Amoah et al. (2006b) over 90% of the consumers in Kumasi, Tamale and Accra said that they wash purchased vegetables at home. However, the survey also showed that the methods vary widely (Table 10.4) and are not very effective.

**Table 10.4:** Common methods used by consumers to clean vegetables (Amoah, unpubl.)

| Cleaning Method | % Respondents | | |
|---|---|---|---|
| | Accra | Kumasi | Tamale |
| Washing with warm water in a bowl | 55 | 53 | 51 |
| Washing with salty water in a bowl | 34 | 34 | 14 |
| Washing with salty water and vinegar or potassium permanganate in a bowl | 6 | 11 | 10 |
| Washing with water and vinegar in a bowl | 4 | 1 | 2 |
| Washing twice with tap water or with water in a bowl | 1 | 1 | 23 |

## 10.5 Perceptions of city officials

Generally, agriculture in Ghanaian cities is at least theoretically recognized as there are bylaws regulating the types and number of crops and animals that could be cultivated or raised (Ghana Local Government Bulletin, 1995). Though the bylaws do not specifically promote urban farming, they do recognize (the possibility of) its existence and seek to control it in order to maintain good sanitary conditions in the city (see Chapter 11).

Moreover, both the National and Local Governments (District Assemblies) have shown their recognition of urban open-space farming in two ways:

- Under the decentralization policy of the Ministry of Food and Agriculture, a Food and Agriculture Directorate for the Accra district was established, which is responsible for the metropolitan level. The Directorate has its own extension staff in charge of open-space farming in the city.

- Throughout the country, best district, regional and national farmers are annually rewarded (Figure 10.1), including those at the metropolitan level labelled as the “Best Urban Farmer” or “Best Metro Farmer” (Annang and Drechsel, 2005).

However, as the following chapter and many other studies have pointed out for West Africa and Ghana in particular, official recognition of urban agriculture has not been reflected in city planning and development (Obosu-Mensah 1999; Drechsel et al., 2006a). The planning of most Ghanaian cities is based on a master plan designed originally by colonial administrators, which does not consider urban farming, although the practice of inner-urban vegetable production dates probably back to the start of the first European forts and castles in the 16$^{th}$ century (Anyane, 1963).

Figure 10.1: Martin Kumah of Ghana during the award ceremony on National Farmers' Day, 2004. In 1998, Martin was the Best Urban Farmer (Kumasi), in 1999, the Best Regional Aquaculture Farmer (Ashanti Region), and in 2002, the Best National Aquaculture Farmer. In 2004, he received the award for the first runner up in the most prestigious 'Best National Farmer' contest (Annang and Drechsel 2005; Photo: Courtesy M. Kumah).

The officials interviewed in this study acknowledge unanimously the importance of urban agriculture in providing food and jobs for unemployed urban dwellers and preventing encroachment of both government and private lands. They also believe that vegetable production in and around Ghanaian cities contributes to the supply of vegetables, which improves the nutritional level of urban diets. However, in all cities, concerns were expressed that without proper monitoring urban agriculture compromises the health of city dwellers. These officials complained about possible crop contamination from two sources: untreated wastewater and inappropriate use of agro-chemicals.

## 10.6 Perception of the Government

In Ghana and Nigeria, urban [backyard] gardening was indirectly encouraged in the seventies through programs like "Operation Feed Yourself" and "Feed the Nation", launched by the respective governments. Despite several projects funded in the meantime, for example, by FAO, DFID and IDRC on urban food supply, the peri-urban interface, etc., urban farming did not receive much political attention. Due to recent efforts from the Resource Centres on Urban Agriculture and Food Security (RUAF) a first national policy seminar on Urban and Peri-urban Agriculture was organized in 2005 as a follow-up to a corresponding Multi-stakeholders Forum. The policy seminar was co-organized by the Ministry of Food and Agriculture (MoFA), the Science and Technology Policy Research Institute of the Council for Scientific and Industrial Research (STEPRI-CSIR), the Food and Agriculture Organization of the United Nations (FAO) and the International Water Management Institute (IWMI). The Honorable Clement Eledi, Deputy Minister of Food and Agriculture, commented during the seminar that urban and peri-urban agriculture is a reality that has come to stay contributing to household income and poverty reduction. However, it also requires strong leadership at both the local and national levels. The Minister promised that MoFA will ensure the provision of safe water for urban farmers and from 2006 on, MoFA would give an award to the *national* best urban and peri-urban farmer during the annual "Farmers Day" celebrations. The seminar closed with a joint statement on urban and peri-urban agriculture, reproduced in Box 10.2.

**Box 10.2**

*Statements of Vision on*
*Urban and Peri-urban Agriculture (UPA) in Accra*

- UPA plays an important complementary role to rural agriculture in contributing to food security, employment and income generation, especially for the urban poor.
- While contributing to livelihoods and food security, it is recognized that UPA faces numerous challenges and constraints such as limited availability of land, access to safe water and other production resources, and market constraints.
- There is the need to overcome current and emerging challenges facing UPA by coordinating all stakeholders, streamlining its operations and creating an enabling environment for its sustainability
- As urban population soars, the role of UPA in supplying perishable food to cities of Africa becomes increasingly important and needs a supportive policy and legislative framework.
- Overcoming the challenge calls for the recognition of UPA in the sector ministries and agencies and for policies to effectively integrate UPA in urban planning and development.

*Statement of Consensus*

We call for the promotion of a shared vision on UPA that takes into account the specific needs and conditions in the country and urge Policy makers, in partnership with Development Partners, to develop gender sensitive policies and appropriate instruments that will create an enabling environment for integrating and supporting UPA into our economies

Endorsed on 13. 12. 2005 by the participants in the presence of Honourable Clement Eledi, Deputy Minister of Food and Agriculture

In 2005/6, IWMI and FAO assisted Ghana's Irrigation Development Authority (GIDA) in developing the first *national irrigation policy* standing up for the recognition of the informal irrigation sector, including irrigated urban and peri-urban agriculture. The importance of this sector is highlighted by the case of peri-urban Kumasi, where about 12,000 ha are under informal dry-season vegetable production (Cornish and Lawrence, 2001), which is more than twice the area currently under formal irrigation in the whole of Ghana (see Chapter 2).

## 10.7 Perceptions and role of the media

Like in other low-income countries, public services in Ghana are constrained by a variety of factors and lack far behind their ambitions. In this situation, some media feel the obligation to point at problems the authorities should address. These ‘appeals’ are powerful instruments as they steer public perceptions of problems. Consequently, authorities give them whenever possible priority attention. Sanitation and waste are ‘hot’ issues in Ghana. Due to the use of polluted drain water, also irrigated urban vegetable production is frequently featured in TV and the printed media (Figure 10.2).

Daily Graphic, Monday, November 7, 2005.

‘Contaminated vegetables pose health hazard’

Story: Naa Lamiley Lamptey

Stop this unhealthy practice now

Minister orders arrest of farmers

Vegetable growers appeal to government

Daily Graphic, Thursday, December 15, 2005

Daily Graphic

THURSDAY, DECEMBER 15, 2005

GROWING SAFE VEGETABLES

MOFA designs technologies to reduce health hazards

Story: Abdul Aziz

THE Ministry of Food and Agriculture (MOFA) is working closely with the International Water Management Institute (IWMI) to design appropriate technologies to reduce the health and environmental hazards associated with using polluted water in fresh vegetable production in urban areas.

The appropriate technologies include the construction of tube wells to support urban irrigation systems in the various Metropolitan areas to improve food safety and human health.

Mr Ernest Debrah, Minister of Food and Agriculture, who announced this at a Seminar on Urban Agriculture for Food Security, said the use of waste water to produce fresh vegetables for the urban population could

**Figure 10.2:** Irrigated urban agriculture in the press (Ghana’s Daily Graphic).

Figure 10.2 depicts the tension under which urban farmers have to operate in Accra, and the pressure on the authorities. Although some journalists and media focus solely on problems, there are increasingly others looking for constructive solutions. These could become a crucial stakeholder in sustaining risk-reduction programs. They could assist authorities and consumers in giving public attention to, for example, farmers using safer irrigation practices while putting pressure on those not using them.

## 10.8 Conclusions

Urban irrigated vegetable farming in open-spaces in Ghana is confronted with numerous constraints in marketing, lack of input, low-quality water, credit/capital, crop disease, soil fertility, and crop theft. Of these constraints, farmers identified and ranked lack of input, water, crop disease and marketing, as most important constraints.

Farmers mentioned the importance of their water sources for continuous irrigation and income, but they do not wish to be openly associated with the low water quality, owing to the media and some public criticisms out of fear that such an association may possibly influence the sale of their produce and livelihoods. For themselves, they do not seem unduly concerned about water contact related health consequences, and also do not appear to believe in other problems, given that according to many of them, they have rarely received complaints about this aspect of the quality of vegetables they produce. Vegetable sellers and consumers seemed to recognize the need for urban open-space agriculture and its benefits to the society. They are generally concerned about the quality of the food they sell or buy, though the criteria of quality do not include contamination through polluted irrigation water.

The city officials recognized the contribution that irrigated vegetable production makes in terms of food supply to cities, but remain concerned about the irrigation water sources. Ghana’s media nurtures these concerns. Though the authorities oppose wastewater irrigation, they tolerate the practice until now due to lack of resources to address the situation or to provide alternatives to the farmers. The officials felt that urban agriculture could be successfully encouraged if it were planned and regulated properly, with sound monitoring so as not to compromise the health and well being of city dwellers. Current efforts by RUAF started a related policy discussion, which resulted in a Vision statement endorsed by the Ministry of Food and Agriculture.

The levels of awareness shown by the stakeholders indicate that there is some degree of reflection about the practice currently. This is encouraging as it lays a fertile foundation to improve negative perceptions in a constructive way, for example, by introducing options to reduce health risks related to wastewater use (see Chapter 12). Educational campaign could build on at least dormant risk awareness and the readiness of consumers to clean vegetables at home, although their practices will have to be improved. That the awareness is dormant and does not affect consumers' decision making during vegetable purchase has probably two different reasons:

- The specific risk factor might not have priority (as other risk factors take the attention, or as it is believed that the risk is under control).
- Health is in general a neglected incentive, like also consumption habits in the developed world show.

Awareness campaigns for consumers should be accompanied by the introduction of safer irrigation practices on farm. Currently there are two research projects of the CGIAR Challenge Program on Water and Food in Ghana (CP38 and CP51) exploring applied options for health risks reduction (www.iwmi.cgiar.org/africa/west_africa).

Farmers appear increasingly interested in practical innovation and are even ready to invest to avoid pressure from the authorities and media.

# 11. Institutional aspects of urban vegetable farming and "wastewater irrigation"

*This chapter examines key institutional issues that are important to the recognition and sustainability of irrigated vegetable farming in Ghanaian cities. It assesses the informal nature of the business and examines current roles being played by relevant agencies in urban vegetable farming and urban wastewater management under consideration of bylaws and new policy developments that have implications for the recognition of informal irrigation and/or the use of polluted water in irrigated vegetable farming. It also suggests an innovative way to facilitate the institutionalisation of urban agriculture.*

## 11.1 Informality of irrigated urban farming

Cornish et al. (1999) define *formal* irrigation as one that is reliant on some form of fixed irrigation infrastructure that was designed and may be operated by the government or a donor agency and which is used by more than one farm household while *informal* irrigation is one that is practiced by individuals or groups of farmers without reliance on irrigation infrastructure that is planned, constructed or operated through the intervention of a government or donor agency. The development of formal irrigation schemes in Ghana is recent compared to other countries. The first of such schemes was initiated in 1960. The Ghana Irrigation Development Authority (GIDA) has 22 irrigation schemes under its jurisdiction covering about 14,700 ha of which 60% are developed and about 5478 ha actually put under irrigation (status of June 2003). All together farmers on these schemes number about 10850 (GIDA-JICA, 2004).

There is little data on formal irrigation schemes set up and managed by the private sector (e.g. Agodzo and Blay, 2002; Gyamfi, 2002). Besides a few – mostly export oriented – commercial schemes near Accra, irrigated vegetable farming in urban and peri-urban Ghana clearly falls under the "informal" smallholder category since it does not involve using fixed irrigation infrastructure, and governmental support is minimal. In the 40 km radius around Kumasi alone, there are estimated to be 12,700 households irrigating at least 11,900 ha in the dry season, which is more than twice the area functioning under formal irrigation in the whole of Ghana (Cornish and Lawrence, 2001). However, informal irrigation goes beyond urban and peri-urban vegetable production and includes, for example, shallow groundwater use, as in the Upper East and Keta area, irrigation around small reservoirs and along the Volta river.

In spite of its size and importance, these forms of irrigated vegetable farming do not yet receive the support they need from policy makers and irrigation institutions. For instance, the

Ghana Irrigation Development Authority (GIDA), which is the government agency officially responsible for developing irrigation in Ghana had always focused solely on public or formal irrigation schemes and had until recently, considered informal irrigation as outside its jurisdiction. Policy or training programs organised to educate farmers on irrigation related issues do not consider the needs of informal irrigators. For this and other reasons, informal irrigators, more often than not, lack the requisite skills and know-how relating to the non-traditional (exotic) vegetables they grow and safe irrigation practices.

## 11.2 Agencies relevant to irrigated urban farming

Improving urban vegetable farming requires dealing with complex issues pertaining to food production, income generation, health, sanitation and environment. A single agency or institution may not be able to adequately and appropriately handle all the complexities involved, suggesting a multi-agency approach. A number of agencies and institutions have specific or general roles regarding urban vegetable farming in Ghana. The number of agencies, and the degree to which each is involved differs among the three major cities of Ghana. Accra displays the highest complexity while the much smaller Tamale displays the least.

The institutional analysis focussed on the policy environment of urban agriculture and classified the concerned institutions under two categories, i.e. those who have direct involvement with urban agriculture on land and water use, food safety; urban planning; and those who indirectly influence the practice, for example from the perspective of sanitation and the environment.

The most prominent institutions that would require to be involved in decisions pertaining to urban vegetable farming are the Metropolitan, Municipal or District Assemblies which are responsible for all activities at the Metropolitan, Municipal or district levels. The other key agencies of direct relevance are:

- The Ministry of Food and Agriculture (MoFA), which operates through the Directorate of Food and Agriculture, which is decentralised down to the district level.
- The Directorate of Health, which is also decentralised is not an agency of the Ministry of Health but stays loosely linked to it. These directorates are closely linked and report directly to the Assembly at a given administrative level.
- The Department of Town and Country Planning and the Department of Parks and Gardens, are departments within the regional administration, which have now been decentralised to the local authority (metropolitan, municipal or district) levels.

- Ghana Irrigation Development Authority, which is a semi-autonomous body under the Ministry of Food and Agriculture.
- Water Resources Commission (WRC) under the Water Directorate of the Ministry of Water Resources, Works and Housing.

More indirectly involved are:

- Waste Management Departments (WMD) of the metropolitan, municipal and district assemblies, and
- Ghana's Environmental Protection Agency (EPA).

There are many other important stakeholders, such as the national research institutions, universities, NGOs, farmers associations, traders associations, consumers associations, the media, etc. which were recently analysed by RUAF for Accra, but not part of this analysis.

### 11.2.1 Food and Agriculture Directorates of MoFA – Extension service

The decentralization of the Ministry of Food and Agriculture (MoFA) resulted in district level directorates also in, for example, Accra, Kumasi and Tamale districts. The purpose of the decentralization policy, among others, was to facilitate grassroot participation in decision-making and implementation of agricultural policies and programs. The directorates were set up to deal with all issues relating to urban and peri-urban food and agriculture within the various districts. Though the directorate represents the MoFA at the different levels, it is more affiliated to the assemblies. Its responsibilities include:

§ Monitoring the performance of all agricultural developments in the metropolis and their impact on food production.

§ Managing and co-ordinating day-to-day activities of the metropolitan agricultural development unit (comprising veterinary services, crops, extension, fisheries, policy planning monitoring and evaluation) and also analyzing participation and adoption of appropriate technologies by farmers and fishermen.

§ Liasing with all partners (e.g. farmers, fishermen, researchers, subject matter specialists, NGOs, educational institutions, and the public on programs related to the development of agriculture in the metropolis, municipality, and district.

§ Organizing and participating in all meetings, workshops, etc. related to agriculture with the view to clarify MoFA to all concerned.

The directorate receives financial support from the parent ministry as well as the metropolitan assemblies.

In all cities, the directorate offers extension services to urban open-space farmers, and is thus actively involved in organizing and educating farmers on improved farming practices such as nursery management, IPM and safe use of organic manure. It also educates farmers on the existing AMA bylaws that regulate urban agriculture (see section 11.3). MoFA-AMA was pro-active with regard to lands for urban agriculture and is trying to pass a bylaw to reserve certain areas in and around Accra as green belt or green zone areas. These areas will be used explicitly for farming until such time as the government requires them for other purposes (some of these areas are currently being used by farmers). The directorate is trying to ensure that these lands are reserved for farmers. The directorate has also assisted many urban farmers to get access to pipe borne water in order to help farmers avoid the use of polluted surface water and untreated wastewater in agriculture. The use of potable water for farming in Accra is currently being questioned due to new commercial tariffs and because potable water is scarce.

MoFA-AMA works closely at the implementation level with the metropolitan sub-committee on agriculture, which mainly plans and evaluates agricultural policies, marketing options etc. The directorate also works with the metro-health directorate to enforce bylaws related to health aspects of urban agriculture (food quality, market cleanliness etc), and is a partner in Accra's RUAF team. The directorate intends to encourage farmers to cultivate high value crops and export crops such as mushrooms and flowers, contribute to the urban economy. It also intends to give farmers land security. However, MoFA-AMA faces some constraints such as inadequate budget allocation, manpower capacity to disseminate policies, logistics to support policies, limited voice to interfere in land tenure issues, etc. While this description reflects largely how the authorities view themselves, Box 11.1 lists what urban vegetable farmers are deprived of at MoFA-AMA.

The national MoFA Extension Directorate supports the district directorates, and started in 2005 exploring groundwater availability for urban vegetable farmers in Accra.

The MoFA directorates in Kumasi and Tamale have the same tasks as in Accra, like organizing training for farmers in areas such as the use of agro-chemicals. MoFA-KMA also assisted farmers securing good quality irrigation water by constructing shallow wells on a cost-sharing basis (KMA 90%, farmer 10%). KMA will pre-fund the whole project while farmers pay their share over a period of time. On land acquisition and use of land in urban areas for vegetable farming, the directorates in Kumasi and Tamale have so far realized little, but try to get urban agriculture recognized in city planning. Since majority of lands in and around Kumasi belong to traditional rulers and individuals there is, however, little it can do to assist farmers in gaining access to such lands. The situation is different where other authorities, like the local university, own the land.

**Box 11.1:** Farmers' 2005 top complaints from six major urban vegetable sites in Accra, on the performance of the MoFA extension service (IWMI, unpublished):

- Slow response to pest problems
- No monitoring of seed quality
- No assistance with marketing
- Too little assistance to reduce post-harvest losses
- Lack of farmers' participation in MoFA program development (too top-down).
- No demonstration farms on, for example, IPM
- No Field Schools for farmers for the past 4 years
- No effective Monitoring & Evaluation of the Extension Services (uncompleted programs, low staff motivation, limited accountability, too long "no see")
- MoFA in general focuses too much on traditional crops, which takes most resources
- No facilitation to get access to loan and credit e.g. from poverty reduction programs etc.
- Poor access to land and water, no assistance to get land use rights
- No linkages with research to improve soil fertility management and yield increase

### 11.2.2 Health Directorates

The health directorates are implementing agencies responsible for health and sanitation issues within the cities. They are responsible for enforcing bylaws, which also touches areas of urban agriculture and wastewater irrigation. The Local Government Act of 1993 (Act 462) Section 14 mandates them to enforce all bylaws relating to metropolitan public health. In Accra, the health directorate represents the environmental management sub-committee of the metropolis which is responsible for making policies in areas of health, sanitation, waste management, pollution control and prevention, management of water bodies and resources among others. In Kumasi and Accra, the health directorates now have a more positive attitude towards irrigated open-space urban agriculture where they were earlier bent on prosecuting farmers. Now they educate farmers and take legal action only when it is really necessary.

Currently, the health directorate is working with MoFA-AMA to educate farmers on the health and environmental implications of their activities. The situation is not different in Kumasi where the directorate works closely with agricultural extension agents of MoFA-KMA. The Kumasi directorate organizes forums for farmers on human health and environmental impact of their farming activities. Like in Accra, they educate the farmers who break their bylaws before taking any legal action.

### 11.2.3 Department of Town and Country Planning

The town and country planning department, a department within the regional administration, which has now been decentralised, has an advisory role to play for the assembly and is responsible for planning various land uses in the whole country. However, it is the local authority (assembly in this case) that makes the decisions pertaining to governmental land use. In Accra, the department assists MoFA-AMA to identify all government lands within the metropolis that could be used for farming while awaiting government decision on what those lands should be used for. Some areas in and around Accra, Kumasi and Tamale have been zoned and declared as open-spaces by the department to be used for landscaping and as recreational centers. Once zoned for this purpose they come under the purview of the Department of Parks and Gardens. Since some of the open-spaces have not yet been developed, this department (Parks and Gardens) has allowed urban farmers to use them in the meantime. In Kumasi for instance, farmers have been allowed to farm in marshy areas and along riverbanks.

### 11.2.4 Department of Parks and Gardens

Like the previous department, this one was also housed within the regional administration and is decentralised to the local authority level. The department is responsible for developing open spaces into recreational grounds and gardens, including grassing. For lack of funds and other reasons, the department has not been able to develop some of these areas. Since these cannot be properly maintained because of the cost involved, they have released part of them to urban farmers, particularly those in Accra, to cultivate. The department sees this as a strategy to avoid encroachment on these lands and to keep them in order. In fact, due to the high beds common for vegetable farming, these sites appear very neat and well integrated, like the site called Marine Drive beside the Independence Square.

### 11.2.5 Ghana Irrigation Development Authority (GIDA)

GIDA is a semi-autonomous government agency also under the responsibility of the Ministry of Food and Agriculture. It is officially responsible for the development of irrigation in Ghana, which was until recently understood as "governmental irrigation schemes". Seasonal or year-round irrigation in urban and peri-urban areas with watering cans was not considered as part of the jurisdiction of GIDA. For this reason GIDA has no regulatory and implementation role in irrigated crop farming in the metropolitan areas of Ghanaian cities. However, GIDA noticed the potential and the need for an informal irrigation sector and initiated together with IWMI the development of a broader national irrigation policy, which should also cover the informal irrigation sector. The policy development was funded in 2005 by FAO and was carried out in a participatory process with full involvement of stakeholders. The current draft will be submitted to Cabinet in 2006. If it remains as the final draft (May 2006) showed, then this will become the first national policy in Africa recognizing the informal irrigation sector including irrigated urban and peri-urban agriculture.

### 11.2.6 Water Resources Commission

Ghana's Water Resources Commission (WRC) was established by an Act of Parliament (ACT 522 of 1996) with the mandate to regulate and manage the country's water resources and to co-ordinate government policies in relation to them as well as the activities of the institutions, which already deal with the resource. The Water Resources Commission is made up of technical representatives of the main stakeholders involved in development and use of water resources. WRC coordinated the recent process of developing Ghana's National Water Policy. Also a National Water Quality Monitoring Programme has been developed and will be implemented from 2004 to 2008. As a first step towards preparation of the program, a Raw Water Quality Monitoring Guideline for the Coastal and Western river systems in the country has been developed. Consultations are going on between the Water Resources Commission and the Environmental Protection Agency aimed at preparing a Memorandum of Understanding on wastewater discharges and pollution of water bodies and the respective roles to be played by each institution. The Water Resources Commission is also initiating studies under the Water Supply and Sanitation Programme (WSSP-II, 2004 – 2008), to develop and establish a uniform buffer policy for riverbanks, reservoirs, lakes, etc., to address the current varying buffer zone demarcation statutes for the protection of water resources. So far, the WRC has completed the compilation of information on various buffer zone demarcation policies and regulations. This policy will target agricultural encroachments and therefore small-scale farmers along the major rivers but also along streams in urban and peri-urban areas using stream water for irrigation. However, since human activities are not expected to be excluded from all buffer areas, the WRC was asked for provisions to accommodate such farmers, especially where impact on water resources can be minimised.

### 11.2.7 Waste Management Department/Environmental Health Department

With the inception of the local government administration, the Metropolitan, Municipal and District Assemblies are today responsible for managing solid and liquid wastes generated within their boundaries. Prior to this, the sewage division of the Ghana Water Company Limited (GWCL)[1], then Ghana Water and Sewerage Corporation (GWSC) was responsible for managing sewerage systems in Ghana. Assemblies have created waste management departments (WMD) and/or Environmental Health Departments to take up the corresponding responsibility. The Assemblies have also made bylaws to give legal backing to the functions of the WMDs. Parts of the solid and liquid waste collection have been subcontracted to the private sector. The transfer of responsibility of managing urban wastewater from GWCL to the Metropolitan and District Assemblies and then to the private sector has not been very smooth.

The WMD also interacts with urban and peri-urban farmers where solid waste and/or excreta are used as composted or raw input, like in Kumasi and Tamale (see Chapter 8.5)

### 11.2.8 Ghana Environmental Protection Agency

One of the statutory functions of the Environmental Protection Agency (EPA) is to co-ordinate activities of such bodies, as it considers appropriate for the purposes of control, treatment, storage, transportation and disposal of waste. Its general objectives include:

- providing technical assistance for the Metropolitan, Municipal and District Assemblies to enable them meet their responsibilities for managing the environment;
- ensuring that the implementation of environmental policy and planning is integrated and consistent with the country's desire for effective long-term maintenance of environmental quality; and
- ensuring environmentally sound use of both renewable resources in the process of national development.

[1] GWCL is currently reformed towards Private Sector Participation. The sewage division was considered as a costly obstacle to the privatisation and was consequently detached (Ridder, 2002).

The EPA provides guidelines for developments that affect the environment and sets standards for emissions and discharges into the environment. EPA's role in the management of domestic wastewater in Ghanaian cities is more of an advisory one. However, it has a monitoring and prosecution mandate as well. Due to limited resources, EPA has not been able to properly monitor the management of domestic wastewater in most Ghanaian cities, hence lacking the basis for any legal suit. Further, government institutions like hospitals, learning institutions etc contribute a lot to water pollution, making the prosecution of individuals or private establishments a farce.

## 11.3 Regulatory bylaws

In the seventies, most municipal bylaws referring to urban food production were put in place, however, not to increase food production but to maintain sanitary standards (Obusu-Mensah 1999). There exist for example the AMA (growing and sale of crops) bylaws, which date as far back as 1972 and were updated in 1976, 1977, 1994 and 1995 (Obosu-Mensah, 1999). They support backyard gardening but demand that open-space farmers register:

> 'No person shall grow crops at a place other than on land within his premises unless he has registered with the Medical Officer of Health furnishing his name and address and the description of the site where the crops are to be grown'

Official explanation indicates that this bylaw is meant to prevent indiscriminate cultivation of crops within the metropolis because of the perceived health and environmental implications of the input used by farmers. It permits inspection by the officials of the metro-health directorate of AMA to ensure that lands used for vegetable farming are not polluted as to cause contamination to crops. Another reason for this bylaw was to allow for inspection of irrigation water to be used by open-space farmers and to avoid the use of degraded/exposed lands and lands close to water bodies that might cause problems of erosion and pollution of water bodies. The bylaw is, however, not enforced, like most bylaws in the cities. The reasons are many and center mostly on the question of who to enforce them, who has the resources to do so, and where to start as nearly all municipal bylaws need a stronger enforcement.

Interactions with officials of the metro-health directorate indicate that the directorate has so far no record of the people cultivating in open-spaces within Accra. They also have no record of places under cultivation. In fact, urban farmers do not register with any authority, including the Medical Officer of Health. Currently, MoFA-AMA is carrying out a project to document all the sites under cultivation and to assess the amount of vegetables produced on each site, both in the dry and rainy season. A GIS-based site assessment was also initiated under RUAF. Strict adherence to the bylaw would imply that most farmers would have to stop cultivating since they fall short of the intentions of the bylaw in one way or the other.

The second relevant bylaw refers specifically to irrigation water and puts a ban on certain sources of water currently being used by most open-space farmers in Accra. It states:

> 'No crops shall be watered or irrigated by the effluent from a drain from any premises or any surface water from a drain which is fed by water from a street drain'

The official reason given for enacting the second bylaw is to protect the public against bacterial gastro-intestinal infection, which is contracted through consuming unwholesome food.

Vegetables grown with effluent from drains are at risk of contamination but studies have shown that effluents from drains is just one of the many possible sources of microbiological contamination of vegetables in the markets of Ghanaian cities. Other sources include manure and improper handling (see Chapter 9). Strict enforcement of this bylaw would imply that most urban farmers in Accra would be affected. However, like with the first bylaw, there is no enforcement due to financial and personnel constraints.

A closer look at the two bylaws reveals that they were not made to ban or promote urban agriculture per se but rather were made to maintain good sanitary conditions in the city. The other AMA (growing and sale of crops) bylaws are not discussed in this paper.

Contravening any of the crop related bylaws attracts a penalty in the form of cash fine, imprisonment or both.

> ‘A person who contravenes any of these byelaws commits an offence and is liable on summary conviction to a fine not exceeding 100,000.00 cedis or in default of the payment of the fine to a term of imprisonment not exceeding three months or to both’
>
> [Eds: 100,000 cedis were about US$ 100 in 1995; and are US$ 11 in 2006]

There are no specific bylaws regulating urban agriculture in Kumasi and Tamale except the general National Land Policy, which prohibits any activity, including agriculture, within drainage reservations (area within 100 m away from water bodies). The penalty for offenders is a fine not exceeding 200,000 cedis and/or six years imprisonment (Keraita, 2002). Farmers in need of irrigation water do not comply with this policy and officials do not enforce it, in part as farming prevents other forms of encroachment or waste dumping.

A new initiative of Ghana’s WRC to reinforce a buffer zone policy aims at stricter rules (see above) which will hopefully consider the livelihoods and needs of small-scale irrigators.

## 11.4 Integration into city planning

In Ghana, a formal integration of urban agriculture into urban planning and city development does not yet exist. To integrate urban agriculture into urban planning, there is the need for improved perceptions and relationships between its different stakeholders. This is a major objective of the RUAF network in Ghana (www.ruaf.org). Key issues are the allocation of land and safe water.

### Land and Water resources

In Accra, Kumasi and Tamale, the common and most challenging constraint to open space farmers is availability of land, access to it, and its usability for farming purposes. Anku et al. (1998) noted in their study on environmental assessment of urban agriculture in Accra that urban agriculture as a land use is missing in most planning layouts due to the fact that “real” agriculture was thought to take place in the rural setting only. Officials of the metropolitan and municipal departments of Town and Country Planning in the three cities confirmed what was found in most urban agriculture literature, that urban agriculture in general is not considered as one of the various land uses in Ghanaian cities. No immediate change is envisaged because very often, old master plans dating from colonial times are still being used, which use does no make allowances for urban agriculture despite its even longer history (Obosu-Mensah, 1999).

As indicated earlier, most lands being cultivated in Accra are government lands, public open space property, or so far unused private lands (Obosu-Mensah, 1999). Due to the fact that these lands are not specifically zoned for agricultural purposes, individual or groups of farmers cultivate them through informal arrangements with local caretakers, security officers or representatives of the local government departments. These informal arrangements are temporary and farmers can be asked to quit the land any time, sometimes without notice. Informal land arrangements serve in part as strategies by which public institutions maintain undeveloped open spaces and avoid encroachment by private developers. Other farmers cultivate open spaces along the roadside, drains, under high-tension electrical transmission lines where any meaningful alternative development is not likely to take place.

Some farmers cultivating plots owned by private persons also have informal agreements with the landowners and they are allowed to cultivate as long as the owners have no immediate use for the land. Presently with increased property development, land area under cultivation in and around Accra is gradually reducing. Due to land insecurity, farmers are not willing to invest in farm infrastructure with medium or long-term returns.

Similar to the situation in Accra, most of the farmers in Kumasi cultivate public/ institutional lands (Keraita, 2002) while others hold leases to the lands they cultivate. Farmers with leased lands face increasing difficulty in renewing their agreements because landowners prefer selling or leasing their lands to private developers at much higher prices. When questioned about the possibility of reserving lands for urban agriculture, an official of the department of Town and Country Planning indicated that it would be extremely difficult for KMA to do this because of the shelter needs of the increasing urban population.

In spite of the mandate of MoFA-KMA it is unable to influence the situation because it has no control over land in the metropolis. As long as there is no provision for "open green spaces/urban farming" in the City's master plan, it will remain difficult.

Compared to zoning in the city, it might be easier to allocate land at its fringe. In Cotonou, Benin, the authorities agreed to allocate about 400 ha of farmland for use by urban and peri-urban farmers outside the city. The site has safe groundwater, which can easily be lifted by treadle pump for all-season irrigation. This initiative addresses tenure insecurity and supports farmers and their food production for the cities. It also transfers farming out of the cities. How far the latter will occur remains open, as farmers will try to maintain their valuable city plots one way or the other (Drechsel et al., 2006a).

Until recently, there had not been any serious attempt in Ghana to either reduce water pollution or help urban vegetable farmers secure safe water for farming. The Accra Metropolitan Assembly (AMA) assisted on some locations farmers to get connected to piped water supply but this was not sustainable due to the common water shortage and efforts by the water suppliers to limit water use for domestic and industrial entities. In 2005, MoFA and Ghana’s Water Research Institute started (independently) to look for safer groundwater but with little success.

### Integration and institutionalisation

Integrating urban agriculture in institutional structures, plans and policies is still a major challenge in Ghana. To achieve this it might be appropriate to highlight those elements of urban open-space farming which have the greatest potential for official recognition, on top of its “classical” contributions to urban greening, livelihoods and food supply. In other words, to attract sustainable support it will be crucial to analyse how urban farming serves the actual challenges of the authorities, instead of promoting its benefits outside their actual priorities and workplans. An innovative approach would be to show, for example, the actual and possible (cost-saving) contributions of irrigated urban farming to urban flood control and sanitation (Annorbah-Sarpei, 1998). Table 11.1 highlights possible contributions of open-space farming to different (urban) development goals.

## 11.5 Conclusions

Irrigated vegetable farming in urban Ghana falls under the informal category and government intervention is very minimal. For instance, the Ghana Irrigation Development Authority (GIDA), which is the government agency officially responsible for developing irrigation in Ghana has always focused solely on public formal irrigation schemes in rural areas and for many years considered irrigated vegetable farming in urban areas as outside its jurisdiction. Current efforts to develop a national irrigation policy which recognizes (peri)urban farming might change the situation.

However, a single policy or institution may not be able to adequately and appropriately handle the complexities involved in urban and peri-urban agriculture, suggesting a multi-agency approach. The most prominent institutions, which would require being involved in decisions pertaining to urban vegetable farming are the Metropolitan, Municipal or District Assemblies.

**Table 11.1:** Possible replicable benefits of urban open-space vegetable production

| Condition/Threat | Innovation/Benefit from open-space farming | Transferable aspects to achieve urban development goals |
|---|---|---|
| Availability of urban marginal wasteland along watercourses. | Transformation of marginal lands into productive use for general benefit | Land reclamation; urban greening, urban biodiversity |
| Availability of wastewater and wastewater channels | Wastewater purification through land application and increased sedimentation (damming, dugouts), filtration gates... | Wastewater filtration, pollution control, reduced treatment costs |
| Ready market | Growing of high value crops for improved diets | Small scale private sector support |
| Lack of cold storage facilities in markets | Production of perishable goods in market proximity | Savings in power, transport and infra-structure investments |
| Squatters and waste dumping on unused land | Land under permanent agricultural use | Land protection, slum prevention, savings in waste collection |
| Land eviction (threat) or official support of farmers (opportunities) | Formation of Vegetable Growers Association for protecting farmers' interests. | Strengthening vulnerable minorities |
| Flooding | Slope upgrading/stabilization, improved infiltration and man-made fencing; minimized waste dumping into streams | Flood control; improved drainage |
| Solid waste accumulation in cities | Need for organic inputs; use of organic waste products | Waste reduction through compost use; resource recovery |
| Competing claims for urban space by commercial and other conventional city land uses | (i) Incorporation of market gardening in land use of newly developing areas<br>(ii) Enaction of municipal bylaws and legislation permitting market gardening | (i) Creating jobs for vulnerable groups<br>(ii) Enacting proactive legislation |
| Economic crisis; civil war | Urban food supply independent of functional rural-urban linkages and external aid | Emergency food program |

Source: Annorbah-Sarpei (1998, modified and extended)

Besides this, a number of other institutions are involved in agriculture within the (larger) urban areas of Ghana. One of these key institutions is the Metropolitan Food and Agriculture Directorate. The agency is employing various means to promote the practice and at the same time training and education of farmers to ensure human and environmental safety.

About decisions on land use and development of urban lands, which are currently used for agriculture, the Department of Town and Country Planning and the Department of Parks and Gardens are the two key institutions involved. Key agencies responsible for the management of urban wastewater are the Waste Management Departments of Metropolitan and Municipal Assemblies.

The study revealed that no formal consideration is given to possible agricultural use of wastewater in all the three cities. Most officials see only the possibility of health risks. This perception is a major obstacle to a more constructive integration of open-space farming. The authorities are in need of risk reduction strategies. Different national universities in collaboration with IWMI responded to this call and took up the task to explore safer irrigation and vegetable cleaning practices. The CGIAR Challenge Program for Water and Food funds these activities (2005-2007).

The low level of interactions within and between the key institutions related to urban vegetable farming and those in charge of waste or wastewater management (Vázquez et al., 2002) has been addressed by recent initiatives in Tamale (Amarchey, 2005) and Accra (e.g. via RUAF and FAO). A first major success was a joint declaration on urban agriculture in Accra (see Chapter 10.6). Pro-active land-use planning, which incorporates open-space farming into larger urban challenges, such as flood control, could be the next step. Such land use would have positive effects on the environment while reducing public spending for maintaining infrastructure. This could be a crucial step towards official recognition of urban open-space farming and its institutionalization.

# 12. The way forward: Health risk management in low-income countries[1]

*This chapter describes various options of an integrated approach how health risks for consumers could be reduced in the context of low-income countries, like Ghana. It also concludes that the new WHO guidelines for wastewater use in agriculture have a higher application potential in the context of urban farming than the previous ones.*

## 12.1 Applying international guidelines

In West Africa, the political recognition and sustainability of irrigated urban and peri-urban vegetable farming is mostly constrained by the use of polluted irrigation water (Drechsel et al., 2006a). Fragmented attempts have been made to improve the nexus among poor sanitation, urban farmers, and the potential health risk to consumers, mostly by relying on technical solutions (wastewater treatment) or regulatory measures (such as banning wastewater irrigation). Both approaches have failed like in other low-income countries. The best approach so far, to reducing health risks was provided by the WHO guidelines for wastewater use in agriculture (WHO, 1989). However, the application of the 1989 guidelines has been found to be difficult, especially in relation to urban agriculture:

i. In many low-income countries, like Ghana, wastewater treatment as expected by the guidelines is not possible due to a variety of (mostly economic) reasons. The enforcement of the guidelines in such situations would stop hundreds or thousands of farmers irrigating along increasingly polluted streams and put their livelihoods at risk. Restrictions would affect also food traders and the general market supply with perishable crops, especially in cases where other water sources are (seasonally) unavailable.

ii. It is similarly difficult to apply in market-oriented vegetable production the recommended additional/alternative health protection measures. Where highly specialized farmers cultivate cash crops according to market demand, crop restrictions would immediately threaten farmers' livelihoods. Also changes from vegetables cash crops to fruit tree cash crops appear unrealistic due to low tenure security in urban areas. Recommendations to change irrigation systems or cease irrigation before harvest

[1] This chapter was written at the same time as IWMI Policy Brief 17 (IWMI, 2006), thus both show overlap. http://www.iwmi.cgiar.org/waterpolicybriefing/files/wpb17.pdf

have equal limitations (see Chapter 8) or do ignore that e.g. lettuce would lose its fresh appearance and market value already after a few days without watering.

Based on these difficulties, it was suggested during a consultation in Hyderabad, India, in November 2002 that the WHO guidelines need adjustment for better application in wastewater exposed urban and peri-urban agriculture in resource-poor countries. The overall goal should be to find a better balance between safeguarding consumers' (and farmers') health and safeguarding farmers' livelihoods. The corresponding 'Hyderabad Declaration on Wastewater use in Agriculture' was signed by representatives of a number of institutions including the WHO and IWMI (http://www.iwmi.cgiar.org/home/wastewater.htm) and has been recognized in the new WHO guidelines (WHO, 2006) and by EPA-USAID (2004).

## 12.2 The new WHO guidelines

The new WHO (2006) guidelines are more flexible and develop further the concept, which considers wastewater treatment as only one component of an **integrated risk management strategy**. To reduce risk from pathogens, the components focus on health-based targets, and offer planners various combinations of locally possible risk management options for meeting them. These options go beyond those suggested in the previous guidelines and have to be used in combination as their impact, for example, on pathogen die-off varies (Table 12.1).

**Table 12.1:** The effectiveness of selected health-protection measures that can be used to remove pathogens from wastewater (irrigated crops) (WHO, 2006, modified)

| Protection measure (examples) | Pathogen reduction (log units) |
|---|---|
| Wastewater treatment (to different degrees) | 1-6 |
| Localized (drip) irrigation (with 'low-growing' crops, e.g. lettuce) | 2 |
| Localized (drip) irrigation (with 'high-growing' crops, e.g. tomatoes) | 4 |
| Pathogen die-off on the surface of crops after the last irrigation | 0.5-2 per day |
| Washing of produce with clean water | 1 |
| Disinfection of produce (using a weak disinfectant solution) | 2 |
| Disinfection of produce (using one part vinegar on two parts water) | 5 |
| Peeling of produce (fruits, root crops) | 2 |
| Cooking of produce | 6-7 |

The guidelines themselves are based on the Stockholm Framework, which suggests that countries should adapt guidelines to their own social, technical, economic, and environmental circumstances. The Stockholm Framework also mentions the concept of "**relative risk**", which requires that one considers all possible sources of risk and exposure when setting guidelines. These would include risks related to poor water supply, sanitation, and other sources of (e.g. post-harvest) food contamination. For example, if contaminated drinking water or lack of toilets causes high background levels of illness in the population, then a costly treatment of wastewater for crop application, is not likely to improve public health, and should not be the priority investment in countries where funds are limited. Wastewater use guidelines can be made more stringent when the relative risk factors change, i.e. when water supply and sanitation improve. Decision-makers are thus encouraged to look at the larger nexus of water-sanitation and health and their interconnections.

## 12.3 Prioritizing risk management strategies

The **long-term** goal of integrated wastewater management will always be to move from the unregulated use of untreated wastewater to the regulated use of treated wastewater. Depending on local possibilities, the level of treatment, however, can vary if a complementary health risk reduction strategy is in place as explained in the new WHO guidelines. This flexibility is appropriate, as long as in most low-income countries, provision of sanitation infrastructure continues to lag far behind the urbanization rates.

Thus even where no wastewater treatment is available, health risks can still be reduced. A simplified decision making process that can be used for identifying locally appropriate **intermediate** health protection measures and entry points for action along the "farm to fork" pathway is shown in Figure 12.1.

The different options have different timeframes for implementation (Table 12.2). The highest priority in the **short-term** should be to minimize the daily risk to consumers and the potential of epidemics, which is possible also with modest investments, like through awareness creation for appropriate vegetable washing and hygiene. In the supply of lettuce in Accra, for example, less than 1000 urban farmers produce salad consumed everyday by 200,000 urban dwellers. In other words, over a 2 to 3 day period, at least one of four urban citizens benefits from urban and peri-urban irrigation, but at the same time is at direct risk from crop contamination with pathogens.

The **medium-term** strategy should be to apply the most effective intermediate solutions while making gradual progression towards the long-term goal of wastewater treatment before use. Helping farmers reduce crop contamination or improve water quality before application through on-site treatment is a possible medium- term goal.

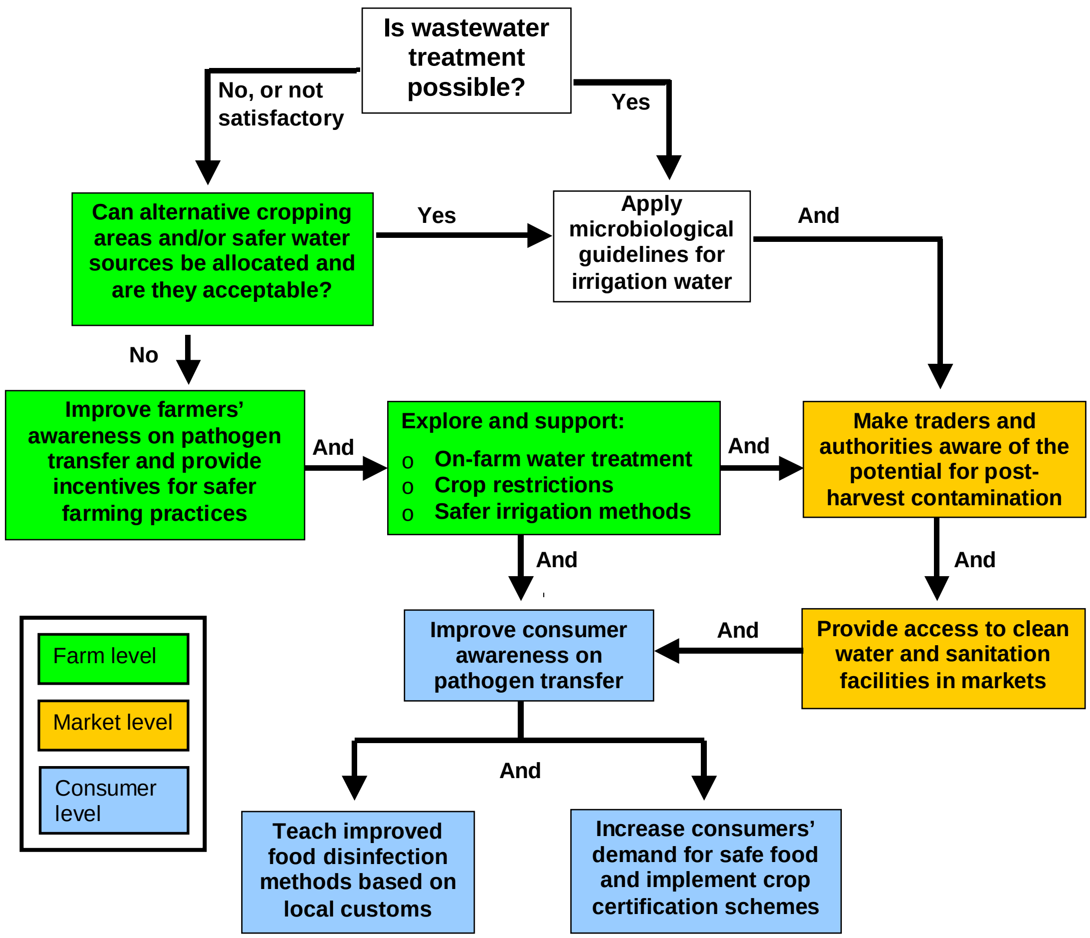



**Figure 12.1:** An example of a decision-making process that can be used to identify locally appropriate entry points to protect consumers' health, where municipal wastewater treatment is not a realistic option in the short or medium term, and polluted water is used to irrigate vegetables in and around cities (Adapted from Drechsel et al., 2002).

## 12.4 Intermediate options for risk management

The philosophy behind the intermediate options is that

- every degree of risk reduction saves lives and money, and is better than none where the desired technologies cannot (yet) be adopted;

- related costs are likely to be low in comparison with the construction and operation of conventional wastewater treatment plants, not to mention the costs of mitigating or recovering from any wastewater related epidemic; and
- water and food related health risks require in any case a comprehensive approach, as wastewater is **not** the only source of food contamination.

**Table 12.2:** Components of an integrated approach for health risk reduction for less developed countries and timeframes for implementation (Faruqui et al., 2004, modified)

| Recommendation | Timeframe |
|---|---|
| 1. Treat produced wastewater and control volumes and contaminants at source and monitor water quality | Long term |
| 2. Develop local guidelines based on appropriate intermediate risk management options, if possible used in combination: | |
| § Increase public awareness | Short to medium term |
| § Promote hygiene and safer vegetable washing in the kitchen | Short term |
| § Allocate farm areas with safer water sources | Short to medium term |
| § Provide incentives for on-farm risk reduction | Short term |
| § Use safer irrigation methods | Short to medium term |
| § Restrict the types of crops grown | Short term |
| § Reduce risk of post-harvest contamination | Short to medium term |
| § Minimize farmers' exposure | Short to medium term |
| § Prevent and treat infections (e.g. anti-worm campaigns) | Short to medium term |
| § Improve institutional coordination | Medium to long term |
| § Increase donor and state funding to support sanitation and introduce applied cost-sharing models | Short, medium and long term |
| 3. Conduct accompanying research on local food safety and the relative and absolute risks of wastewater use, on related stakeholders perceptions, and identify opportunities and constraints to the adoption of locally applicable options. | Short to medium term |

**a) Explore alternative farmland and safer water sources**

Authorities could reduce farmers' and consumers' health risks easily if they provide the concerned farmers in urban and peri-urban areas with safer water sources. In Cotonou, Benin, for example, the authorities recognized the contribution of urban agriculture and allocated new pieces of land to urban farmers outside the city with unpolluted shallow groundwater In

Accra, the Ministry of Food and Agriculture is exploring options for groundwater use in urban agriculture areas currently irrigating with water from city drains.

**b) Promote safer irrigation methods**

In many parts of the world and Sub-Saharan Africa in particular, most farmers use watering cans, which require only little investment. However, this method increases crop contamination, especially of leafy vegetables through spraying of droplets on the leaves. Irrigation techniques, which apply water to the root zone (such as a wastewater adapted drip irrigation) are much safer and use less water. Reducing crop contamination by ceasing irrigation a few days before harvest to allow for pathogen die-off is a recommendation that can be applied only to vegetables, which are less sensitive to water loss.

Ongoing research by KNUST and IWMI shows that with simple changes in shallow well construction, water collection and application, even using watering cans, the amount of suspended material and number of worm eggs in irrigation water can be reduced significantly (Keraita et al., forthcoming). Similar possibilities exist to address crop contamination from other sources, like fresh poultry manure or already contaminated soil. Participatory on-farm research targeting farmers' perception of such innovations and related changes in labor allocation is critical for understanding which 'best practices' with their corresponding risk reduction rates have the highest adoption potential in a given context. For the institutionalization of safer practices, the extension services have to be fully involved in any project and equally trained.

**c) Influence the choice of crops grown**

When irrigation projects are centrally managed, and when laws are strongly enforced, it is possible to introduce restrictions to ensure that wastewater is not used to irrigate high-risk crops, such as leafy vegetables that are eaten raw. Research in Mexico, Chile and Peru has shown that this is possible but it is only successful when the crops allowed under the restrictions are of similar profitability, i.e. in high demand. It is doubtful that such an approach would be successful in the context of Ghana. However, public awareness campaigns (e.g. through the media) might steer consumers' demand for safer crops, and influence farmers' decision making.

**d) Avoid post-harvest contamination**

Health risk reduction measures should not only focus on improving irrigation water quality. Post harvest contamination might occur during transport or in markets[2]. This is due to poor sanitation facilities and lack of water supply for personal hygiene as well as washing and "refreshing" of vegetables. Displaying vegetables on the ground instead of on tables is an additional source of contamination. It is important that authorities do not overlook well established but often officially ignored informal vegetable markets in their effort to improve cleanliness in markets.

**e) Promote incentives for adoption of on- farm risk reduction measures**

Feeling secure about land allows farmers to invest in mitigation measures at the farm level. Most urban and peri-urban farmers in many countries occupy/squat on public lands or are tenants on lands owned by others and have no tenure security. Where policy reforms can provide greater (formal or informal) tenure security, farmers are more likely to invest labor and capital in irrigation infrastructure, such as drip or furrow irrigation, which reduces crop contact with wastewater. More tenure security would also allow simple water storage reservoirs to be built on farmers' land. Storage reservoirs provide basic treatment by supporting pathogen die-off and help to balance irrigation water supply with demand. Credit systems could facilitate such investments.

A certification program for "safer crops" and awards for innovative farmers, etc. are other possible incentives. These efforts have to be strongly supported by the media to increase market demand for safer crops. Although it is unlikely that all farmers will change their practices, some will, which offers the consumer alternatives, and in average a general risk reduction. A bottleneck is wholesale, where vegetables from different sources are usually combined. To avoid that wholesaler sell all as "safer crops", a monitoring program would be necessary.

**f) Increase public awareness of vegetable washing at the point of consumption**

An important option for complementary risk reduction is vegetable washing and disinfecting at home and at food outlets, which is a common practice in developed and developing countries. Well-designed awareness programs can have a significant impact on safeguarding public health where treatment technologies cannot be put in place. It does not require large

[2] In Ghana, post-harvest contamination was not identified as a major issue (Chapter 9).

financial outlays at the consumer level and has a high potential for large-scale risk reduction where pathogen contamination is likely, be it from wastewater irrigation or post-harvest handling. However, washing methods vary between households and countries, and can be very ineffective if not carried out properly (Amoah et al., forthcoming). Food hygiene campaigns could be linked to other hygiene campaigns (e.g. "WASH") and have to be based on well-understood perceptions of risk and risk mitigation and (if necessary improved) local customs. Programs might involve the mass media, but also target school curricula.

#### g) Improve institutional coordination and develop integrated policies

Case studies from around the world show that sanitation, agricultural, environmental and health guidelines are usually vested in various agencies, and might overlap or conflict. This is especially the case of urban and peri-urban agriculture, which is most exposed to polluted water sources and often has no official standing in the agriculture sector. Multi-stakeholder platforms are vital to find mutually satisfactory solutions with a high potential for institutionalization.

#### h) Farmers' exposure

Last but not least, reducing farmers' exposure is important. Surveys in Asia and Africa, however, show that farmers do not perceive their own health risks as a priority issue. A reason could be that they face the same or other health risks also from other sources (e.g. lack of toilets and piped water) besides their exposure to wastewater. Protective clothing or other means to reduce exposure seldom finds users, thus more attention must be paid to perception studies to understand farmers' health and needs and design interventions for awareness creation accordingly.

## 12.5 Need for further research

One so far uncharted area of research is a comprehensive assessment of the positive and negative *economic* impact of urban agriculture in general and irrigated open-space farming [with raw or diluted wastewater] in particular. The results of such and other analyses could potentially impact the way in which "wastewater agriculture" is viewed by those authorities with the power to support irrigated urban agriculture in Ghana and beyond.

Research is also needed to substantiate and quantify the contributions of open-space farming to other urban development objectives (see table 11.1 in the previous chapter) than food supply and livelihood support. This could be a crucial step towards official recognition of urban open-space farming and its institutionalization.

In view of health risks related to the use of polluted water, research should continue to explore options for risk reduction at various entry points including safer irrigation practices with a high local adoption potential. This includes the analysis of perceptions of risks and risk mitigation of the concerned stakeholders, and a quantification of the relative and absolute risk of wastewater use in the local context of developing countries from both farmers' and consumers' perspective.

From the technical angle, simple technologies are needed to improve land and water productivity where water is scarce or labor in short supply. Emphasis should also be placed on options to treat chemically polluted wastewater before it enters the domestic wastewater stream used for irrigation as well as on low-cost options for farm-based systems, which conserve nutrients of value for agriculture while removing pathogens.

A final note of caution: Over the years, the "wastewater topic" has attracted the interest of many scientists and students working on sanitation and/or urban agriculture, including those affiliated to IWMI. Today, many urban farmers, especially in Accra, are experiencing what we might call 'survey fatigue' and are asking for less analysis but more concrete follow-up to improve their situation. Thus research has to move on from baseline surveys to concrete action for changes on the ground.

## References


Abban, C.B. 2003. A comparative study on the economics of formal and informal irrigated urban vegetable production in the Greater Accra Region. Unpublished M.Phil.thesis, Dept of Agr. Economics and Agribusiness, University of Ghana, Legon. 114pp.

Abdul-Ghaniyu, S., Kranjec-Berisavljevic, G., Yakubu, I.B., and Keraita, B. 2002. Sources and Quality of Water for urban vegetable production (Tamale, Ghana). Urban Agriculture Magazine 8: 10.

Abdul-Raouf, U.M., Beucht, L.R. and Ammar, M.S. 1993. Survival and Growth of E. Coli on Salad Vegetables. Applied Environmental Microbiology. Vol. 59 (7): 1999-2006.

Adam, M. 2001. Definition and Boundaries of the Peri-urban Interface: Patterns in the Patchwork. In: Drechsel, P. and Kunze, D. (eds.) Waste Composting for Urban and Peri-urban Agriculture: Closing the Rural-Urban Nutrient Cycle in Sub-Saharan Africa. CABI Publishing, Wallingford, pp. 193-208.

Afrane, A.A., Klinkenberg, E. Drechsel, P., Owusu-Daaku, K., Garms, R. and Kruppa, T. 2004. Does irrigated urban agriculture influence the transmission of malaria in the city of Kumasi, Ghana? Acta Tropica 89 (2) (special issue): 125-134

Agodzo, S.K. 1998. Water management study of six selected irrigation projects in Ghana. FAO-GIDA Project. KNUST, Kumasi, Ghana.

Agodzo, S.K. and A.K. Blay. 2002. A case study of the Volta River Estates Limited (VREL), Ghana. In: Sally, H. and Abernethy, C.L. (eds.) Private irrigation in sub-Saharan Africa. IWMI-FAO-CTA, Proceedings of a regional seminar 22-26 Oct 2001, Accra, Ghana; pp. 157-164

Agodzo, S.K., Huibers, F.P., Chenini, F., van Lier, J.B. and Duran, A. 2003. Use of wastewater in irrigated agriculture. Country studies from Bolivia, Ghana and Tunisia. Volume 2: Ghana. Wageningen: WUR, 2003. (www.dow.wau.nl/iwe)

Akpedonu, P. 1997. Microbiology of street foods from a high density community in Accra. Noguchi Memorial Institute for Medical Research, University of Ghana (mimeo).

Akuffo, S.B. 1998. Pollution control in a developing economy. A study of the situation in Ghana. 2nd edition. Ghana Universities Press, Accra, 128 p.

Amarchey, C.A. 2005. Farmer response to urban pressures on land, the Tamale experience. Urban Agriculture Magazine 15:39-40

Amoah, P. 2000. Identification of suitability indices of poultry litter for cowpea and maize production. Unpublished M.Sc. thesis; Department of Biological Sciences of the Kwame Nkrumah University of Science and Technology, KNUST, Kumasi, Ghana (unpublished)

Amoah, P., P. Drechsel, R.C. Abaidoo and W.J. Ntow. 2006a. Pesticide and pathogen contamination of vegetables in Ghana’s urban markets. Archives of Environmental Contamination and Toxicology 50 (1), 1–6

Amoah, P., P. Drechsel, R.C. Abaidoo and M. Henseler. 2006b. Irrigated urban vegetable production in Ghana: Pathogen contamination in farms and markets and the consumer risk group. WHO-IWA Journal of Water and Health (in press).

Amoah, P., P. Drechsel, and R.C. Abaidoo. 2005. Irrigated urban vegetable production in Ghana: Sources of pathogen contamination and health risk elimination. Irrigation and Drainage 54:49-61 (special issue)

Amoah, P., Drechsel, P. and R.C. Abaidoo. 2007. Vegetable irrigation with polluted water in urban Ghana: Contamination pathway and risk remediation. IWMI Research report (in preparation).

Anku, S., Doe, B. and Tetteh, D. 1998. Environmental Assessment of Urban Agriculture in Accra: In: Armar-Klemesu, M. and Maxwell, D. (eds.) Urban Agriculture in Greater Accra Metropolitan Area. Final Report to IDRC. Centre file: 003149. Noguchi Memorial Institute for Medical Research, University of Ghana.

Annang, L. and P. Drechsel. 2005. Nana Kwaku Saiw: A success story. Urban Agriculture Magazine 14: 40.

Annorbah-Sarpei, A.J. 1998. Urban Market Gardens. Accra, Ghana. The Mega Cities Project MCP-018C, 26 pp. (http://www.megacitiesproject.org/publications/pdf/mcp018c.pdf)

Anyane, S. La, 1963. Vegetable gardening in Accra. The Ghana Farmer 1 (6): 228-230

APHA. 1989. Standard Methods for the Examination of Water and Wastewater. 17$^{th}$ Edition, American Public Health Association, Washington DC. 1,268 pp.

Apt, N.A. 2002. Accra in the 21$^{st}$ century Visions from the crystal ball of a sociologist. In: Mills-Tettey, R and K. Adi-Dako (eds). Visions of the City. Accra in the 21$^{st}$ Century. Woeli Publishing Services, Accra, p. 39-47

Armar-Klemesu, M. and Maxwell, D. (eds.) 1998. Urban Agriculture in Greater Accra Metropolitan Area. Project: 003149. Final Report to IDRC. Noguchi Memorial Institute for Medical Research, University of Ghana.

Armar-Klemesu, M., Akpedonu, P., Egbi, G. and Maxwell, D. 1998. Food Contamination in Urban Agriculture: Vegetable production using wastewater. In: Armar-Klemesu, M. and Maxwell, D. (eds.) Urban Agriculture in Greater Accra Metropolitan Area. Final Report to IDRC. Centre file: 003149. Noguchi Memorial Institute for Medical Research, University of Ghana.

Armon, R., Dosoretz, C. G., Azov, Y. and Shelef, G. 1994: Residual contamination of crops irrigated with effluent of different qualities: a field study. Water Science and Technology 30, 239-248

Asare, I., Kranjac-Berisavljevic, G. and Cofie, O. 2003. Faecal Sludge Application for Agriculture in Tamale. Urban Agriculture Magazine 10: 31-33.

Asomani-Boateng, R. 2002. Urban cultivation in Accra: an examination of the nature, practices, problems, potentials and urban planning implications. Habitat International 26: 591-607

Biney, C.A. 1998. The threat of pollution to the coastal zone of the Greater Accra Metropolitan Area, Ghana. Ghana Journal of Science 31-36: 47-54

Blake, B. and Kasanga, K. 1997. Kumasi Natural Resource Management Research project, Inception report; NRI, Natural Resource Institute, The University of Greenwich, UK and University of Science and Technology, Kumasi, Ghana.

Boadi, K.O. and M. Kuitunen, 2002. Urban Waste Pollution in the Korle Lagoon, Accra, Ghana. The Environmentalist 22**:** 301-309.

Bowyer-Bower, T.A.S. and G. Tengbeh. 1995. The environmental implications of illegal UA in Harare, Zimbabwe. Working Paper No. 4 of ODA Research Project R5946.

Bowyer-Bower, T.A.S., Mapaure, I., & Drummond, R.B. 1996. Ecological degradation in cities: Impact of urban agriculture in Harare, Zimbabwe . *Journal of Applied Science in Southern Africa* 2(2): 53-68

Brook, R. and Dávila, J. (eds.) 2000. The Peri-Urban Interface: a tale of two cities. School of Agricultural and Forest Sciences, University of Wales, Bangor and Development Planning Unit, University College London. 251+vii pp

CEDAR 1999. Inception Report. R7330: Peri-urban natural resources management at the watershed level, Kumasi, Ghana. Royal Holloway University of London

Chancellor, F. 2004. Gender, water and urban agriculture. Urban Agriculture Magazine 12:18-19

Chinery, W.A. 1984. Effects of ecological changes on the malaria vectors Anopheles funestus and the Anopheles gambiae complex of mosquitoes in Accra, Ghana. J.Trop Med. Hyg. 87: 75-81

Clarke, E.E., Levy, L.S., Spurgeon, A, and I.A. Calvert. 1997. The problem associated with pesticide use by irrigation workers in Ghana. Occupational Medicine 47(5): 301-308.

Cofie, O.O, R. van Veenhuizen, and P. Drechsel. 2003. Contribution of urban and peri-urban agriculture to food security in Sub-Saharan Africa. Paper presented at the Africa Day of the 3rd WWF in Kyoto, 17-3-2003.

Cofie, O.O., Agbottah, S., Strauss, M., Esseku, H., Montangero, A., Awuah, E. and Kone, D., 2006. Solid–liquid separation of faecal sludge using drying beds in Ghana: Implications for nutrient recycling in urban agriculture, Water Research 40(1): 75-82.

Cofie, O.O., G. Kranjac-Berisavljevic and P. Drechsel. 2005. The use of human waste for peri-agriculture in northern Ghana. Renewable Agriculture and Food Systems 20(2): 73–80

Cornish, G A. and P. Lawrence. 2001. Informal irrigation in peri-urban areas: A summary of findings and recommendations, DFID's Water KAR Project R7132, Report OD 144, HR Wallingford, Wallingford, UK, 54 pp.

Cornish, G.A. and Aidoo, J.B. 2000. Informal Irrigation in the peri-urban zone of Kumasi, Ghana. Findings from an initial questionnaire survey. Report OD/TN 97 March 2000. HR Wallingford, UK., 41 pp.

Cornish, G.A., Mensah, E., Ghesquire, P. 1999. Water quality and peri-urban irrigation: An assessment of surface water quality for irrigation and its implication for human health in the peri-urban zone of Kumasi, Ghana. Report OD/TN 95 September 1999. DFID's Water KAR (Knowledge and Research) Project R7132, HR Wallingford, UK, 44 pp.

Cornish, GA, J.B. Aidoo, and I. Ayamba. 2001. Informal irrigation in the peri-urban zone of Kumasi, Ghana. An analysis of farmer activity and productivity. Report OD/TN 103, February 2001. DFID's Water KAR Project R7132, HR Wallingford, UK, 39 pp.

Danso, G. 2002. Farmers Perception and Willingness-to-pay for urban Waste Compost in Ghana. Unpublished M.Sc. thesis, Department of Agricultural Economics and Farm Management, KNUST, Kumasi.

Danso, G. and Drechsel, P., 2003. The marketing manager in Ghana. Urban Agricultural Magazine 9: 7

Danso, G., Fialor, S.C. and P. Drechsel. 2002b. Perceptions of organic agriculture by urban vegetable farmers and consumers in Ghana. Urban Agricultural Magazine 6: 23-24

Danso, G., Keraita, B., Afrane, Y. 2002d. Farming systems in urban agriculture, Accra, Ghana. Consultancy report submitted to FAO-Ghana office via IWMI, Ghana-office.

Danso, G., P. Drechsel, T. Wiafe-Antwi and L. Gyiele. 2002a. Income of farming systems around Kumasi, Ghana. Urban Agriculture Magazine 7: 5-6.

Danso, G., S.C. Fialor and P. Drechsel, 2002c. Farmers' perception and willingness-to-pay for urban waste compost in Ghana. In: Almorza, D., C.A. Brebbia, D. Sale and V. Popov (eds.) Waste Management and the Environment, WIT Press, Southampton, Boston, p. 231-241

Danso, G., P. Drechsel, S. Fialor and M. Giordano. 2006. Estimating the demand for municipal waste compost via farmers' willingness-to-pay in Ghana. Waste Management (in press)

De Lardemelle, L., 1996. The Role of Local authorities in the Food Supply and Distribution Systems in Ghana, Food into Cities Collection, FAO, Rome.

Doe, S.S. 2002. An inventory of dry season vegetable production in peri-urban and urban Tamale Municipality. Unpublished B.Sc. dissertation. Department of Agricultural Economics and Extension, University for Development Studies. Tamale, Ghana.

Dowuona, G.N. 2006. Personal Communication. Dept. of Soil Science, University of Ghana.

Drangert, J.O. 1998. Fighting the Urine Blindness to Provide More Sanitation Options. Water South Africa, Vol. 24, No. 2, April

Drechsel, P, Graefe, S, and M. Fink. Forthcoming, 2006b. Rural-urban food, nutrient and water flows in West Africa. IWMI RR (in preparation)

Drechsel, P. 1996. AFRICALAND - Applied research for peri-urban areas. IBSRAM Newsletter 42:5-7

Drechsel, P. and G. Danso. 2005. Nutrient recycling from organic waste for urban and peri-urban agriculture in West Africa: Really a win-win situation? In: D.N. Laband (ed). Emerging issues along urban-rural interfaces: Linking science and society. Conference Proceedings, The Center for Forest Sustainability, Atlanta, Georgia, USA, 13-16 March 2005; p. 212-217

Drechsel, P. and U. Zimmermann, P. 2005. Factors influencing the intensification of farming systems and soil nutrient management in the rural - urban continuum of SW Ghana. Journal of Plant Nutrition and Soil Science 168 (5): 694-702.

Drechsel, P. S. Graefe, M. Sonou, and O.O. Cofie, 2006a. Informal Irrigation in Urban West Africa: An Overview. IWMI Research Report (in press)

Drechsel, P., Abaidoo, R.C., Amoah, P. and O.O. Cofie, 2000. Increasing use of poultry manure in and around Kumasi, Ghana: Is farmers' race consumers' fate? Urban Agricultural Magazine 2:25-27

Drechsel, P., M. Giordano and L.A. Gyiele. 2004. Valuing Nutrients in Soil and Water: Concepts and Techniques with Examples from IWMI Studies in the Developing World. IWMI Research Report 82, Colombo

Drechsel, P., M. Giordano, and T. Enters. 2005. Valuing Soil Fertility Change: Selected Methods and Case Studies. In: B. Shiferaw, H.A. Freeman and S.M. Swinton (eds.) Natural Resources Management in Agriculture: Methods for Assessing Economic and Environmental Impacts. ICRISAT-CABI Publishing, Wallingford, p. 199-221.

Drechsel, P., U.J. Blumenthal and B. Keraita. 2002. Balancing health and livelihoods: Adjusting wastewater irrigation guidelines for resource-poor countries. Urban Agriculture Magazine 8: 7-9.

EPA. 2001. Status of Sewage Treatment Plants: Internal monitoring report. EPA: Accra

EPA-USAID. 2004. Guidelines for water reuse. US Environmental Protection Agency. EPA/625/R-04/108, Washington, D.C. page 246

Essamuah, E. and S. Tonah, 2004. Coping with urban poverty in Ghana: An analysis of household and individual livelihood strategies in Nima/Accra. Legon Journal of Sociology 1 (2): 79-96

Faruqui, N.I., C.A. Scott, and L. Raschid-Sally. 2004. Confronting the realities of wastewater use in irrigated agriculture: Lessons learned and recommendations. In: C.Scott, N.I. Faruqui, L.Raschid (eds.) Wastewater Use in Irrigated Agriculture: Confronting the Livelihood and Environmental Realities, IWMI-IDRC-CABI, Wallingford, p. 173-185.

Faruqui, N.I., Niang, S., and M. Redwood. 2004. Untreated wastewater use in market gardens; a case study of Dakar, Senegal. In: C.Scott, N.I. Faruqui, L.Raschid (eds.) Wastewater Use in Irrigated Agriculture: Confronting the Livelihood and Environmental Realities, IWMI-IDRC-CABI, Wallingford, p. 113-125.

Flynn-Dapaah, K. 2002. Land negotiations and tenure relationships: Accessing land for urban and peri-urban agriculture in Sub-Saharan Africa. CFP Report Series 36. IDRC: Ottawa.

Gbireh, Z.A. 1999. Development of urban and peri-urban irrigation for food security within and around Accra Metropolitan Area. FAO Technical Report. (unpublished)

Gerstl, S. 2001. The economic costs and impact of home gardening in Ouagadougou, Burkina Faso. PhD dissertation. University of Basel, Switzerland. www.sti.unibas.ch

Ghana Local Government Bulletin. 1995. Published by Authority. Accra

Ghana Statistical Service. 1999. Poverty trends in Ghana in the 1990s. Tenth Consultative Group Meeting. 23-24 Nov. 1999. Republic of Ghana, Accra

Ghana Statistical Service. 2002. 2000 Population and housing census; Summary report of final results, Accra, Ghana.

GIDA-JICA. 2004. Strategies for effective utilization of existing irrigation projects. SSIAPP-FU, March 2004, 328 pp.

Gijzen, H.J. 2001. Low Cost Wastewater Treatment and Potentials for Re-use: A cleaner production approach to wastewater management. Paper presented at the International Symposium on Low-Cost Wastewater Treatment and Re-use, NVAWUR-EU-IHE, February 3-4, 2001, Cairo, Egypt, www.cepis.ops-oms.org/bvsaar/e/fulltext/gestion/low.pdf

Gilbert, R. J., de Louvois, J., Donovan, T. 2000. Guidelines for the microbiological quality of some ready-to-eat foods sampled at the point of sale. Communicable Disease and Public Health 3 (3): 163−167

Gyamfi, A.A. 2002. Commercial irrigation farming. In: Sally, H and Abernethy, C.L. (eds.) Private irrigation in sub-Saharan Africa. IWMI-FAO-CTA, Proceedings of a regional seminar 22-26 Oct 2001, Accra, Ghana; pp. 151-155

Gyiele, L. 2002a. Integrated economic and environmental impact assessment of urban and peri-urban agriculture in and around Kumasi. Vol. 1: Financial analysis. Final report submitted to FAO (Project PR 17951). IWMI-IBSRAM-KNUST, Kumasi, Ghana.

Gyiele, L. 2002b. Integrated economic and environmental impact assessment of urban and peri-urban agriculture in and around Kumasi. Vol. 2: Economic analysis. Final report submitted to FAO (Project PR 17951). IWMI-IBSRAM-KNUST, Kumasi, Ghana.

Henseler, M., G. Danso, and L. Annang. 2005. Lettuce survey. Project Report. Lettuce Survey Component of CP51, CGIAR CPWF Project 51. Unpublished report, IWMI, Ghana.

Hodgson, I. and Larmie, S.A. 1999 Sewage, Septage and Faecal Sludge Management in Tamale Municipality of Ghana. Journal of Applied Science & Technology 4(1/2):67-71.

ISSER. 2002. The state of the Ghanaian Economy. Published by The Institute of Statistical, Social and Economic Research (ISSER). University of Ghana, Legon.

IWMI. 2006. Recycling Realities: Managing health risks to make wastewater an asset. Water Policy Briefing 17; IWMI and GWP, Colombo, Sri Lanka

Keraita, B. 2002. Wastewater use in urban and peri-urban vegetable farming in Kumasi, Ghana. Unpublished MSc. Thesis. Wageningen University, The Netherlands.

Keraita, B. and P. Drechsel, 2004. Agricultural use of untreated urban wastewater in Ghana. In: C.Scott, N.I. Faruqui, L.Raschid (eds.) Wastewater Use in Irrigated Agriculture: Confronting the Livelihood and Environmental Realities, IWMI-IDRC-CABI, Wallingford, p. 101-112.

Keraita, B., Danso, G. and Drechsel, P. 2003a. Urban irrigation methods and practices in Ghana and Togo. Urban Agriculture Magazine 10: 6-7

Keraita, B., Drechsel, P. and Amoah, P. 2003b. Influence of urban wastewater on stream water quality and agriculture in and around Kumasi, Ghana. Environment & Urbanization 15 (2): 171-178

Keraita, B., P. Drechsel, and L. Raschid-Sally. 2002a. Wastewater use in informal irrigation in urban and peri-urban areas of Kumasi, Ghana. CTA/ETC-RUAF/CREPA, Atelier International sur la Réutilisation des Eaux Usées en Agriculture Urbaine. 3-8 June 2002, Ouagadougou. Final Report, p. 124-141

Keraita, B., P. Drechsel, F. Huibers, and L. Raschid-Sally. 2002b. Wastewater use in informal irrigation in Urban and Peri-urban areas of Kumasi, Ghana. Urban Agriculture Magazine 8: 11-13

Kessler, A. Streiffeler, F. and Obuobie, E. 2004. Women in Urban Agriculture in West Africa. Urban Agriculture Magazine 12: 16-1.

Klinkenberg, E., P.J. McCall, I.M. Hastings, M.D. Wilson, F.P. Amerasinghe and M.J. Donnelly. 2005. Malaria and irrigated crops, Accra, Ghana. Emerging Infectious Diseases 11 (8):1290-1293

KNRMP. 1999. Kumasi Urban Natural Resources Studies, June 1999. Kumasi Natural Resources Management Research Project, KNUST/NRI/DFID.

Kufogbe, S.K., G. Forkuor, and G. Muquah. 2005. Exploratory studies on urban agriculture in Accra. Land use mapping and GIS. Final Report. RUAF-IWMI: Accra (mimeo)

Kyei-Baffour, N., E. Ofori, and E.M. Takyi. 2005. Domestic water wells in peri-urban areas of Kumasi. In: Bobobee, E.Y.H and A. Bart-Plange (Eds.) Hunger without frontiers. Proceedings of the 2nd West Africa Society of Agricultural Engineering, in Kumasi, Ghana, Sept. 2004. WASAE-GSAE. Printed by Design Press, KNUST, Kumasi, p. 222-234

Lamptey, N.L. 2006. Urban Poverty reduction project launched. Daily Graphic, 4-3-06, p. 18

Laryea, J.A., 2002. AMA, Accra; Rules, Regulations, Enforcement and Sanction on Street Vended Food in the Accra Metropolis; in Street Foods in Ghana: Types, Environment, Patronage, Laws and Regulations; Proceeding of a Roundtable Conference (6.Sept. 2001), ISSER, Ghana, Accra.

Leitzinger, C. 2000. Ist eine Co-Kompostierung aus stofflicher Sicht in Kumasi/Ghana sinnvoll? Unpublished M.Sc. thesis, SANDEC, Eidgenoessiche Technische Hochschule (ETH), Zurich.

Leitzinger, C. and D. Adwedaa. 1999. Field monitoring of the faecal sludge treatment plant in Kaasi, Kumasi Ghana. A practical report. Zurich, Switzerland (mimeo)

Mara, D. D. 1978. Sewage Treatment in Hot Climates. Chichester: John Wiley & Sons.

Mawoneke, S. and B. King, 1999. Impact of urban agriculture research in Zimbabwe. CFP Report 29D, IDRC: Ottawa

Maxwell, D. and M. Armar-Klemesu. 1999. Urban Agriculture in Greater Accra: Reviewing Research Impacts for Livelihoods, Food and Nutrition Security. CFP Report 29F, IDRC: Ottawa

Mbaye, A. and Moustier, P. 2000. Market-oriented urban agricultural production in Dakar. . In: Bakker, N., Dubbeling, M., Gündel, S., Sabel-Koschella, U. and de Zeeuw, H. (eds.) Growing Cities, Growing Food: Urban Agriculture on the Policy Agenda. DSE/ZEL, Feldafing/ Germany, pp. 235-256.

McGregor, D., Simon, D., Thompson, D., Quashie-Sam, J., Edusah, S. and K. Nsiah-Gyabaah. 2006. A co-management approach to sustainable watershed utilization: Peri-urban Kumasi, Ghana. In: McGregor, D., D. Simon, and D. Thompson (eds.) The Peri-urban Interface: Approaches to sustainable natural and human resource use. Earthscan, London, p. 287-309.

McGregor, D., Simon, D. and Thompson, D. 2002. Peri-urban natural resources management at the watershed level: Kumasi, Ghana. Final Technical Report for DFID project R7330. CEDAR-IRNR, Royal Holloway University of London: London.

Mensah, E., Amoah, P., Abaidoo, R.C. and P. Drechsel. 2001. Environmental concerns of (peri-) urban vegetable production – Case studies from Kumasi and Accra. In: Drechsel, P. and D. Kunze (eds.) Waste Composting for Urban and Peri-urban Agriculture - Closing the rural-urban nutrient cycle in sub-Saharan Africa. IWMI/FAO/CABI: Wallingford, p. 55-68

Mensah, P., D. Yeboah-Manu, K. Owusu-Darko and A. Ablordey. 2002. Street foods in Accra, Ghana: how safe are they? Bulletin of WHO 80: 546-554.

Miah, Z. 2004. Mortalities of immature stages of Culex quinquefasciatus at various breeding sites in Accra, Ghana. MSc thesis, Liverpool School of Tropical Medicine. Liverpool.

Nelson, A., Abdul-Halim, A, and Husseini, R. 1996. Baseline Study on Urban Agriculture in Tamale Municipality. Faculty of Agriculture, University for Development Studies, Tamale

Niemczynowicz, J. 1996. Megacities from a water perspective. Water International, 21 (4): 198-205

NRI/DFID/FRI 2000. Enhancing the food security of the peri-urban and urban poor through improvements to the quality, safety and economics of street-vended foods; Report on workshop for stakeholders, policy makers and regulators of street-food vending in Accra , 25- 26, Sept. 2000.

Ntow, W.J. 2001. Organochlorine pesticides in water, sediment, crops, and human fluids in a farming community in Ghana. Arch. Environ. Contam. Toxicol. 40: 557–563

Ntow, W.J., H.J. Gijzen, P. Kelderman and P. Drechsel. 2006. Farmer perception and pesticide use practices in vegetable production in Ghana. Pest Management Science 62 (in print).

Nugent, R.A. 2000. The impact of urban agriculture on the household and local economies. In: Bakker, N., Dubbeling, M. Gündel, S. Sabel-Koschella, U. and de Zeeuw, H. (eds.)

Growing Cities, Growing Food: Urban Agriculture on the Policy Agenda. Deutsche Stiftung für internationale Entwicklung (DSE), Zentralstelle für Ernährung und Landwirtschaft, Feldafing/ Germany, pp. 67-97.

Nurah, G.K. 1999. Baseline study of vegetable production in Ghana. NARP Report, 151 pp., July 1999, KNUST, mimeo

Nyanteng, V.K 1998. Draft Summary Report on Food Markets and Marketing in the Accra Metropolis, in: AMA-FAO. Food Supply and Distribution to Accra and its Metropolis. Workshop - Proceedings, Accra, Ghana, 13th - 16th April 1998

Obosu-Mensah, K., 1999. Food production in urban areas. A study of urban agriculture in Accra, Ghana. Ashgate Publishing, Aldershot, UK, 227 pp.

Obuobie, E. 2003. Institutional Aspects of Urban Agriculture and Wastewater use in Accra, Ghana. Unpublished M.Sc. Thesis, Wageningen University. The Netherlands.

Obuobie, E., Danso, G. and Drechsel, P. 2003. Access to land and water for urban vegetable farming in Accra. Urban Agriculture Magazine 11:15-17.

Obuobie, E., Drechsel, P., Danso, G. and L. Raschid-Sally. 2004. Gender in open-space irrigated urban vegetable farming in Ghana. Urban Agriculture Magazine 12: 13-15.

Okorley E. L and Kwarteng J. A. 2002. Current status of the use of pesticides in urban and peri-urban vegetable production in the central region of Ghana. Paper presented at RESEAU Ghaneen/SADOAC Workshop on Sustainable Food Security in Southern West Africa. January 30-31, 2002, Miklin Hotel, Accra, Ghana

Okorley, E. L., M. M. Zinnah and E. A. Bampoe 2002. Promoting participatory technology development approach in integrated crop protection among tomato farmers in Anyima in the Kintampo district of Brong Ahafo Region, Ghana. AIAEE 2002 Proceedings of the 18th Annual Conference Durban, South Africa, p. 337-343

Olsen, M. 2006. Risk awareness of street food handlers and consumers. Lettuce survey. Project Report. Lettuce Survey Component of CP51, CGIAR CPWF Project 51. Unpublished report, University of Copenhagen, Denmark.

Owusu-Bennoah, E. and Visker, C. 1994. Organic wastes hijacked. ILEIA Newsletter Oct 1994. p.12-13

Quansah, C. 2000. Country case study: Ghana. In FAO: Integrated soil management for sustainable agriculture and food security FAO-RAF 2000/01, Accra, p. 33-75

Ridder, D. 2002. Umweltmanagement in Ghana. SPRING Research Series 39, Unversity of Dortmund, Germany, 259 pp.

Schwartzbrod, J. 1998. Methods of analysis of helminth eggs and cysts in wastewater, sludge, soils and crops. University Henry Poincare, Nancy, France.

Scott, C.A., N.I. Faruqui, and L. Raschid-Sally 2004. Wastewater Use in Irrigated Agriculture: Confronting the Livelihood and Environmental Realities; IWMI-IDRC-CABI, Wallingford, UK. 193 pp. www.idrc.ca/en/ev-31595-201-1-DO_TOPIC.html

Shuval, H.I., Adin, A., Fattal, B., Rawitz, E., Yekutiel, P., 1986. Wastewater irrigation in developing countries: Health effects and technical solutions. World Bank Technical Paper No. 51. The World Bank, Washington.

Simon, D., D. McGregor and D. Thompson. 2006. Contemporary perspectives on the peri-urban zones of cities in developing countries. In: McGregor, D., D. Simon, and D. Thompson (eds.) The Peri-urban Interface: Approaches to sustainable natural and human resource use. Earthscan, London, p. 3-17.

Simon, D., O. Poku and K. Nsiah-Gyabaah 2001. Survey of large industries in Kumasi: Water use and environmental impacts. CEDAR-IRNR Kumasi Paper 6, 27 pp.

Smith, O.B. 2002. Overview of urban agriculture and food security in West African cities. In: Akinbamijo, O.O., S.T. Fall and O.B. Smith (eds.). Advances in crop-livestock integration in West African cities. ITC-ISRA-IDRC. Printed by Grafisch Bedrijf Ponsen en Looijen B.V., Wageningen, p. 17-36.

Sonou, M. 2001. Periurban irrigated agriculture and health risks in Ghana. Urban Agriculture Magazine 3:33–34

Strauss, M., Larmie S. A., Heinss, U. 1997. Treatment of Sludges from On-Site Sanitation: Low-Cost Options. Water Science and Technology 35(6): 129-136.

Tallaki, K. 2005. The pest control systems in the market gardens of Lomé, Togo. In: L. Mougeot (ed.) AGROPOLIS The social, political and environmental dimensions of urban agriculture. IDRC, Ottawa, Earthscan, London, p. 51-67

Twum-Baah, K.A. 2002. Population growth of Mega-Accra: Emerging issues. In: Mills-Tettey, R and K. Adi-Dako (eds). Visions of the City. Accra in the 21st Century. Woeli Publishing Services, Accra, p. 31-38

UNDP, 1996. Urban Agriculture: Food, Jobs and Sustainable Cities. UN Development Program, Publication Series for Habitat II, Vol.1. UNDP, New York, USA.

UNDP, 2002. Human Development Report, UNDP, Oxford University Press, New York.

UN-Habitat, 2001. Cities in a globalizing world. Global Report on Human Settlements 2001. UNCHS, Earthscan Publications, London

UN Population Division, 2004. World Urbanization Prospects: The 2003 revision. Department of Economics and Social Affairs, United Nations. New York, USA http://www.un.org/esa/population/publications/wup2003/WUP2003Report.pdf

Vázquez, R., Cofie, O.O., Drechsel, P. and I.F. Mensa-Bonsu, 2002. Linking urban agriculture with urban management: A challenge for policy makers and planners. In: C.A. Brebbia, J.F. Martin-Duque and L.C. Wadhwa (eds.): The Sustainable City II. Urban Regeneration and Sustainability, WIT Press, Southampton, Boston, p. 925- 934

Velez-Guerra, A. 2004. Multiple means of access to land for urban agriculture: a case study of farmers' groups in Bamako, Mali. CFP report series 40. IDRC: Ottawa.

WHO, 1989. Technical report series 778, Health guidelines for the use of wastewater in agriculture and aquaculture, WHO: Geneva.

WHO, 2006. Guidelines for the safe use of wastewater, excreta and grey water: Wastewater use in agriculture (Volume 2). WHO: Geneva, 219 pp.

WHO/UNICEF, 2000. Global Water Supply and Sanitation Assessment 2000 Report, WHO/UNICEF: Geneva

Zakaria, S., Lamptey, M.G. and D. Maxwell. 1998. Urban Agriculture in Accra: A Descriptive Analysis. In: Armar-Klemesu, M. and Maxwell, D. (eds.) Urban Agriculture in Greater Accra Metropolitan Area. Final Report to IDRC. Centre file: 003149. Noguchi Memorial Institute for Medical Research, University of Ghana.

Zibrilla, I. and A.A. Salifu. 2004. Information gathering from urban and peri-urban communities with potential land areas for vegetable production. Report submitted to Urban Agriculture Network – Northern Ghana. 30th June 2004, 16 pp. (mimeo)

## Irrigated urban vegetable production in Ghana: Characteristics, Benefits and Risks

More than 200,000 urban dwellers eat exotic vegetables daily on Accra's streets and in canteens and restaurants. Most of the perishable vegetables are produced on open spaces in the cities or its fringes due to insufficient cold transport and storage. This activity is highly profitable and can lift vulnerable groups out of poverty. It can also contribute to flood control, land reclamation and city greening. However, poor farmers have increasing problems finding in and around the cities unpolluted water sources for irrigation.

This book gives a comprehensive overview of urban and peri-urban vegetable farming in Ghana's major cities with a special focus on 'wastewater' use. It ends with recommendations on how in a low-income country like Ghana health risks for consumers could be effectively reduced, while simultaneously supporting the important contribution of open-space urban and peri-urban agriculture.

The book highlights further research needs and will serve students, the academia and decision makers as an important resource.