RESEARCH REPORT

102

Informal Irrigation in Urban West Africa: An Overview

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Cover photograph: Irrigated urban vegetable production in front of the Ministry of Finance in Cotonou, Benin (Photo: E. Klinkenberg, IWMI).

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Acronyms

CAADP	Comprehensive Africa Agriculture Development Program
CEDAR	Center for Developing Areas Research (Royal Holloway University of London)
CFP	Cities Feeding People Program at IDRC
CIRAD	French Agricultural Research Centre for International Development
CORAF	West and Central African Council for Agricultural Research and Development
CPWF	Challenge Program on Water and Food (CGIAR)
CTA	Technical Centre for Agricultural and Rural Cooperation (CTA)
DFID	Department for International Development, UK
ECOWAP	ECOWAS Agricultural Policy
ECOWAS	Economic Community Of West African States
EHP	Environmental Health Project, funded by USAID
FAO	Food and Agriculture Organization of the United Nations
IAGU	Institut Africain de Gestion Urbaine (Dakar, Senegal)
IBSRAM	International Board for Soil Research and Management
IDRC	International Development Research Centre (Canada)
IRNR	Institute for Renewable Natural Resources (at KNUST)
ISRA	Institut Sénégalais de Recherche Agricole
ITC	International Trypanotolerance Centre
IWMI	International Water Management Institute
KNUST	Kwame Nkrumah University of Science and Technology (Kumasi)
MDP	Municipal Development Partnership (Harare, Zimbabwe)
MPN FC	Most Probable Number of Faecal Coliforms
NRI	Natural Resources Institute, UK
RUAF	Resource Centres on Urban Agriculture and Food Security
SSA	Sub-Saharan Africa
UN	United Nations
UNCHS	United Nations Centre for Human Settlements (UN Habitat)
UNDP	United Nations Development Program
WARDA	Africa Rice Center
WHO	World Health Organization
WUR	Wageningen University and Research Centre

Summary

In West Africa, the urban population is taking over the rural. Informal irrigation in urban and peri-urban areas taking advantage of the growing urban markets and the common lack of refrigerated transportation and storage, complements rural agriculture in feeding the cities with fresh vegetables. This report tries to provide a state-of-the-art overview on irrigated urban agriculture in the West African sub-region based on a comprehensive literature review supported by the results of three IWMI-FAO projects.

In some countries, like Ghana, informal irrigation in the rural-urban interface covers an area greater than the area under formal irrigation in the whole country. This calls for a policy shift as informal irrigation receives so far little recognition and is facing many constraints. Especially in urban areas, tenure security is usually low and investments in infrastructure, minimal. Manual water fetching with watering cans is most common. Appropriate sites with access to safe irrigation water are rare, particularly in and downstream of the cities. Many farmers are poor migrants from rural areas. Where groundwater is not accessible, they often have no other water sources than polluted streams or they do farming along storm water drains and gutters. However, those involved in year-round irrigated farming can earn twice more than those in traditional rain-fed farming despite much smaller farm sizes. Even more profitable is vegetable marketing, which is –in contrast to farming in most cities- the domain of women. Data on the aggregate benefit of urban agriculture to society are rare. There are 20 million people engaged in different forms of urban agriculture in West Africa, and in many cities 60-100 percent of the consumed perishable vegetables are also produced within the city. In Accra, for example, 280,000 urban dwellers benefit from urban vegetable farming everyday. This figure also gives an estimate of the number of people at risk from “wastewater irrigation”, an issue which constrains the support of urban farming in many cities. Thus, despite its benefits, the urban vegetable production in most countries remains in a state of *laissez-faire* without enforced restrictions or serious assistance. Current initiatives show positive signs for a change towards higher recognition of the informal irrigation sector, also in urban and peri-urban areas.

Informal Irrigation in Urban West Africa: An Overview

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Introduction

Urban agriculture is a widely practiced phenomenon actively involving more than 800 million people, worldwide. Although most of these urban dwellers are engaged in subsistence gardening, more than 200 million practice market-oriented farming on undeveloped urban spaces (UNDP 1996).

This report focuses on this second group. It is dominated by small-scale irrigated agriculture which forms part of the informal irrigation sector. By 'informal irrigation' we refer to those sections of the irrigation sector, which have established themselves without public funding and official recognition, i.e. in the shade of government-initiated 'formal irrigation' schemes.

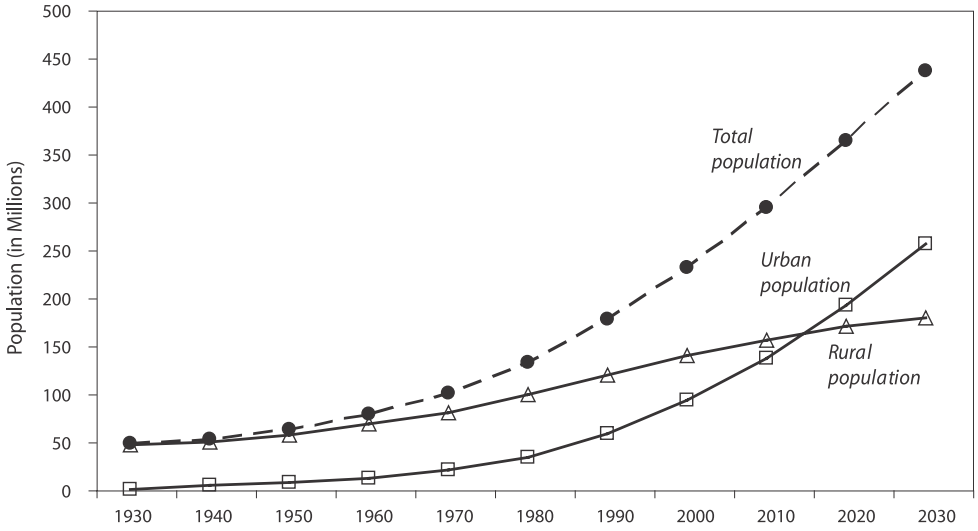
The objective of this report is to provide the first comprehensive sub-regional overview ever published on this sector. It is based on a thorough literature survey supported by the results of three joint research projects of the International Water Management Institute (IWMI) and the Food and Agriculture Organization of the United Nations (FAO). Emphasis is placed on the extent of these activities, common irrigation practices, and the significance and political recognition of the subsector. A second report will focus in more detail on the common use of polluted irrigation water, the contamination pathway and options to reduce related health risks (Amoah et al. 2007, forthcoming). Both reports are supported by a comprehensive country case study on Ghana (Obuobie et al. 2006).

Urbanization in Africa

Africa's rate of urbanization is estimated to be about 3.5 percent per annum, which is one of the highest in the world (UN Population Division 2004). The projection is that by 2015 there would be 25 countries in Sub-Saharan Africa (SSA) with higher urban than rural populations, and by 2030 there would be 41 countries in this group with 54 percent of all the Africans living in urban areas (UN-Habitat 2001; UNEP 2002). This means the traditional focus of development aid on rural areas would be increasingly targeting a minority of Africans.

Urbanization is particularly visible in West Africa, where rural-urban migration is catalyzed by the emergence of the market economy and the relative concentration of investments in urban trading centres (Club du Sahel 2000). The dynamic expansion of the sprawling conurbation of Lagos in Nigeria from a population of only 75,000 in 1940 to one of the world's largest mega cities with a current population of 13-16 million is the most noticeable example. This development, which directed the UN Secretary General, Kofi Annan to announce the "Urban Millennium" (UN-Habitat 2001), poses a major challenge to emerging and exploding cities, not only in providing urban services, like shelter, water, energy and sanitation, but also in ensuring urban food supply and security.

FIGURE 1.
Rural and urban population development in West Africa between 1930 and 2030 (in million people).



Source: Based on data by UN Population Division, 2004.

Urban, Peri-urban and Rural 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 (Mougeot 2000)[1]. The terms "urban agriculture" and "peri-urban agriculture" are often used synonymously. This poses considerable challenges to comparative city studies as there is no universally accepted definition as to what constitutes "peri-urban" and especially as to where the peri-urban area ends and the rural hinterland begins (Simon et al. 2006). Even what authorities in Sierra Leone call "urban" might qualify only as a small town in Nigeria (Moustier and Fall 2004)[2]. While it is practical to consider the administrative boundary of a city as the "urban area," general commonalities define the "peri-urban area" more as a dynamic interface with urban and rural features rather than a fixed geographical zone (Rakodi 1999; Brook and Dávila 2000; Simon et al. 2006). Its spatial extent might be best analyzed using the approach described by Adam (2001). Corresponding studies by the Natural Resources Institute (NRI), IWMI, and the African Rice Center (WARDA) in Ghana, Côte d'Ivoire and Mali estimated a rural-urban interface (peri-urban area) to be about 30-40 km from urban centers with larger distances along major roads and much shorter, where the road network is limited (Adam 2001; Erenstein et al. 2004; Drechsel et al. 2007a, forthcoming). This agrees with observations made by Moustier (2001) in West and Central Africa that beyond about 50 km from city centers, agriculture stops showing the typical features of peri-urban farming.

[1] For other definitions see for example, Moustier and Fall (2004).

[2] In this report, the terms urban agriculture, peri-urban agriculture or urban and peri-urban agriculture are used as conscientiously as possible.

Categories of Urban Farming Systems

Traditionally, agriculture is considered a quintessential rural activity, hence "urban agriculture" may appear to be an oxymoron (UNDP 1996). In fact, research and development efforts in the agricultural sector, including farming systems research, continue to focus on rural areas. The absence of a generally accepted nomenclature of urban farming systems does not facilitate its recognition.

Urban farming systems can be classified according to different criteria such as location, crops cultivated, tenure modality, scale of production, seasonality and product destination (Moustier 1999; Mougeot 2000). Often, the selection of a particular criterion is based on the purpose of its use or reflects the disciplinary background of the respective author(s) which can range from architecture to public health, a variety less typical in rural farming.

From our perspective, a basic differentiation among urban farming systems in general and in West Africa in particular is to distinguish between: (i) open-space (usually but not only market-oriented) production of high-value products on undeveloped urban land, (ii) (mostly subsistence) gardening in backyards of private houses, and (iii) livestock rearing in and/or outside one's own yard (table 1).

The most widely distributed "backyard gardening" is practiced by about 20 million urban dwellers in West Africa mostly for subsistence purposes (box 1). In Accra, for example, there are about 80,000 small backyards, covering in total, however, only about 50-70 ha. But there are, also in the same city, more than 1000 ha of open spaces so far undeveloped, which are largely used for rainfed farming and, wherever possible, for irrigated vegetable production (Obuobie et al. 2006). Throughout the West African sub-region, exotic and traditional vegetables are the dominant high-value food crops cultivated on such open urban spaces (Moustier 2000; Smith 2002). The production in most cases is market-oriented, i.e. for income generation and also highly input and output intensive. It complements rural farming and supports the diets of urban consumers. With its focus on fresh vegetables of a short shelf life, this production system requires irrigation and will be our focus.

TABLE 1.
The three major categories of urban agriculture in West Africa.

Farming systems	Urban areas	Peri-urban areas
Market gardening	Irrigated vegetables (year-round or seasonal), flowers and ornamentals, rain-fed cereals on undeveloped open spaces.	Fruits, dry-season irrigated vegetables alternating with rain-fed cereals; rice.
Subsistence production	Backyard or front yard farming.	Home gardens; farming around homestead.
Livestock husbandry and aquaculture	Predominantly poultry, small and large ruminants, equines.	All kinds of poultry and livestock, increasingly aquaculture.

Source: Authors.

Box 1: Subsistence farming in the city

Data compiled by Moustier (2000) and Drechsel et al. (2007a, forthcoming) in West Africa showed that on the average, between 20 and 50 percent of all urban households have some form of backyard garden where they keep a few small ruminants or poultry, or plant some plantain or other crops, often on plots as small as 2-10 m^2. With an urban population of 100 million (figure 1), at least 20 million West Africans currently live in urban households with some kind of urban agriculture. In Accra and Kumasi, our surveys showed that in each city at least 600,000 residents from all income categories benefit from their backyard gardens (IWMI 2006, unpublished). Cultivation for subsistence purposes mainly relieves the household to some extent of its necessary budget allocation for foodstuff. Thus in many cities, such cultivation does not play a key role in household livelihood strategies but is part of them and reduces their vulnerability. Those who have more space and larger gardens or chicken coups might also sell surpluses. In Kumasi, the cultivation of plantain (90%) and cassava (40%) is most common, followed by cocoyam, fruity or leafy vegetables, maize and sugarcane. In every third backyard in the city plants are watered temporarily, 87 percent of them with pipe borne water, 10 percent with well water and 3 percent with stream water (KNRMP 1999). In irrigated open-space farming, for comparison, 70 percent of all farmers in Kumasi use [polluted] stream water, 27 percent shallow wells and 3 percent wastewater drains. Pipe borne water is used only in exceptional cases (Obuobie et al. 2006).

FIGURE 2.
A typical open-space site in Accra used for vegetable cultivation. There are about 12 ha irrigated around the Dzorwulu electric power station and a storm water drain (photo: IWMI).

Origin of data

The report presents the first subregional state-of-the-art review and analysis of irrigated urban agriculture in Africa, derived from a vast body of individual studies to which IWMI contributed significantly over the past years (see indication in the Literature Cited). A large share of the publications is grey literature (Ph.D theses, consultancy and project reports) provided by the two RUAF focal points at IAGU, Dakar, and IWMI, Accra. The compiled information has been complemented by an IWMI led Ghana case study (Obuobie et al. 2006) and information extracted from three joint projects of IWMI and FAO:

- A literature review on the profitability and sustainability of urban and peri-urban agriculture in Africa and Asia (Danso et al. 2003).
- Baseline surveys of urban farming systems in six West African cities (Klinkenberg 2002).
- An integrated economic and environmental impact assessment of urban and peri-urban agriculture in Ghana (Gyiele 2002).

The location of the cities considered in this report is shown in figure 3. They represent a range of agro-ecological zones and a large variety of socioeconomic conditions that are typically found in West Africa. As with all literature reviews, materials and methods vary from study to study which makes data comparisons difficult. However, as far as possible all data were cross-checked through our own farm surveys and/or local contacts.

FIGURE 3.
Study sites in West Africa.

Source: IWMI.

Characteristics of the farming system

In West Africa, urban agriculture dates back to pre-colonial times when agriculture was an integrated component of the urban space (UNDP 1996), while the cultivation of exotic vegetables became popular in colonial times (Anyane 1963; Zallé 1997; Yapi Affou 1999).

The comparative advantages of urban and peri-urban agriculture are market proximity and minimal transportation costs. Market proximity is especially important due to lack of refrigerated transportation and storage for perishable crops (Obuobie et al. 2006). Open spaces with access to water year-round or at least during the dry season which is the season when profits are the highest, are preferred locations for irrigated farming in the city or in its fringes. This takes place on unused governmental land, on clan or "stool" lands or undeveloped private plots. Such open spaces are common in lowlands or along power lines, streams/drains, roads or airports. Where water is available, the same urban open space used in the dry season for vegetable irrigation might be used in the rainy season for (rainfed) maize cultivation depending on the respective market values as seen, for example, in Accra and Ouagadougou.

In the same city, there can be a range of mostly informal land use "arrangements" such as free use/squatting, sharecropping, care taking, toleration, wage earning, illegal or inofficial rents, as well as formal tenancy (Tricaud 1987; Flynn-Dapaah 2002; Velez-Guerra 2004). Some private landowners tolerate urban farming as protection against other forms of encroachment. In general, however, tenure arrangements are mostly insecure and many farmers are continuously at risk of eviction without any compensation (Obuobie et al. 2003; Endamana et al. 2003). In rare cases, like in Bamako, urban farmer cooperatives are strong enough to take such cases to court (Velez-Guerra 2004). Farmers cope with tenure insecurity through low capital investments and by cultivating crops which need only a few weeks to mature. Thus the risk remains manageable and potentially lucrative profits can accrue in a short period. Tenure security usually increases along the urban-rural gradient.

Area under cultivation

Table 2 shows that in the various cities, between 20 and 650 ha are under "informal" urban irrigation. As some city assessments were less strict with city boundaries, the larger figures might also cut into the peri-urban fringes. Yet, these figures show net irrigated areas. In most cities, the gross area is much larger because, depending on the crop and growing period, one and the same vegetable bed might be used for 3 to 10 subsequent crops during the year. The relatively low area in some cities should be attributed to the lack of streams or available land, and not to the lack of demand (Tricaud 1987). Where particularly large areas are under cultivation, such as in and around Bamako, a significant share of the produce is exported to other cities.

There can be large variations in the cultivated area between seasons and years due to economic or physical changes, or the expulsion of farmers. For example in Freetown, Kumasi or Ibadan, inland valleys become flooded in the rainy season. In Bamako and Niamey, plots on the banks of the Niger River are inundated in the rainy season, while fields along seasonal streams (*wadis)* are abandoned in the dry season unless wastewater or wells continue to provide the water requirement. Often, more

TABLE 2
Area of irrigated open space in selected cities of West Africa.

	Population, 2005 (million)	Annual urban growth rate 1995-2005 (%)	Area of actually irrigated open space in the city (ha)	Annual rainfall (mm)
Accra (Mega-Accra)	2.7	4.6*	47-162	810
Bamako	1.4	4.3	300-650	856
Banjul	0.04	4.3	45	1,096
Cotonou	1.1	4.6	36	795
Dakar	2.5	3.9	150	450
Freetown	1.1	5.7	45	3,590
Kumasi	1.1	5.9	41	1,432
Lagos	13.0	4.9	40-100	1,740
Lomé	0.9	4.8	60	688
Niamey	0.9	5.6	400-600	545
Nouakchott	0.7	8.6	150	130
Ouagadougou	1.2	6.1	25-43	880
Tamale	0.2	2.5	33	1,033
Yaoundé	1.8	4.6	20	1,600

* In some cities, like Accra, the administrative city boundaries are outdated and the population growth in peri-urban districts (6-9%) is better reflecting urbanization.

Sources: UN statistics for population data. Areas of irrigated open space derived from Klinkenberg (2002), Obuobie et al. (2006), expert consultation and the literature survey.

sites are under cultivation and/or irrigation in the dry season due to higher profits.

The sandy coastal ribbon along the ocean is the area preferred by Lomé's market gardeners. Irrigated market gardening has been practiced there for more than a century, making it a traditional feature of the city: the total cultivated area varies in different assessments (Schreurs 2001) but reaches up to 900 ha from Lomé's industry-port zone to peri-urban Kpogan, about 20 km from the city (Tallaki 2005). In general, areas under irrigation in the peri-urban fringe are more difficult to estimate as the assessment depends on the demarcation of the "peri-urban" zone (see above). An impressive example is reported from Kumasi (box 2), where a 40 km radius was used to define the peri-urban zone. The same radius was applied to peri-urban Bamako, where an area of more than 2,000 ha is irrigated (Sofreco-HN'D 2002), and Niang (1999) reports 8,000 ha for peri-urban Dakar, which includes a part of Senegal's "Niayes" which stretch along the ocean up to Saint-Louis. A beneficial climate and shallow groundwater support in the Niayes informal irrigation and the production of the majority of Senegal's vegetables and fruits (Fall et al. 2000; Cissé et al. 2005).

Box 2: Formal vs. informal irrigation in West Africa

Cornish et al. (1999) define *formal* irrigation as one that is reliant on some form of fixed irrigation infrastructure that has been designed and may be operated by the government or a donor agency and which is used by more than one farm household. *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. Examples are found in irrigated urban and peri-urban agriculture, but even more in inland valleys, flood plains, around small reservoirs or lakes and along streams and rivers or where smallholders use (shallow) groundwater. West African countries with more informal than formal irrigation are for example Nigeria, Sierra Leone and Liberia. While in the Sudano-Sahelian zone of West Africa 89 percent of all irrigation takes place in equipped schemes, this is only the case in 39 percent in its Guinea zone (FAO, 2005). In most countries, however, comprehensive assessments of the informal sector are still missing.

Besides a few mostly export oriented commercial schemes of the private sector, also irrigated vegetable farming in urban and peri-urban Ghana clearly falls under the informal category since it does not involve the use of fixed irrigation infrastructure, and the governmental support or interventions are minimal. For all cities in the middle and southern part of Ghana, IWMI estimated about 40,000 ha of informal peri-urban irrigation (Keraita, unpublished). In and around Kumasi city alone, Cornish and Lawrence (2001) estimated an area of about 11,900 ha under dry season vegetable production. Already this is more than twice the area that is under formal irrigation in the whole of Ghana where, in 22 irrigation schemes, only about 5478 ha are actually developed and put under irrigation (GIDA-JICA 2004). In 2006, and with support from FAO and IWMI, the irrigation authorities and related ministries recognized the existence and needs of the informal irrigation sector in Ghana's new irrigation policy draft, wherein informal and formal irrigation receive equal attention (Obuobie et al. 2006).

Crops and farm sizes

Orchard et al. (1998) and Gerstl (2001) recorded 28 to 35 different vegetable species cultivated in urban farms in Nigeria and Ouagadougou. Most common are perishable (often leafy) vegetables such as lettuce, spring onion, spinach greens, and cabbage. Other common vegetables are carrot, onion, amaranth, egg plant (aubergine), tomato, okra (okro), hot pepper, green bean and cucumber. Traditional vegetables such as *Solanum* spp, *Amaranthus* spp. and *Corchorus* spp. are an important component of several West African dishes and have a high nutritional value (Gockowski et al. 2003; Kessler et al. 2004). While these vegetables are often used in stews or otherwise cooked, the "exotic" ones, like lettuce, spring onion and cabbage are mostly eaten raw and hence cause concern where polluted water sources are used (Kessler et al. 2004; Endamana et al. 2003). While exotic vegetables are usually produced only for the urban market, farmers of traditional vegetables might consume a share of their produce (Gerstl 2001; Kintomo et al. 1997).

The main vegetables grown depend on local customs but also increasingly reflect international "urban" diets, especially in a multi-cultural city environment. In Ghana, for instance, the exotic lettuce is mostly produced for the urban fast-food sector. In other cities, like Lomé, farmers take advantage of opportunities to export to other West African countries or Europe (box 3). Constrained by space, individual or groups of farmers often specialize in 3 to 5 specific crops. As extension staff is usually under-trained in the production of vegetables compared with traditional staple crops; farmers depend largely on their own initiative and knowledge sharing in their community. Depending on seasonal supply and demand, market prices vary frequently and farmers might change crops from month to month in order to grow the most profitable ones (Dossa et al. 2000; Danso and Drechsel 2003;

Moustier et al. 2004). Short-duration crops, such as lettuce, are generally preferred for immediate cash returns, and are advantageous too in view of farmers' insecure tenure situations. Besides temporal variations, farmers also use spatial variations, i.e. different crops on different beds. Intercropping is also common (e.g. *Amaranthus-Corchorus* combinations). The crop to be planted depends strictly on farmers' specialization and prediction of market demand.

Urban farm sizes depend on land and labor available especially for irrigation, and range between 0.02 and 0.3 ha (typically 0.05-0.1) throughout the sub-region. This corresponds with figures from other parts of Africa (Moustier et al. 2004). Farm sizes are even smaller where land is scarce but increase on the urban-rural gradient, i.e. usually with increasing availability of land and also with more tenure security. Individual farm sizes can also be larger where small motor pumps, support irrigation.

Around Kumasi or Dakar, common farm sizes range from 0.1- 0.8 ha while near Bamako and Lomé, farms might reach 1.5 to 2.5 ha or more (Tallaki 2005; Cornish et al. 2001; Moustier et al. 2004; Eaton 2003; Zallé 1997).

The Farmers

Due to the wide cultural diversity within the West African sub-region, only a few common patterns in the characteristics of farmers can be found. In several cities, like Lagos, Abidjan, Dakar, Niamey, Freetown and Accra, most open-space vegetable farmers are migrants or represent a minority. In Lagos, for example, 70 percent originated from the northern states of Nigeria (Ezedinma and Chukuezi 1999). Also, many urban farmers in Accra or Dakar are originally from rural areas, or in the case of Dakar, also from Guinea or Guinea-Bissau while many farmers in Niamey originated from Burkina Faso[3].

Depending on water access and market demand, cultivation is year-round or only in the dry-season. In many areas where men dominate vegetable production (see below), it remains an individual business activity. In other cases, family members assist or external workers are hired. This can be on cash or share-crop basis.

The gender ratio varies significantly among countries and cities (table 3). In Banjul, urban farming is dominated by community groups of women (Akinbamijo et al. 2002), while in

Box 3: Export oriented urban and peri-urban farming systems

Larger commercial systems (fruits, vegetables, herbs) appear where sufficient space for production finds easy access to harbors and airports for export, like around Cotonou, Dakar, Accra, Thiès, Saint-Louis and Banjul. Also, urban smallholders, for example, in Lomé, produce for neighboring countries: Carrots for Ghana and Benin; vegetables and spices for Europe (Tallaki 2005; Gyamfi 2002; Akinbamijo et al. 2002). Depending on market demand and available space and site conditions, rice also is common in peri-urban areas (e.g. around Bouaké and Korhogo in Côte d'Ivoire, Sikasso in Mali, Ouagadougou in Burkina Faso and Niamey in Niger). Another common peri-urban feature is the poultry industry (Drechsel 1996). However, both the West African rice and poultry production are significantly challenged by cost-competitive imports (Zachary 2004).

[3] Vegetable farmers in peri-urban areas are usually indigenous (Cornish and Lawrence 2001), but can also be migrants (Harris et al. 2006).

TABLE 3.
Gender ratio in open-space farming in various cities of West Africa.

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: Klinkenberg (2002), extended and updated.

Freetown vegetables are cultivated by individual women farmers. Both cases appear to be exceptions. In 10 out of 13 countries or 16 out of 20 cities in the sub-region, mostly men are involved in open-space urban vegetable farming (table 3). On the other hand, in most of these countries, women dominate the vegetable retail sector. Reasons for the gender differentiation are often described as cultural or traditional. Certain crops are associated with one or the other gender and women have limited access to land or starting capital or the tedious manual irrigation practice (Velez-Guerra 2004; Obuobie et al. 2004, 2006; Gerstl 2001). The picture appears to be different in Eastern Africa, where in cities like Nairobi and Dar es Salaam, women farmers dominate urban vegetable production (Cornish and Lawrence 2001; Jacobi et al. 2000).

In many cities, the situation is more complex than table 3 might imply. There can be further gender differences between urban and peri-urban areas and in the same city. In Yaoundé, for example, Gockowski et al. (2003) found that intensive urban vegetable farming is the domain of men, while women dominate extensive vegetable production in peri-urban areas. In one and the same city as in Accra, an equal number of men and women can be found on sites with flood (furrow) irrigation, while on sites with watering cans, mostly men do the job. Women interviewed on vegetable farms along the beach of Lomé were usually part-time farmers or hired laborers. In Ouagadougou, more women than men grew traditional vegetables for subsistence supply, while more men than women grew exotic ones for income generation (Gerstl 2001).

Farming Input

Competition for urban farmland is high and farmers maintain their plots despite often-marginal (tropical and urban) soil conditions. Better soils are found only in more fertile inland valleys. In many cities along the West African coast, like in Lomé, urban farmers have been cultivating poor sandy (beach) soils for more than 20 to 40 years. Due to continuous and intensive production, a significant amount of nutrients is exported with each harvest. On such poor soils, corresponding external inputs are mandatory. In the more humid parts of West Africa, farmers prefer poultry manure due to its high nutrient content coupled with its fast release of nutrients for vegetables, and the usual low price (Zickermann et al. 1998; Drechsel et al. 2000). Manure application rates can be high (20-100 t/ha/yr) depending on soil quality. For some crops, like cabbage, industrial fertilizer is considered an important addendum (Drechsel et al. 2005).

In general, urban farmers use every organic waste available, thus contributing significantly to (waste) resource recovery (Moustier et al. 2004; Harris et al. 2006). In Lomé, for example, farmers use cotton grains, different manures and mineral fertilizers (Schreurs 2001). In the Sahelian cities of Bamako, Ouagadougou and Niamey where large-scale poultry farming is increasingly constrained by heat, it is common to apply cattle manure and mineral fertilizer. However, due to the reduced availability of organic input in drier climates, unsorted solid waste, waste compost or sludge from latrines are also used, but more in (peri-) urban staple crop production than in vegetable farming (Asare et al. 2003; Eaton 2003; Cofie et al. 2005). In Kano, Nigeria, it is a traditional practice to use compost from manure, household waste, compound sweepings and ash. According to Lewcock (1995), within a 7.5 km radius of the city, 25 percent of farmers' fertilizer needs are met in this way at an average application of 3-5 t/ha per annum.

Leitzinger (2001) and Eaton (2003) estimated that in Kumasi, Bamako and Ouagadougou, more compostable urban waste is produced than urban agriculture could absorb. However, what appears like a win-win situation for authorities and farmers (Drechsel and Kunze 2001; Asomani-Boateng 2002) is often not viable and hence requires careful planning and coordination as shown by Drechsel et al. (2007b, forthcoming).

Pests are a serious problem in urban vegetable farming due to the continuous nature of production. A wide variety of pesticides are used (Cissé et al. 2002; Tallaki 2005). These are often inappropriately applied thereby putting farmers (Danso et al. 2002b), consumers (Amoah et al. 2006) and the environment (Cissé et al. 2002) at risk. However, pesticide use appears to be similar to intensive and continuous vegetable farming in rural irrigation schemes and thus does not appear as a particular feature of urban agriculture.

Irrigation Techniques

Maintaining year-round production depends on access to a water source for irrigation purposes and consequently, on water lifting/fetching and irrigating technologies. Depending on the risk of flooding or water stress, vegetables are usually planted on a series of raised beds (figure 4), or on low beds between ridges, or along furrows. Vegetable beds are often only 2-4 m^2 large. Irrigation is usually done in the cooler morning and late afternoon, which suits man and crop.

The most common method of urban irrigation in the sub-region is manual water fetching and application using a watering can (table 4) (Keraita et al. 2003a). Cans are used to draw water directly from a stream or shallow well or to carry water after using a water-lifting device as shown in figures 5 and 6. Although the watering can might appear as "archaic," it has many advantages: precise water application on fragile vegetables, low investment costs, low risk of

FIGURE 4.
Cultivated urban inland valley (sketch after Tricaud 1987, modified) and photograph from a similar site in Freetown, Sierra Leone. Farmers use raised beds for vegetable farming. Water is applied through furrows, or else with buckets or cans from the stream or shallow wells (dug outs) along the slopes. In the rainy season, parts of the valley are flooded (Photo: IWMI).

theft, easy maintenance, a high level of spatial and temporal flexibility, and the possibility of withdrawing the whole equipment in seconds when there is a risk of expulsion from the land.

However, using watering cans is labor-intensive as water application rates are high (640-1,600 mm per year as measured in Accra and Kumasi in year-round irrigation). The weight of the water (10-15 liter per can) limits its use to the fields close to streams or shallow wells/ponds (usually between 20 and 80 meters from the source/reservoir), except where pumps or carrier systems are used. Simultaneous irrigation with two cans per walk was cited as one of the reasons why women irrigators are seldom seen where watering cans dominate (Obuobie et al. 2004). In Lomé's area, a market gardener's workday lasts on the average 10-12 hours with 40-75 percent of his/her time spent on watering (40 percent for those with a pump and 75 percent for those without). Thus one grower alone can hardly manage more than a quarter of a hectare (Tallaki, 2005). For Kumasi, with less sandy soils and twice the annual precipitation, Danso et al. (2002a) estimated that 38 percent of farmers' time is required for manual watering and Faruqui et al. (2004) cited 60 percent for Dakar. To perform all the tasks required or irrigate larger areas, most growers use relatives and/or paid workers.

To simplify on-farm water conveyance in urban and peri-urban areas around Cotonou and Lomé, pipe-connected water reservoirs are common, which are refilled from (tube) wells using small motor or treadle pumps (figure 5) while the final watering is done using cans. In Accra, in a similar system, dugouts are used as intermediate reservoirs. In Ouagadougou, mobile

barrels are used to facilitate water transport, a system originally introduced for small-scale drinking water supply (figure 6).

Increasingly, small pumps are used for spray irrigation, although their availability is often a constraint. Spray irrigation is an intermediate technology between manual systems and more sophisticated sprinkler or drip irrigation technologies. It is a low-cost, overhead system that consists of a small petrol pump with a lay-flat hose of 40 or 50 mm diameter at the end of which is sometimes a hand-held spraying head of the type normally found on watering cans. The system, which was observed, for example in Lomé, Kumasi, Niamey and Bamako, appears to be energy efficient, saves labor, adapts well to the yield limitations of low-cost hand-dug wells, is mobile and can reduce irrigation costs per m^3 by 40 percent or more (Ezedinma and Chukuezi 1999; Mbaye, 1999; Van't Hof and Maurice 2002). Unlike when using watering cans, however, the hose has to be pulled across fields and beds, which might harm bed structure and fragile vegetable (nursery) beds unless a second person assists. The need for a second person was also mentioned by urban smallholders as constraining the use of treadle pumps.

Stationary water pumps can be found in larger commercial vegetable and fruit plantations common in peri-urban areas with secure land tenure.

FIGURE 5:
Water lifting via treadle and motor pump form tubewells into small tanks along the beach of Lome. A series of tanks can be connected through tubes to shorten distances for irrigation with watering cans (Photos: IWMI).

TABLE 4.
Major water sources, water lifting technologies and irrigation techniques used in irrigated urban vegetable production in West Africa.

Water sources	Abidjan	Nouak-chott	Ac-cra	Bamako	Cotonou	Banjul	Dakar	Free-town	Kumasi	Lomé	Niamey	Ouaga-dougou	Yaoundé
Shallow (dugout) well	V		V	V	V	V	V	V	V	V	V	V	V
Storm water drain, usually highly polluted	V	V	V				V	V	V		V	V	V
Deep well		V			V	V				V	V	V	
Pipe-borne water		V	V				V		(V)				
River and stream, often polluted			V	V					V		V	V	V
Partially treated wastewater		V	V				(V)					(V)	
Larger water tank or reservoir												V	
Inland valley								V	V				V

Water lifting and irrigation technologies	Abidjan	Accra	Bamako	Cotonou	Banjul	Dakar	Free-town	Kumasi	Lomé	Niamey	Ouaga-	Yaoundé
											dougou	
Watering can (with rope)	V	V	V	V	V	V		V	V	V	V	V
Motor pump/water hose	V	V	V	V	V	V		(V)	V	V	V	
Buckets and bowls		V		V	V	V	V	V			V	
Treadle pump and cistern				V					V	V		
Sprinklers		V		V				(V)				
Ridge and furrow		V					V			V		
Drip irrigation					(V)	V				V		

Source: Data compiled and updated, Klinkenberg (2002) and Obuobie et al. (2006).

V: common; (V): few cases

Water Sources and Water Quality

In most West African cities, gaining access to low-cost but high-quality irrigation water raises enormous difficulties (Barry 2002). Most surface water bodies are polluted, thus water access means, in many cases, access to marginal-quality water or some kind of diluted, partially treated or untreated urban wastewater (including storm water). Ghana and Mauritania are typical examples where less than 10 percent of the urban households are connected to a piped sewerage and (usually dysfunctional) treatment system (Keraita et al. 2003a; Tandia 2002). For most households, urban floodwater drains take over the sewerage function for grey water. As these drains end in natural water bodies, it is difficult to find any clean water source for irrigation in and around most cities. The situation is different where farmers have access to safer groundwater or water reservoirs, or can afford piped water. Thus, it should not be assumed that all or most irrigated urban and peri-urban agriculture uses wastewater (table 4) although it is likely that in general, most irrigation with raw or diluted wastewater takes place in and around urban areas. As a result, farmers in different suburbs of the same city like Nouakchott, might extract in the dry season irrigation water from drinking water pipes, sewage pipelines, treatment plants or the underground. Piped water is rarely an official or reliable option for farming due to its price and/or common supply shortages (Tandia 2002; Moustier and Fall 2004; box 4). In this regard, reusing grey water for irrigation could be considered an important step for reducing the pressure on ground water or (other) potable water resources, as long as related health risks are controllable.

The availability of (used) water affords farmers year-round production with a strong competitive advantage in the dry season. In Dakar, the use of polluted water allows 8-12 harvests of lettuce per year compared with 5-6 before farmers had access to wastewater (Gaye and Niang 2002). Faruqui et al. (2004) reported larger crops and reduced growth periods where wastewater is used, and for lettuce, a higher insect resistance but also lower density and faster spoilage.

In many cities like Dakar, Accra, Tamale, Kano and parts of Ouagadougou, the supply of vegetables largely depends on the availability of used water. Thus, farmers who want to escape poverty, rarely complain about water quality although perception studies show that farmers are well aware of different water qualities (Obuobie et al. 2006). However, they hardly have a choice as to what to use if their livelihood depends on dry-season irrigation.

Degree and type of water pollution

Depending on the nature of water source, its degree of pollution can vary widely (Mensah et al. 2001; Keraita and Drechsel 2004). Studies

Box 4: Production constraints

Due to this informal nature, in many cities, irrigated urban agriculture encounters similar constraints. Limited access to a reliable and cheap water supply is one of them. Other common constraints mentioned by farmers are:

- Unfavorable input and output markets.
- Lack of socio-political recognition.
- Tenure insecurity.
- Limited or lack of support from extension services.

Farmers associations are trying to address these constraints, for example, in Cotonou, Bamako, Ouagadougou, Lomé, Freetown, Nouakchott, Banjul and Accra. They are often formed as a reaction to land conflicts or for a collective financial strategy and can become important bodies in land discussions.

from Ghana, Burkina Faso, Senegal and Cameroon confirmed that the bacteriological contamination of urban irrigation water sources often ranges between 10^3 and 10^6 MPN FC per 100 ml, i.e. generally exceeds the common WHO or FAO irrigation standards (Cissé, 1993; Niang et al. 2002; Armar-Klemesu et al. 1998; Keraita et al. 2002; Keraita et al. 2003b; Cornish and Lawrence 2001; Endamana et al. 2003; Faruqui et al. 2004, Sonou 2001). Largely, the water pollution levels vary over the day as well as between days, seasons, suburbs and cities, with clear upstream-downstream gradients around the urban centers. Faruqui et al. (2004) mentioned, for example, the effects of "laundry days" and "Friday prayer" on stream water quality.

The flow of industrial effluents into streams is relatively rare in the sub-region as most heavy industries are alongside the ocean. Household discharge of pathogens is the dominant source of pollution, with little evidence of water pollution from heavy metals above common irrigation standards (Cornish et al. 1999; McGregor et al. 2002, Faruqui et al. 2004). The situation can be different in certain locations, for example, in Kano or Ouagadougou, which are known for their tanneries and water contamination with chromium (Binns et al. 2003, Bosshart 1997). But there can also be other contamination sources in the urban context than wastewater. In Lagos, increased copper (Cu) and nickel (Ni) levels were found in vegetables grown in industrial areas compared with the levels in those grown in residential areas (Yusuf et al. 2003). Increased levels of lead (Pb) were found in soils and crops close to highways (Bakare et al. 2004).

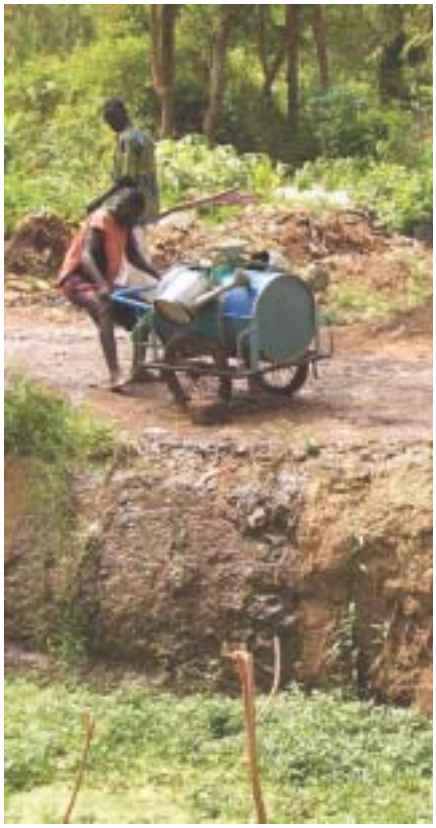
Besides pathogens, urban wastewater also contains nutrients. Like the load of pathogens, the fertilizer value of wastewater varies with the degree of dilution in natural streams or storm water drains. If diluted, the nutrient load can be negligible compared with what farmers apply through manure and/or fertilizer (Drechsel et al. 2005). In other cases it can be significant. It is sometimes debated if farmers look more for water or nutrients when they use "wastewater". Our surveys show that even in the humid part of West Africa, farmers are looking mainly for 'water' [to irrigate year round] and only in selected cases they consciously consider its (additional) nutrient value. A particular exception is the use of 'black water' (faecal sludge) around Tamale, Ghana, where farmers are seeking a low-cost fertilizer (Cofie et al. 2005).

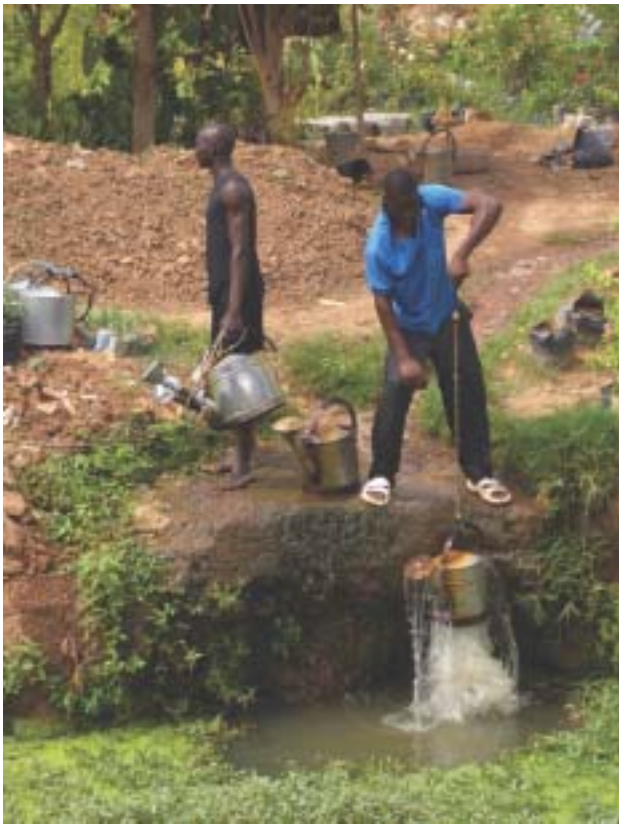
Health risks

Wherever polluted water is used, the common water fetching and overhead irrigation with watering cans pose high health risks to farmers and consumers. In a comparison of perceived diseases among more than 750 households under two groups, one engaged in irrigated urban agriculture and the other in non-agricultural control activities in three areas in Ouagadougou, Gerstl (2001) did not find any different patterns between the two groups in respect of illnesses including malaria/fever and gastro-intestinal diseases like diarrhea during the rainy and dry seasons. This does not correspond with the general perception one might have of 'farmers exposed to wastewater' (Hussain et al. 2002). Faruqui et al. (2004), for example, reports that in Dakar, farmers using wastewater had 20 percent more worm infections than those irrigating with mixed water sources. Thus the actual risks might vary from site to site. In many cases, urban farmers use groundwater or polluted stream water and not raw wastewater, and many have relatively little direct contact with the water during fetching and application (figure 6).

Crop contamination is of special concern where vegetables are eaten raw (Amoah et al. 2005; Faruqui et al. 2004; Endamana et al. 2003). Safer irrigation practices and effective vegetable washing practices in fast food restaurants and at home are needed to safeguard public health while maintaining the benefits of irrigated urban agriculture (Redwood 2004; Drechsel et al. 2002; IWMI, 2006). Interventions will have to consider the perceptions of farmers, traders and authorities, and especially, consumers' total exposure and variations in risk awareness (Gerstl, 2001; Obuobie et al., 2006; Faruqui et al., 2004).

FIGURE 6:
Water lifting from a polluted channel in Ouagadougou (with rope, above right) and a stream in Accra (below). The photograph above left (also in Ouagadougou) shows how irrigation water from the stream is conveyed in bulk to fields more than 50-100 m from the water source (Photos: IWMI).





Economic Impact of Irrigated Urban Agriculture

Specialization in high-value crops enables farmers to earn a significant income and provide the city with a reliable supply of perishable crops. Particularly during the dry season, when the supply goes down and prices might easily soar (Dossa et al. 2000; Gerstl et al. 2002; Mbaye and Moustier 2000), irrigated urban vegetable production is financially attractive in providing income and livelihood. This section will provide some data on individual benefits and the larger impact for society.

Producer income

The data compiled by Danso et al. (2003) and Klinkenberg (2002) on individual profits from mixed vegetable production in open-space urban agriculture show that the monthly net income ranges in wide margins between US$10 and more than US$300 per farmer, mostly depending on the size of the farm (table 5). For Dakar, Faruqui et al. (2004) estimated an average annual gross income of US$620 and a net income of US$365 per farmer. Zallé (1997) estimated in Bamako a monthly net income range of US$10 to 400 dependent on a corresponding increase in farm size and the use of hired labor, with the majority of farmers earning on the average, US$40. According to Cornish and Lawrence (2001), the greatest factor influencing farmers' profits is not much the yield obtained but the ability to produce at the right time what is in short demand and sell consistently at above average prices. A major advantage is market proximity: Gockowski (1999) analyzed that at a distance of 100 km from the city markets, transportation costs were estimated as equivalent to a 26 percent tax on vegetable production versus only 7 percent at a distance of 10 km. Sonou (2002) estimated a transport share of up to 60 percent in urban food prices.

If farmers can produce throughout the year, they have a good chance of passing the international poverty line of US$1 per day (Obuobie et al. 2006; Faruqui et al. 2004). When the monthly net income of urban vegetable farmers is compared with the national per capita GNI (General Net Income), it becomes evident that in most cases, vegetable farming provides an income source

TABLE 5.
Monthly net income from irrigated mixed vegetable farming in West and East Africa (US$ per actual farm size).

City	Typical net monthly income per farm in US$[4]	GNI per capita (US$ per month)
Accra	40-57	27
Bamako	10- 300	24
Bangui	n.d. -320	22
Banjul	30 – n.d.	26
Bissau	24	12
Brazzaville	80-270	53
Cotonou	50-110	36
Dakar	40- 250	46
Dar Es Salaam	60	24
Freetown	10-50	13
Kumasi	35-160	27
Lagos	53-120	27
Lomé	30-300	26
Nairobi	10-163	33
Niamey	40	17
Ouagadougou	15-90	25
Takoradi	10-30	27
Yaoundé	34-67	53

Note: GNI = General Net Income (UN statistics); n.d.= not determined/reported.

Source: Data compiled and updated from Danso et al. (2003), Klinkenberg (2002) and Gyiele (2002).

[4] Some reports lack information on the time/ period (number of harvests, seasons) the revenues are based on. Only a few valued family labor input and depreciated for investment costs. Data were combined in case of multiple reports per city.

above the national average. This concerns especially the production of exotic (or "European") vegetables, such as lettuce.

An economic comparison of year-round irrigated urban agriculture, dry-season irrigated agriculture in peri-urban areas and rain-fed farming in rural areas was carried out by IWMI in and around Kumasi in Ghana (Danso et al. 2002a). It was found that urban farmers on irrigated land earned about twice the income of their rural counterpart engaged in traditional rain-fed agriculture (table 6) despite their much smaller farm sizes. Dry-season vegetable production in peri-urban areas allowed at least a significant additional income, providing farmers with more wealth than other community members, but only in selected cases to pass the poverty line (Cornish et al. 2001; Danso et al. 2002a).

There are significant variations between seasons and crops, and the production of flowers and ornamentals or non-agricultural employment opportunities can be more profitable if farmers have the necessary starting capital to access them (Gerstl 2001; Ezedinma and Chukuezi 1999). Velez-Guerra (2004) reported that in Bamako, for some rural migrants, urban agriculture is their first job in the city and they remain in the activity because the profit they make is higher than the salaries they could get from formal employment available to them. Two examples of common stories: A farmer in Bamako stated that after 20 years as an urban producer, he was able to generate enough profit to buy two houses with land titles and additional two houses in informal settlements. A woman joined the group after her husband had an accident and could not support the family anymore, and she is now able to support her husband, and send her children to school with the money she makes from urban farming.

Moustier (2001) noted that urban vegetable production is one of only a few stable sources of income for less qualified workers with limited initial capital for investment. This is especially important for migrants who cannot afford high investments or production costs as in formal irrigation schemes where farmers have to pay for water. A similar picture was described by Abban (2003) in a comparison of informal urban vegetable farming with vegetable production in formal irrigation schemes in the same area of Greater Accra. The "informal" farmers had lower operational costs and higher returns on investment than their "formal" counterpart who had, however, higher net profits. A general advantage of producing vegetables like lettuce is the quick return on investments. After the nursery stage, lettuce only needs a month to grow.

TABLE 6.
Comparison of revenues of rain-fed and irrigated farming systems in and around Kumasi, Ghana.

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

[a)] The smaller figure refers to the smaller farm area, the larger one to the larger area.

[b)] For easier comparison, the assumption is that farmers sell all harvested crops. It is possible that farmers consume a significant part of their maize and cassava harvest at home.

Source: Danso et al. (2002a).

Post-harvest sector

Marketing of urban and peri-urban produce is another important economic sector of urban agriculture. As stated above, vegetable marketing in West Africa is a traditional domain of women. This concerns especially retailers while wholesalers (for retailers, shops and canteens) and shopkeepers can also be men, sometimes depending on the type of crop (Mbaye and Moustier 2000; Obuobie et al. 2004, 2006; Gockowski et al. 2003). In most cases, the traders, and not the farmers, harvest the leafy vegetables, based on long-term agreements. These traders are often the farmers' only source of credit and farmers can sell to other traders only after the regular customers have made their choices. The traders identify the vegetable beds with the best crops and offer a price per bed. Once they have made their choices, other traders or the growers' wives could take the rest of the produce for sale. Farmers generally complain that the women traders determine the prices, and thus control their business relationship, but limited knowledge of vegetable marketing as well as cultural customs prevent the farmers from bypassing the traders (Kessler and Helbig 2001; Danso and Drechsel 2003; Tallaki 2005).

Studies in Ouagadougou, Brazzaville and Yaoundé confirm that retailers gain at least as much as farmers (Moustier 2001), with sellers of exotic lettuce earning higher revenues than sellers of indigenous leafy vegetables (Gockowski et al. 2003; Gerstl 2001). Wholesalers especially can generate a significant income. In Kumasi, their dry season income was four times that of the vendors or farmers (table 7). Higher profits of market vendors than that earned at farm gate were also confirmed from Lomé, Ouagdougou and Freetown (Gerstl 2001; Tallaki 2005; Kroma et al. 2005).[5] Thus, where women specialize in the wholesale trade and/or retail while men farm, women can have a significantly better income. All four groups in table 7 have a good chance of passing the poverty limit of about one US dollar per day.

TABLE 7.
Household income of farmers and marketers per week in Kumasi, Ghana.

	Average income (US$) per week (range reflects seasonal differences)			
	Farmers	Wholesalers	Sellers	Hawkers
Number of observations	62	54	190	30
Average household size (adults and children)	4.7	5.2	4.6	7.1
Net profit from vegetable sales	17-23	80-108	9-25	(n.a.)-23
Nonagricultural income	0-8	9	8	9
Contribution by other household members	15-16	35	6-11	(n.a.)-13
Total household income per week	32-39	124-152	23-44	(n.a.)-45

Note: n.a. = not available.

Source: IWMI, unpublished.

[5] Such assessments need some caution as daily sales might vary where there are no options for storage (Moustier 2001). Tallaki (2005) reports from Lomé that sellers being aware of this problem only pay producers after they have sold the vegetables to consumers. If the produce does not sell, both parties bear the loss.

Impact on Society

There are several ways how urban centers benefit from irrigated vegetable cultivation in addition to the provision of fresh vegetables, jobs and income for farmers, traders and input suppliers. These comprise reduced transportation costs, traffic and produce spoilage; savings in vegetable import, storage and packaging; recycling of solid and liquid waste resources; productive use and aesthetic appearance of unused plots; protection of open spaces against desertification or non-agricultural encroachment, etc. (Mougeot, 2000; Obuobie et al. 2006).

On the other hand, there are negative effects, like competition for potable water and health risks from the use of polluted irrigation water. Even the use of clean irrigation water might have a negative impact (box 5). Nugent (1999) suggested applying an extended cost-benefit analysis to identify and quantify the economic, social and ecological impact of urban agriculture in order to analyze if urban agriculture is beneficial and worth sustaining. Moukoko-Ndoumbe and Van der Pol (1999) suggested a related "integrated economic environmental impact assessment". Its initial application in and around Kumasi showed, however, the limitations of such an approach as: (i) the overall balance would be based on different evaluation techniques, which might be difficult to compare (Gyiele 2002); (ii) certain benefits might be non-replaceable for certain stakeholders (but not all); and (iii) the assessment would probably remain a snapshot considering the typical dynamics of urban agriculture over time (see below).

There is hardly any study yet addressing the '*aggregate impact*' (Nugent 2000) of urban agriculture or irrigated urban agriculture in Africa on the urban economy or society at large, not to speak of measuring the less tangible benefits and costs (Mougeot 2005). Especially from West Africa, only a patchwork of quantitative information is available. Some examples are:

- **Employment:** Irrigated vegetable production supports, for example, in Accra, about 1,000 urban farmers (IWMI 2006, unpublished.) and in Bamako, about 2,000 employing in addition about 4,000 laborers (Zallé 1997). The direct and indirect creation of employment of urban agriculture has been estimated at over 15,000 jobs in the Dakar region (Mbaye and Moustier 2000).
- **Food supply:** In cities like Dakar, Bamako, Accra, Kumasi and Tamale, depending on crop and season, between 60 and 100 percent of the consumed leafy vegetables are produced within the respective cities[6] (Mbaye and Moustier 2000; Faruqui et al. 2004; Drechsel et al. 2007a, forthcoming; Smith 2002).
- **Reduced transport (energy footprint):** The average food item in Accra's food shops and supermarkets travels 3700 km (by air) before it arrives on its shelf (IWMI 2006, unpublished.). Some products, also common in peri-urban areas, like poultry, rice and canned tomatoes, even come from as far as Brazil, Thailand and China (Zachary 2004).
- **Beneficiary group quantification:** In Accra, with a population of 1.6 million, every day more than 280,000 urban dwellers eat fast food supplemented with lettuce, cabbage or spring onions produced by irrigated urban agriculture. Over one week, at least a quarter of the urban population benefits from this contribution. The figure also gives an idea of the risk group exposed to "wastewater irrigation" (Obuobie et al. 2006).

[6] Some data (e.g. Accra: 90 percent of 'all' vegetables) are persistently cited although they are wrong. Such high percentages only apply to certain leafy vegetables.

- **Cost assessments:** Agodzo et al. (2003) estimated for year 2000, an income generated benefit of about 6.4 million US$ through the targeted use of only 10 percent of Ghana's urban wastewater. Zigah (2005) estimated that if imports from neighboring Togo, Côte d'Ivoire and Burkina Faso are to replace the most common urban produced vegetables it would cost Accra annually US$ 14 million, in case 'wastewater' irrigation gets banned. Obuobie et al. (2006) summarized some other preliminary cost assessments related to pesticide use, soil nutrient depletion and increased malaria risk through irrigated urban agriculture.

Box 5: Irrigated urban agriculture and malaria

Besides health risks through wastewater irrigation, irrigated urban farming can also have other health implications (Birley and Lock 1999). As West Africa is a highly malaria endemic region, a potentially important risk factor would be a positive link between irrigated urban farming and urban malaria. In comparison with rural areas, West African cities have in general a reduced malaria toll as they are too polluted to provide suitable breeding grounds for the malaria vector *Anopheles*. Thus, the use of polluted water or wastewater for irrigation would not increase the risk. Breeding of anopheles in urban agricultural sites was however observed where clean water was used (Vercruysse et al. 1983; Warren et al. 1999). Also, the possible adaptation of the vector to less clean water has been indicated (Chinery 1984). However, only a few studies investigated actual larval survival or tried to isolate and quantify the impact of urban agriculture on malaria transmission (Dossou-Yovo et al. 1994, 1998; Klinkenberg et al. 2005). Julvez et al. (1997), for example, reported from the Niger River that shallow wells along the stream are better breeding grounds than the stagnant and polluted river water. The authors observed, however, that probably the permanent disturbance of the water due to the refilling of watering cans does not allow larvae to develop into the pupa stage. On an urban farming site in Accra with nearly 80 man-made shallow water reservoirs filled with either piped water or polluted water, natural predators and other competitors (tadpoles) effectively controlled larval development (Miah 2004), while in Dakar, fish was introduced for the same purpose (Robert et al. 1998). 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 greener city areas which might generally offer more resting and breeding grounds than other city spaces, an explicit link with local farming activities could not be established in these cases.

Political Recognition and Sustainability

In Africa, there is a growing recognition of informal irrigation practiced by smallholders although only few statistics are yet available and institutions mandated to address this sector (Cornish and Lawrence 2001; Sonou 2002; Agodzo 2005). Emblematic is the official reaction to irrigated urban farming which has varied across space and time and has tended to be more inhibitive rather than accommodative (Drakakis-Smith 1993; Rogerson 1997; Mbiba 2000).

The "*laissez-faire*" attitude

In some countries, urban gardening was indirectly encouraged in the seventies through programs like "Operation Feed Yourself" in Ghana and "Operation Feed the Nation" in Nigeria, launched by the governments concerned. In Ghana, during the same period, most municipal bylaws referring to urban food production were put in place, however, not to increase production but to maintain sanitary standards (Obusu-Mensah 1999). Tricaud (1987) concluded from similar observations that government ministries in general tend to support urban agriculture, especially during times of economic crisis (box 6), while resistance is higher at the level of the concerned municipalities. Usually, this resistance does not affect backyard farming[7] but open-space vegetable production and/or livestock rearing. The reasons for the negative perception of open-space vegetable farming vary. If visible to the public, it might go against the image of modern civilization and progress. In other cities, health authorities lobby against the use of polluted irrigation water (Van der Berg 2002; Mensah et al. 2001; Obusu-Mensah 1999; Cissé et al. 2005).

Box 6: Urban agriculture during economic crises

During political and economic crises, urban agriculture is a popular strategy for maintaining urban food supplies (Drescher et al. 2000). After seven years of conflict owing to a civil war lasting from 1989 to1997, the Liberian Ministry of Agriculture in conjunction with FAO developed a plan of action for supporting emergency agricultural activities. Part of it was the encouragement of urban agriculture within the suburbs of Monrovia, mainly backyard farming, livestock raising and aquaculture. Due to the high-rainfall pattern in Monrovia% vegetable cultivation does not depend on irrigation.

In other civil-war prone countries of SSA, war-related shortages of food supplies led to other often FAO aided initiatives in support of urban agriculture, as reported in the 1970s, 1980s and the 1990s from Ghana, Zambia and Congo. In Freetown, Sierra Leone, urban agriculture played a significant role during the civil war when the rural-urban road network was blocked. In the 1980s, as national indebtedness in Zambia increased, a reversal of urban agriculture related policy attitudes from repression to recognition took place, with the state shifting to a position of urging people to grow their own vegetables and cereals (Rogerson 1997).

[7] Backyard gardening is very common among civil servants throughout the sub-region. While salaries are usually low, they have fringe benefits including subsidized housing, often with some space used for poultry farming or gardening.

In general, West African cities face many urbanization-related challenges, especially in regard to waste, shelter, health, drinking water supply and sanitation so that it is not surprising if urban agriculture does not get much political attention except where it has a strong lobby or a media coverage (Obuobie et al. 2006). Usually, it is tolerated without much enforced restriction or particular support. In municipal planning, it is usually marginalized (Cissé et al. 2005). This "laissez-faire" attitude does not give urban farmers the recognition they need to argue, for example, for more tenure security and credit access, which could allow investments in farm infrastructure, such as fences, wells or treadle pumps (Bourque 2000; Mougeot 2000, Ezedinma and Chukuezi 1999). Investments might be important not only to the farmer (eg. in labor saving irrigation infrastructure) but also to society, for example, in safer water sources or small sedimentation reservoirs for on-farm wastewater treatment. Win-win scenarios appear possible where a city can grant farmers improved land-use security as incentive for private investments in safer irrigation practices.

Increasing recognition

A major institutional challenge not common in rural farming is the large variety of authorities with a stake in urban agriculture (Campilan et al. 2001). Without coordination, one ministry may award the best urban farmers while another may prosecute them (Obuobie et al. 2006). In other cities, like Cotonou, authorities have started to work together to offer farmers space with safer water sources (box 7). In most cases, however, the different actors related to urban agriculture work virtually in isolation, with no formal relations among them (Cissé et al. 2005). A key initiative supporting stakeholder platforms is the network of Resource Centres on Urban Agriculture and Food Security (RUAF), with several strategic focal points around the globe. In Africa, these are based at the Institut Africain de Gestion Urbaine (IAGU) in Dakar, the Municipal Development Partnership (MDP) in Harare and IWMI in Accra. IAGU also coordinates the Francophone Network on Urban Agriculture in West and Central Africa. This network facilitated

Box 7: Action beyond declarations

Following a multi-stakeholder process initiated by IAGU, the cities of Cotonou and Seme-Kpodji in Benin, supported by the Ministries of Agriculture, Interior, Finance, and the State Ministers Council, agreed to allocate about 400 ha of farmland for the use of urban and peri-urban farmers. The site is located at a major road about 20 km from Cotonou towards Porto-Novo and has shallow groundwater which can easily be lifted by treadle pump for all-season irrigation. About 1,000 farmers declared their interest to move to this site and more than 100 have so far moved. The constraints are the required subsidies for setting up houses and infrastructure. This initiative addresses tenure insecurity and access to safe water 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 might try to maintain their valuable city plots one way or the other.

In Accra, the Ministry of Food and Agriculture pledged its support for urban agriculture in a Vision Statement (Obuobie et al. 2006) and started on different sites in the city to explore the ground for safer irrigation water.

In Bamako, the Yiriwaton farmers cooperative has been effectively lobbying at the local government to gain access to public land in the peripheries of the city. Following a directive from the central government, the municipality started to explore the possibilities of leasing to farmers up to 600 ha near Bamako's international airport (Velez-Guerra 2004).

In Niamey, the overall urban development plan of the city considers the intensification of irrigated and rainfed agriculture, particularly along the Niger River (Cissé et al. 2005).

the Dakar Declaration[8] of March 2002 on urban agriculture, signed by seven mayors and city councilors from West Africa in support of developing the urban agriculture sector and recognizing the potential problems of wastewater use (Niang et al. 2002). Taking the lead, the Mayor of Pikine in Dakar decided to support the farmers in his area and banned the removal of farmers from their lands. The Harare Declaration[9] of 29 August 2003 signed by five ministers of local government from East and Southern Africa was a RUAF supported milestone calling for the promotion of a shared vision of urban agriculture[10]. In Ghana, the new national irrigation policy draft recognizes the informal irrigation sector including irrigated urban and peri-urban agriculture and calls for a thoughtful management of the wastewater challenge (Obuobie et al. 2006). Also at the sub-regional level of West Africa urban farming receives increasing attention (CORAF 1998; ECOWAS 2005).

Sustainability

Many authors described significant changes in urban farming areas over time (Olofin and Tanko 2003; Zallé et al. 2003; Cissé 1997). In fact, with low tenure security and power to lobby against construction projects, urban vegetable farmers are often expelled. This makes open-space farming appear unsustainable (Van den Berg 2002). However, "urban shifting cultivation" where farmers have to move to another site in the vicinity or towards the peri-urban fringe is an essential part of this particular farming system, which is similar to shifting cultivation in most parts of rural West Africa. In both cases, mobility is a crucial necessity and also a coping strategy, be it against soil fertility decline or urban expansion.

In the long term, urban farming shows a significant level of resilience dating back to more than 100-150 years (Mbaye 1999; Tallaki 2005; Anyane 1963; Soumahoro 1999). Although many sites were changed over the years, others have a farming record of 20 to 50 years or more under *continuous* cultivation (Amoah et al. 2005; Tallaki 2005). The continuous nature of cultivation is remarkable as many urban soils ("anthrosols") can be of very poor nature. Considering the high nutrient exports with each harvest, it becomes obvious that the biophysical sustainability of these systems over so many years is based on correspondingly high input (Kessler and Helbig 2001; Drechsel et al. 2005).

In addition to economic sustainability, FAO's Framework for the Evaluation of Sustainable Land Management (FESLM) considers environmental and socio-cultural factors (Smyth and Dumanski 1994). These criteria are of specific significance in urban agriculture due to its exposure to urban pollution, possible health risks and limited socio-political recognition. Based on these indicators, irrigated urban agriculture appears to be only commendable from the perspective of society if safe farming practices or other health risk reduction measures along the farm-to fork pathway can be put in place (IWMI 2006).

In the long run, irrigated open-space vegetable farming might eventually lose its economic advantage and significance for local markets due to improved infrastructure (cold transport and storage) and/or increased competition through food imports. Ghana's peri-urban poultry industry, for example, which supplied about 95 percent of the domestic demand in 1992, has today dropped down to a one-digit figure due to Ghana's continuously increasing imports of frozen poultry meat (Zachary 2004; Kudzodzi 2006).

[8] http://www.idrc.ca/pda/en/ev-24954-201-1-DO_TOPIC.html

[9] http://www.idrc.ca/pda/en/ev-50187-201-1-DO_TOPIC.html

[10] This did not limit the Government of Zimbabwe from banning open-space farms in Harare in June 2005 (The Mail & Guardian (SA) 2005).

Conclusions

In general, most urban lands have a higher monetary value than what conventional farming could provide, but there are always areas such as moist lowlands where farming is a competitive form of land use, contributing significantly to the urban supply with perishable crops. However, throughout the subregion, official recognition by the municipality is only slowly developing and support for the "informal" irrigation sector is still low. As a result, farmers have to cope with a variety of challenges usually uncommon in rural farming, such as a continuous risk of eviction or even prosecution. Despite lack of support, the phenomenon of urban farming continues, indicating the demand for urban agriculture as well as its high level of resilience.

International and regional networks and advocacy facilitate the increasing recognition of this sector. A case in point is the integration of informal irrigation and irrigated urban and peri-urban agriculture in Ghana's designated new national irrigation policy (Obuobie et al. 2006). The leading arguments in support of the recognition has as its base the vast extent of the informal irrigation sector in Ghana when compared with that of the formal one, its impact on livelihoods and the cities' dependence on urban produced perishable vegetables. The policy also addresses the concerns of the authorities about the common use of polluted water for irrigation. In fact, while access to water is a crucial requirement for year-round vegetable production, the marginal water quality affects throughout West Africa the official perception and sustainability of informal irrigation in urban and peri-urban areas. Authorities are requesting for concrete suggestions for health risk reduction, a challenge taken up by the research community (Redwood 2004; CPWF 2006).

To catalyze the general recognition of urban farming, it is recommended to analyze how it addresses the challenges the various urban authorities are facing. The results might differ from the conventional argumentation focusing on food supply and livelihood support. An innovative approach would be to quantify, for example, the possible contribution of irrigated urban farming to urban flood control, land reclamation, poverty alleviation, resource recovery, urban biodiversity, and savings in transport and infrastructure investments. There are only few quantitative data hitherto available on the tangible and intangible aggregate contribution of urban farming in general and irrigated urban farming in particular to the welfare of the African city.

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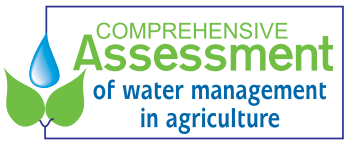

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