AGRICULTURAL MANAGEMENT,
MARKETING AND FINANCE
OCCASIONAL PAPER

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by
René van Veenhuizen
ETC-Urban Agriculture, Leusden, the Netherlands
George Danso
International Water Management Institute (IWMI), Ghana

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Preface

Urban agriculture (UA) is a dynamic concept that comprises a variety of livelihood systems ranging from subsistence production and processing at the household level to more commercialized agriculture. It takes place in different locations and under varying socio-economic conditions and political regimes. The diversity of UA is one of its main attributes, as it can be adapted to a wide range of urban situations and to the needs of diverse stakeholders.

UA or urban and peri-urban agriculture (UPA) as it is referred to in this paper, can make important contributions to social, economic and ecological objectives of sustainable urban development (SUD).

UA is increasing in cities in developed countries as well as in developing countries, and the number of cities revising existing policies or formulating new policies and action programmes on UA is growing rapidly (van Veenhuizen, 2006). However, many urban farmers around the world operate without formal recognition of their main livelihood activity and lack the structural support of proper municipal policies and legislation. Appropriate policies and regulations are required to enhance the potential of agriculture in cities and mitigate its potential risks. The challenge is for UPA to become part of SUD and to be valued as a social, economic and environmental benefit rather than a liability.

To support this development, an overview is provided of the role and importance of UPA on the basis of three studies. In 2002, two assessments of the profitability and sustainability of urban farming were undertaken for the Food and Agriculture Organization of the United Nations' (FAO) Rural Infrastructure and Agro-Industries Division (AGS), by the International Water Management Institute (IWMI) (Ghana Office) and the French Agricultural Research Centre for International Development (CIRAD). These studies were carried out in selected urban and peri-urban sites in Ghana, West Africa (Gyiele *et al.*, 2002) and in Thailand, Asia (Vagneron *et al.*, 2002). The studies attempted to contribute to a greater understanding of issues and opportunities characterizing intra-urban and peri-urban farming from a long-term perspective. In a third study, Danso *et al.* (2003) sought to identify and typify urban farming systems (UFSs) and discuss indicators to measure and assess profitability and sustainability of urban farming, with a focus on Africa.

FAO requested ETC-Urban Agriculture to integrate the results of the three studies, putting them in a wider context, using additional published and unpublished information available at the International Network of Resource Centres on Urban Agriculture and Food Security (RUAF), and also to appraise aspects on policy. Hence, no new field research was undertaken, but the study by Danso *et al.* (2003) as well as recent publications and information on the profitability and sustainability of farming in UPA sites, mainly in Africa and Asia (available at RUAF-ETC), have been incorporated and put in a broader context in this paper. More insights and discussion are certainly necessary. Coordination and improvement of further research

on the multiple functions of UA and monitoring of its impacts are recommended to provide municipalities and other city stakeholders with proper information and tools to include UA into sustainable city development.

Acknowledgements

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Acronyms

AUA	Advocates for Urban Agriculture, United States
ANUMI	African Network of Urban Management Institutions, Zimbabwe
CBO	Community Based Organization
CFAF	Currency of French-speaking Western African Countries
CFP	Cities Feeding People
CGIAR	Consultative Group on International Agricultural Research, United States
CIRAD	French Agricultural Research Centre for International Development
CREPA	Regional Centre for Potable Water and Sanitation at Low Cost, Burkina Faso
CTA	Technical Centre of Agricultural and Rural Cooperation, The Netherlands
DFID	Department For International Development, United Kingdom
DGIS	Directorate General for International Cooperation, The Netherlands
DSE	German Foundation for International Development
FAO	Food and Agriculture Organization of the United Nations, Italy
FSA	Farming Systems Analysis
GDP	Gross Domestic Product
GNI	Gross National Income
GNP	Gross National Product
GTZ	German Agency for Technical Cooperation
IDRC	International Development Research Centre, Canada
ITDG	Intermediate Technology Development Group, United Kingdom
IWMI	International Water Management Institute, Sri Lanka
LED	Local Economic Development
MDGs	Millennium Development Goals
MENA	Middle Eastern and North African countries
NGO	Non-Government Organization
NRI	National Resources Institute, United Kingdom
PAIA	Priority Area for Interdisciplinary Action
RUAF	International Network of Resource Centres on Urban Agriculture and Food Security
SGUA	Support Group for Urban Agriculture, Canada
SIUPA	Strategic Initiative on Urban and Peri-Urban Agriculture
SSA	Sub-Saharan Africa
SUD	Sustainable Urban Development
TFPC	Toronto Food Policy Council, Canada
TUAN	The Urban Agriculture Network, United States
UA	Urban Agriculture
UAAC	Urban Agriculture Advisory Committee
UAM	Urban Agriculture Magazine
UFS	Urban Farming System

UMP	Urban Management Programme
UN-HABITAT	United Nations Human Settlements Programme, Kenya
UNDP	United Nations Development Programme, United States
UPA	Urban and Peri-Urban Agriculture
WHO	World Health Organization, Switzerland
WSSD	World Summit on Sustainable Development

Executive Summary

With the increase in urban poverty, food insecurity and malnutrition shifting from rural to urban areas, renewed interest arises in alternative strategies for improving urban livelihoods, local governance, urban design, local economic development (LED) and waste management, as well as for urban food security and nutrition. Many citizens have turned to UA as a livelihood strategy and source of income for a substantial number of urban households. It is estimated that 200 million urban residents produce food for the urban market, providing 15 to 20 percent of the world's food (Armar-Klemesu 2000).

To a large extent, UA complements rural agriculture and increases the efficiency of the national food system. UPA can make important contributions to social, economic and ecological objectives of SUD. This development is strongly influenced by the dynamics of the urban social, economic, political, ecological and spatial systems with which it is connected. Consequently, there is a great variety in UFS and the people involved. These systems adapt to the city's continuously changing local conditions and UA takes on new functions.

UPA can be defined as a form of urban 'shifting cultivation', but this definition is only one of many. The various definitions though, only capture part of the reality and often suffer from a lack of clarity. Further available data on UPA do not allow for comparisons between cities, hence it is suggested that a definition be sought that not only serves research purposes, but will form a sound basis for identifying adequate development strategies, action planning and policy development.

Increasingly, UPA is seen as part of SUD. Many national and local authorities have come to understand the role urban farmers can play in various urban policy areas such as LED (production, employment and income generation, enterprise development), health (food security and nutrition, food safety); urban environmental management (urban greening, climate and biodiversity; waste recycling; reducing ecological footprint of the city), and social development (poverty alleviation, social inclusion of disadvantaged groups, HIV-AIDS mitigation, recreation and education). However, UA may have risks for health and to a minor degree, the urban environment. Of course, as in rural areas, agriculture in the city needs proper management and support to minimize health and environmental risks. In addition, urban farmers often lack tenure security, critical information on the best farming practices and available support services. While political support for UA has been steadily increasing, financial support for urban growers has been more limited.

UA must be understood as a permanent and dynamic part of the urban socio-economic and ecological system, using typical urban resources, competing for land and water with other urban functions, influenced by urban policies and plans, and contributing to urban social and economic development. The integration of UA into the urban land use system and the creation of a favourable policy environment are critical steps in the development of the sector.

The paper will discuss policy development and action planning needed for the sector. The formal acceptance of UA as urban land use, integrated in urban development and land use plans as well as creating a conducive policy environment, are crucial steps towards effective regulation and facilitation of UA development. Efforts should be made by multi-stakeholders to find effective ways to integrate UA into urban sector policies and urban land use planning, and to facilitate the development of safe and sustainable UA. Some of the other recommended actions that can be taken to improve UA include:

- Supporting the establishment and strengthening of urban farmer organizations.
- Reviewing and adapting existing policies and by-laws on UA in order to identify and remove unsubstantiated legal restrictions on UA and to integrate more adequate measures to effectively stimulate and regulate the development of sustainable UA.
- Integrating UPA into urban planning and policymaking, by characterizing the specific urban context and different types of UPA.
- Facilitating access by urban farmers to available urban open spaces. Access to suitable and adequate land within a conducive legislative framework will ensure sustainable UA.
- Increasing the attention to agriculture in the urban environment through agricultural research and supporting urban farmers in improving extension and facilitating training and education activities.
- Enhancing the productivity and economic viability of UA by improving access of urban farmers to training, technical advice, services and credit. Additional measures should be taken to reduce the health and environmental risks associated with UA.
- Supporting more economic-oriented urban farming (market-oriented, entrepreneurial).
- Supporting innovation in urban livelihoods in which agriculture usually complements other employment.

It is expected that this paper will foster reflection on the role of UA in SUD and in the enhancement of urban food security and poverty alleviation at the national and local levels in developing countries. Subsequent discussions concern how the dynamism and diversity of UA can be sustainable and respond to urbanization processes and other urban dynamics. UA will be sustainable especially if its potential for multi-functional land use is recognized and fully developed. The sustainability of UA is strongly related to its contributions to the development of a sustainable city; an inclusive, food-secure, productive and environmentally healthy city.

This paper aims to provide pertinent information on profitability and sustainability of UA to a wide audience of managers and policymakers from municipalities, ministries of agriculture, local government, Non-Governmental Organizations (NGOs), donor organizations and university research institutions. It aims to highlight the benefits of linkages between agriculture and the urban environment, leading to a more balanced understanding of the conflicts and synergies. It examines how UA can contribute substantially to the Millennium Development Goals (MDGs), particularly in reducing urban poverty and hunger (MDG 1) and ensuring environmental sustainability (MDG 7).

1. Introduction

> *To manage a city is to attempt to manage something spontaneous. Cities emerge, grow, and evolve as a result of vast numbers of individual decisions about where to live, work, locate a firm, source suppliers, recreate, get educated and so on… It is interconnections that make a city attractive… (Chris Webster, in Van Dijk, 2006)*

UA can be defined as the growing of plants and the raising of animals for food and other uses within and around cities and towns, and related activities such as the production and delivery of inputs, processing and marketing of products.

Ensuring food security and appropriate nutrition of the urban population, in particular of the poorest households, has become a tremendous challenge in many cities in developing countries. Cities are therefore among the principal territories for intervention and planning of strategies that aim to eradicate hunger and poverty and improve livelihoods.

Growing poverty, hunger and lack of formal employment opportunities, as well as the special opportunities provided by the city – including the growing demand for food, proximity to markets and availability of cheap resources such as urban organic wastes and wastewater – have stimulated the development of diverse agricultural production systems in and around cities. These systems are often specialized in perishable products, such as green leafy vegetables, milk, eggs and meat, and exploit vacant open spaces. This development has important potential and responds to some of the key challenges facing the cities (see section 2.1). However, UA may also have negative effects, however, if certain associated risks are not considered and proper preventive and guiding measures not taken (see sections 2.1 and 3.2).

The development of UA is strongly influenced by the dynamics of the urban social, economic, political, ecological and spatial systems with which it is connected. UA adapts to new economic and spatial conditions. Consequently, there is a great variety in UFSs, people involved and their relations. These systems adapt to the continuously changing local conditions of the city where UA takes on new functions. A major function of UA is and will always be food supply and income generation in the cities, but increasingly, UA also plays a role in environmental, landscape and biodiversity management and in providing recreational services, among others. This flexibility and multi-functionality of UA will likely determine its sustainability in the long- term.

1.1 Urban agriculture on the policy agenda

The attention given to UA has grown quickly over the past decade, both on the international development agenda and in terms of policy recognition and project implementation by national and city authorities and NGOs.

In 1991, the United Nations Development Programme (UNDP) established the Urban Agriculture Advisory Committee (UAAC) , which in 1992 resulted in the establishment of the Support Group on Urban Agriculture (SGUA). Participants in SGUA include representatives of the International Development Research Centre (IDRC), UNDP, FAO, the Directorate General for International Cooperation, Netherlands (DGIS), the French Agricultural Research Centre for International Development (CIRAD), ETC Foundation, Urban Harvest (Consultative Group on International Agricultural Research [CGIAR], International Water Management Institute (IWMI), German Agency for Technical Cooperation (GTZ) and The Urban Agriculture Network (TUAN), who have met irregularly since 1992. The SGUA has been identifying key research and development needs in UA and how to coordinate and pool support from SGUA participants.

Since the early 1990s, IDRC has been actively supporting policy-and action-oriented research on UA through its Cities Feeding People (CFP) programme and its AGROPOLIS programme. Many research reports and publications produced by CFP have been published on the IDRC website (www.idrc.ca). In 1996, UNDP published the well-known book Urban Agriculture, edited by Smit et al. In 1999, the German Foundation for International Development (DSE) and the Technical Centre for Agricultural and Rural Cooperation (CTA), the Netherlands, in cooperation with ETC and the German Agency for Technical Cooperation (GTZ), organized the international conference on 'Growing Cities Growing Food' in Havana, Cuba, which marked an international breakthrough and led to more policy attention at the international, national and local levels

The FAO has been working on UA, notably since the Committee on Agriculture (15th Session) of FAO in 1999, which recommended the establishment of an inter-departmental initiative on UA. This initiative later became part of FAO's Priority Areas for Interdisciplinary Action (PAIA) under the heading 'Food for the Cities'. Among others, it resulted in the publication of a briefing guide on UPA (FAO, 2001a). Subregional workshops and seminars on UA were organized in Stellenbosch, South Africa (2001), Bangkok, Thailand (2001 with City Net), Addis Ababa, Ethiopia (2002, with the World Bank) and Nairobi, Kenya (with UN Habitat, IDRC, RUAF and Urban Harvest). National workshops on UPA were implemented in various countries, including Botswana, Congo, Côte d'Ivoire, Guinea, Bolivia and Namibia, among others, often in combination with technical support in baseline studies and project formulation. FAO has also been commissioning studies on aspects of UA including hydroponics, micro-technologies and urban forestry, leading to available FAO on-line publications. In 2006, FAO, IDRC and RUAF cooperated in a comparative study and the development of urban producers organizations and their influence in local policies and regulations.

The Urban Management Programme (UMP) of UN-HABITAT and UNDP, especially through its Latin American Office, has been working with municipalities in the region on the integration of UA in urban policies and planning (see the Quito Declaration of 2000). The experiences gained in these cities have been systematized and resulted in a number of policy briefs on UPA, available at www.ipes.org. Recently, this effort has also been taken up by the African Network of Urban Management Institutions (ANUMI), for example, in the Harare Declaration of 2004. (Both declarations can be found at www.ruaf.org.)

Since 1999, RUAF partners , the International Network of Resource Centres on Urban Agriculture and Food Security, funded by DGIS and IDRC and coordinated by ETC, have

been playing a crucial role in facilitating international exchange of experiences on UA , implementing regional and local training, as well as promoting multi-actor policy development and action planning on UA in various parts of the world with a focus on 20 pilot cities. RUAF organized international e-conferences with FAO (Urban Agriculture on the Policy Agenda in 2000), CGIAR's Urban Harvest (Appropriate Methods for Urban Agriculture, 2001), IWMI (Agricultural Use of Urban Wastewater, 2001) and UN-Habitat (Optimizing Agricultural Land Use in the City Area, 2002). They also held regional workshops: in Ouagadougou with Centre Régional pour l'Eau Potable et l'Assainissement à Faible Coût (CREPA, Regional Centre for Potable Water and Sanitation at Low Cost) and CTA (Reuse of Waste Water, 2003); in Nairobi with National Resources Institute (NRI), the Department for International Development, United Kingdom (DFID) and CTA, (Urban Livestock, 2004); and in Cape Town/Johannesburg with CTA, (Urban Micro-farming and HIV-AIDS, 2005). Many publications can be found on the www.ruaf.org website, which also includes the Urban Agriculture Magazine (UAM). In 2006, the RUAF Partners published the book, 'Cities farming for the future – urban agriculture for green and productive cities'.

1.2 Aims and structure of this study

Despite increasing attention and the growing number of cities interested in action programmes on UA, both in developed and developing countries, UA still remains a relatively new field of research. It is generally agreed that it can make important contributions to SUD, but debates continue on its viability, relationship to pollution, and its contribution to urban economic development, as well as its need for political support.

The second chapter introduces UA, the concept, its most outstanding features, its regional presence, and provides a short description of its main potentials and risks. Subsequent discussions concern how the dynamism and diversity of UA relates and responds to urbanization processes and other urban dynamics. The chapter ends with a discussion on methodological problems encountered in FAO studies and during the preparation of this document. The third chapter first reviews the criteria and methods used by authors to measure the economic impacts of UA. Outcomes of the reviewed studies on the economic impacts of UA are then presented, first at the household level and then at the city level. The last section of the chapter further discusses the sustainability of UA. The need for adequate support to UA is the focus of the fourth chapter, which indicates the main areas of focus when developing (municipal) policies on UA. The final chapter summarizes the main conclusions and recommendations of this paper.

2. Urban and peri-urban agriculture

This chapter will discuss UA, the concept, its most outstanding features and its regional presence. A short overview of its main potentials and risks (some of which will be discussed further in chapter 3) will also be provided after characterizing UPA, how the diversity of UA and its dynamics relate and respond to urbanization processes and other urban dynamics. The third section discusses some methodological issues encountered during the preparation of this report. Following the study by Danso *et al.* (2003), this study initially set out to describe and compare the profitability and sustainability of selected UFSs. On reviewing available literature, however, it was observed that the criteria used to classify and describe the local UFSs were not always given, or vary considerably according to author. A number of typologies on UA are examined.

2.1 Characterization of urban agriculture

UA as defined in the introduction can be subdivided in intra-urban and peri-urban agriculture.

Intra-urban agriculture takes place within the inner city. Most cities and towns have vacant and under-utilized land areas that are or can be used for UA, including areas not suited for building (along streams, close to airports, etc.), public or private lands not being used (lands waiting for construction) that can have an interim use, community lands and household areas.

Various types of UA can be observed; community gardens (formal and informal), home gardens, institutional gardens (managed by schools, hospitals, prisons, factories), nurseries, roof top gardening, cultivation in cellars and barns (e.g. mushrooms, earthworms). Research data seem to indicate that intra-urban agriculture tends to be more small-scale and more subsistence-oriented than peri-urban agriculture, although exceptions can regularly be found (e.g. vegetable production and production of mushroom or ornamental plants).

Peri-urban agriculture takes place in the urban periphery. Peri-urban areas tend to undergo dramatic changes over a given period of time, there is an influx of people from both rural and urban areas, population density increases, land prices tend to go up and multiple land use emerges. Such changes effect the agricultural production systems, which tend to become smaller scale with more intensive production, and shift from staple crops towards more perishable crops and animal production (meat, eggs, milk). In addition, in peri-urban agriculture, many types of agriculture may be distinguished depending on size, capital intensity and technology used, crop mix and degree of market-orientation, among others; it is often dominated by irrigated vegetable production (see Potutan *et al.*, 2000 for Cagayan de Oro, Philippines; Danso, 2001 for Kumasi, Ghana). Experiences in various parts of the world including Cuba, Argentina, Lebanon and Viet Nam seem to indicate that farm enterprises located in the fringe of the city are on average larger than those in the city centres and more strongly market-oriented.

Urban and peri-urban agriculture (UPA) – a permanent part of the urban system

Several researchers have tried to clearly distinguish between UPA and rural agriculture. Criteria used to make such distinctions include closeness to the city centre, inclusion in the administrative municipal boundaries and type of products grown (Mougeot, 2000; de Zeeuw, 2004).

After reviewing the related literature, Mougeot (2000) concludes that the most important distinguishing feature of UA is not so much its location, or any of the above-mentioned criteria, but the fact that it is an integral part of the urban economic, social and ecological system. It uses urban resources such as land, labour, urban organic wastes, water and produces for urban citizens. Further, it is strongly influenced by the urban conditions such as policies, competition for land, urban markets and prices, and makes a strong impact on the urban system (urban food security and poverty, urban ecology and health).

This explains how Mougeot (2000) came to define UA:

> *'Urban agriculture is located within (intra-urban) or on the fringe (peri-urban) of a town, a city or a metropolis, and grows or raises, processes and distributes a diversity of food and non-food products, (re-)uses largely human and material resources, products and services found in and around that urban area, and in turn supplies human and material resources, products and services largely to that urban area.'*

Although some forms of UPA are based on a temporal use of vacant lands, UA is a permanent feature of many cities in developing and developed countries, and thus an important component for sustainable city development.

Urban farmers

There is a wide variety of urban farmers. Although many urban farmers are from the poorer strata of the population, one can often observe lower and mid-level government officials, school teachers involved in agriculture, as well as richer people seeking good investment for their capital, or for leisure. Some urban farmers are recent immigrants, but contrary to popular belief, more often than not urban and peri-urban farmers have already lived in the city for long periods of time and gained access to urban land, water and other productive resources (see e.g. Drakakis-Smith *et al.*, 1995; del Rosario, 1999). Further there are many who are not from rural backgrounds, but who choose agriculture as one of their livelihood strategies.

Women represent an important portion of urban farmers since they tend to have most of the responsibility for feeding the households, while men tend to seek other urban employment. If the plot is close to home, farming activities can be more easily combined with their other tasks in the household, which is not the case with other jobs that often require travelling to the city centre, industrial areas or 'better off' residential areas. Women often face more difficulties in accessing resources and services or cultural constraints, which further limit their ability to contribute more to UPA (Danso *et al.*, 2003).

Urban farmers can operate on an individual or family basis, formally or informally, and be organized in a group, cooperative or other types of farmer organizations. According to Smit (UNDP, 1996) approximately 800 million urban citizens worldwide are involved in UA in some way. Sixty-eight percent of the households are reported to be involved in Dar es Salaam, Tanzania (Sawio, 1998); 35 percent in Kampala, Uganda (Maxwell, 1999), 22 percent in Amman, Jordan (Department of Statistics, 2002) and 40 percent in Havana, Cuba (Lappe, 2002; FAO, 2001).

Regional differentiation of urban agriculture

An FAO-implemented study (2001) provides estimations per region of urban-based agriculture, as well as the population and main crop and livestock systems involved (Table 1).

Table 1: Urban farming per region

Region	Agriculture population (% of region)	Principal livelihoods	Characteristics
Sub-Saharan Africa	3	Fruit, vegetables, dairy cattle, goats, poultry; off-farm work	Heterogeneous and dynamic; it is estimated that in some cities, 10 percent of the population are engaged in UPA
Middle East and North Africa	6	Horticulture, poultry, off-farm work	Fruit and vegetables; small contribution to income
South Asia	1	Horticulture, dairy, poultry and other activities	Often seen as a livestock- based farming system
East and South East Asia	1	Horticulture, dairy, poultry and other work	Milk and vegetables, often commercial
Latin America and the Caribbean	3	Horticulture, dairy, poultry	Focuses on high-demand perishable products; limited space requirements
Eastern Europe and Central Asia	7	Vegetables, poultry and pigs	Recently grown in importance; mainly for own consumption, with occasional selling

Source: FAO, 2001.

In sub-Saharan Africa (SSA), it is estimated that ten percent or more of the urban population is active in UA (around 11 million people).[1] Urban farming in this region is found to be very heterogeneous, ranging from small-scale, but capital-intensive, market-oriented commercial vegetable growing or dairy farming, to part-time subsistence farming by the urban poor. The study concludes: 'Overall, this is a very dynamic farming system that has considerable growth potential' (FAO, 2001). In Northern Africa and the Middle East region, approximately six million urban residents are engaged in small-scale production of horticultural and livestock

1 This estimate is low compared to those provided by other sources (e.g. Smit, 1996). One likely reason is that FAO estimates refer to households officially registered as farmers, which is normally only a small fraction of all urban producers.

products – notably fruit, vegetables and poultry –in addition to off-farm work. In south Asia, 11 million urban residents are involved in UPA, including intensive production of perishable high-value commodities such as milk and fresh vegetables. In this region, UPA contributes substantially to food security in the cities. In most large towns and cities throughout East and Southeast Asia, seven million people were engaged in UA activities, notably in intensive production of perishable, high-value commodities. The farming system was characterized as a high external input, commercial system with well-functioning links to the surrounding rural areas for livestock, feed and fodder supplies. In Latin America, urban agricultural systems include mainly horticulture, dairy and poultry. In Eastern Europe, farming is widespread by urban residents, but mostly for consumption (fruits, vegetables, pigs).

Box 1. The Millennium Development Goals

World leaders and member states of the United Nations have agreed on an agenda for reducing poverty and improving livelihoods, MDGs. The agenda consists of eight main MDGs specified in 18 development targets: each goal has a target figure, most set for 2015, using 1990 as a benchmark, and indicators designed to monitor the extent to which the target has been achieved. The different targets are not specified for rural and urban areas. UA is an important, complementary strategy to achieve MDG 1 (Eradicate extreme poverty and hunger), MDG 3 (Promote gender equality and empower women), MDG 6 (Combat HIV-AIDS and other diseases) and MDG 7 (Ensure environmental sustainability). UN-HABITAT's Urban Management Programme and the Urban Millennium Partnership aim to support cities and local actors in developing adequate intervention strategies (see www.unhabitat.org).

Potentials of urban agriculture

UA can contribute substantially to the MDGs, particularly in reducing urban poverty and hunger (MDG 1) and ensuring environmental sustainability (MDG 7).

In sum, the main potentials of UA are as follows:

a. Urban food security and nutrition

The contribution of UA to food security and healthy nutrition is probably its most important asset. Food production in the city is often a response of the urban poor to inadequate, unreliable and irregular access to food and lack of purchasing power. In urban settings, lack of income translates more directly into lack of food than in rural settings. The costs of supplying and distributing food from rural areas to the urban areas, or to import food for the cities, are rising continuously, and distribution within the cities is uneven. As a consequence, urban food insecurity will increase (Argenti, 2000).

In addition to enhanced food security and nutrition of urban producers themselves (Nugent, 2000 and Bourgue, 2000), large quantities of food are produced for other categories of the population. It is estimated that 200 million urban residents (FAO, 1999) produce food for the urban market providing 15 to 20 percent of the world's food (Armar-Klemesu, 2000).

b. Local economic development

UA is an important source of income for a substantial number of urban households (see chapter 3). In addition to income from sales of surpluses, farming households save on household expenditures by growing their own food, which can be substantial since poor people generally spend a sizeable part of their income (50–70 percent) on food. UA also enhances the development of micro-enterprises in the production of necessary agricultural inputs (e.g. fodder, compost, earthworms), the processing, packaging and marketing of products (Homem de Carvalho, 2001) and the provision of services such as animal health services, transportation (Moustier and Danso, 2006).

c. Social impacts

UA may function as an important strategy for poverty alleviation and social integration of disadvantaged groups (e.g. HIV/AIDS-affected households, disabled people, female-headed households with children, elderly people without pensions, jobless youth), with the aim to integrate them more strongly into the urban network, provide them with a decent livelihood, and prevent social problems such as drugs and crime (see Garnett 2000; Gonzalez Novo and Murphy, 2000). Urban and peri-urban farms may also assume an important role by providing recreational and educational activities to urban citizens or in landscape and biodiversity management and community building (Smit and Bailkey, 2006).

d. Contributions to urban environmental management

Waste disposal has become a serious problem for most cities. UA can contribute to solving this and related problems by turning urban wastes into productive resources (Cofie *et al.,* 2006): compost production, vermiculture, irrigation with wastewater. UA and forestry may also positively impact on the greening of the city, the improvement of the urban micro-climate (wind breaks, dust reduction, shade) and the maintenance of biodiversity (Konijnendijk, 2004). They may also reduce the city's ecological footprint by producing fresh foods close to the consumers, thereby reducing energy use for transport, packaging and cooling, among others.

Risks associated with urban agriculture

UA may also have negative effects if certain associated risks are not considered and proper preventive and guiding measures not taken. The main risks are briefly summarized below (see also section 3.2).

a. Health risks

Review of the available literature indicates that although insight into the potential health risks of UA is growing, detailed information on the actual health impacts of UA is still scant (Obuobie *et al.*, 2006). The associated health risks of UA should be taken seriously and a number of actions carried out (see section 3.3), including adequate regulating and preventive measures. To avoid exaggerated reactions, however, the fear of contaminated food and other health risks associated with UA should be compared with those of rural agriculture.

The main health risks associated with UA can be grouped into the following categories (Birley and Lock, 2000):

- *Contamination of crops with pathogenic organisms* caused by irrigation that uses water from polluted streams, or inadequately treated wastewater, or to the unhygienic handling of the fresh products during transport, processing and marketing;

- *Human diseases* transferred from disease vectors attracted by agricultural activity such as breeding of mosquitoes; plague, lime and tick-born diseases
- *Contamination of crops and/or drinking water by residues* of agrochemicals (fertilizers, pesticides, fungicides);
- *Contamination of crops by heavy metals* from contaminated soils, air or water caused by heavy traffic and industry;
- *Transmission of diseases from domestic animals* to people (zoonosis)
- *Occupational health risks,* for example, through improper handling of agrochemicals and untreated wastewater in food production and food-processing industries.

b. Negative environmental impacts

UA may contaminate local water sources if large amounts of chemical fertilizers and pesticides are used. Also, the excessive use of nitrate-rich manure, such as chicken or pig manure can contaminate groundwater. In particular, wastewater discharge from intensive poultry farms can carry heavy loads of micro-organisms and may contaminate drinking water supplies. Further, under certain situations, inappropriate farming practices may lead to reduction of vegetation and siltation of water bodies (Bowyer-Bower, T. & Drakakis-Smith, D. 1996). Because of the undervaluation of UA and stiff competition for land, UA is often pushed back to marginal areas within the city, such as wetlands and hill slopes, where it may harm the fragile ecosystems if not properly guided.

Differences between urban and peri-urban agriculture (UPA) and rural agriculture

Researchers and planners have gradually come to recognize that there is no clear border between urban and rural areas and that it is more realistic to think in terms of a continuum of rural and urban features, both in the physical and organizational sense. Several authors have shown that UA to a large extent complements rural agriculture and increases the efficiency of the national food system since it provides products that rural agriculture cannot supply easily (for example, perishable products, products that require rapid delivery upon harvest), can be a substitute for food imports, and can release rural lands for the production of export commodities.

However, differences between urban and rural agriculture are not negligible. Table 2 shows frequently encountered differences between UPA and rural agriculture, which have important consequences for the design of policies and support programmes.

2.2 Dynamics of urban agriculture

The development of UA is strongly influenced by the dynamics of the urban social, economic, political, ecological and spatial systems with which it is connected.

Rapid urbanization

People increasingly live in and around cities throughout the world. In 'State of the World Cities'(2004/2005), UN-HABITAT predicts that by 2030, 60 percent of the world's population will live in cities. The growth of cities, or urbanization, is caused by migration from the rural areas added to the cities' natural growth of the urban population (Drescher and Iaquinta, 1999). The latter is gradually becoming the dominant one in most cities.

Table 2: Agriculture in rural and urban situations

	Rural agriculture	Urban and peri-agriculture (UPA)
Farm types	Conventional; farms consisting of interdependent subunits	Unconventional; partly mobile; partly without soil; more specialized independent units acting in cluster/chains
Livelihood	Faming is a primary livelihood; farmers engaged full-time	Farming is often a secondary livelihood; farmers often work on a part-time basis only
Farmer type	Usually 'born farmers'; Strong traditional knowledge	Some are 'beginners': urban citizens engaging in agriculture by necessity or by choice (entrepreneurs); others are recent migrants with weak traditional knowledge
Products	Mainly staple crops; cattle, sheep	Perishable products, especially green vegetables, dairy products, poultry and pigs, mushrooms, ornamental plants, herbs, fish etc.
Cropping calendar	Seasonal periods	Year-round growing of crops (irrigated)
Production factors	Low land price; lower costs of labour; high costs of commercial inputs; variable cost of water	High land price, land scarcity; higher costs of labour; lower costs of commercial inputs; high cost of clean water; availability of low-cost organic wastes and wastewater
Farmer organization	Often already in place and more easy to accomplish since farmers share same social background	Often lacking and more difficult to accomplish since farmers are dispersed and are from greatly varied social backgrounds
Social context	Community; most families engaged in farming and share a common social background; more homogeneous; relatively stable; few external stakeholders; farmers are more organized	Urban farmers often undertake activities outside their own neighbourhood. The percentage of households engaged in farming in a neighbourhood is highly variable. Urban farmers vary in socio-cultural backgrounds. Highly dynamic environment with strong fluctuations; many external stakeholders with different interests and contrasting views on UA; farmers are hardly organized
Environmental context	Relatively stable; land and water resources rarely polluted	Fragile; often polluted land and water resources
Availability of research and extension services	More likely (although declining)	Hardly available, but individuals may gain direct access to libraries, research organizations, market information, etc.
Availability of credit services	More likely (although possibly for larger farmers and mainly men)	Hardly available, but credit services for the informal sector are available and might assist farmers too, including women
Market	Distant markets; marketing through chain; low degree of local processing	Closeness to markets; direct marketing to customers possible; higher degree of local processing (including street foods)
Land security	Relatively high	Insecure; often informal use of public land; competitive land uses

Source: De Zeeuw, 2004.

Urban agglomerations and their resource uses are becoming the dominant feature of the human presence on earth, profoundly changing humanity's relationship to its host planet and its eco-systems. Massive and rapid urbanization takes place predominantly in urban areas of the world's least developed regions. The 'State of the World Cities' shows important regional differences in the urbanization process.

Latin America as of 2005 is the most urbanized region in the developing world, 75 percent, or 391 million, of its people live in cities. It is estimated that by 2020 the urban population in the region will approach 539 million, or 81 percent, of its projected total population of 665 million. With the exception of Brazil, the urbanization pattern in most countries in the region typically involves one very large city that accounts for much of the country's urban population. In 2005 in SSA, urban areas account for 34 percent of the total population of 611 million, which will approach 440 million, or 46 percent of its projected total of 952 million, by 2020. Global economic processes have stalled in SSA, while the urban population is quickly growing, bringing severe consequences for livelihoods in urban areas. In Asia and the Pacific, urban areas accounted for 35 percent in 2005; this is expected to grow to 46 percent in the next 15 years. An increasing number of the region's poor live in urban areas.

Urbanization of poverty and food insecurity

City authorities around the world face enormous challenges in creating sufficient employment, providing basic services such as drinking water, sanitation, basic health services and education, as well as planning and maintaining open green spaces. Other challenges include managing urban wastes and wastewater, as well as social inclusion, decentralization and local autonomy, among other issues.

UN-HABITAT calculated that in 2001, nearly 32 percent of the world's urban population lived in irregular settlements without sufficient access to decent food, shelter, water and sanitation, and predicted that in the next 30 years the number of slum dwellers worldwide will increase to two billion if no action is taken (UN-Habitat, 2001).

Many cities cannot cope with the massive growth of its population, which leads to a decrease in urban shelter and security of tenure, backlogs in delivery of basic services, increasing inequality and segregation, degradation of the urban environment, and increase in poverty, malnutrition and food insecurity. In many countries, the situation is aggravated by a very unstable macro-economic and/or political situation.

As urbanization develops, there is an increase in urban poverty, food insecurity and malnutrition, shifting from rural to urban areas. Urbanization of poverty occurs everywhere, but is deeper and more widespread in developing countries. For instance, a massive 40 percent of the population of Mexico City, Mexico, and one-third of the population of São Paulo, Brazil, is at or below the poverty line. In 2001, there were 128 million slum dwellers in Latin America and the Caribbean (14 percent of the world's total), 187 million in Africa (20 percent) and 554 in Asia (or 60 percent). People without resources and social networks are most vulnerable to food insecurity. Food has become increasingly difficult to access for the urban poor, especially in the bigger cities (Mougeot, 2005).

The size and urgency of these challenges require innovative ways of managing cities and their related infrastructure and service requirements. There is a renewed interest in alternative strategies for improving urban livelihoods, local governance, urban design, LED and waste management, as well as for urban food security and nutrition.

Urban sprawl

The rapid urbanization process also accelerates the extension of the city into the rural areas, bringing ever larger areas under the direct influence of the urban centres. In the formerly rural areas, now peri-urban areas, the following changes are gradually becoming more intense:

- Rural customary land rights slowly get pushed aside or dominated by urban statutory rights.
- Traditional systems for land distribution are disrupted by urban newcomers seeking to buy land (for speculation; mining of loam, sand and stones; infrastructure development; construction; more urbanized types of agriculture).
- Competition for land of prices and land sales increases; social cohesion is weakened.
- Some farmers give up farming, sell their land and switch to other income-earning activities; in other households, generally the men have urban jobs, while women become responsible for the farming operations.
- There is an increase of land subdivision. and both formal and informal house construction (ownership and rental).
- Some farmers start to intensify their farming systems and adapt to the new, increasingly urban conditions – i.e. change crops, become more market-oriented, use new technologies such as production under cover, take up direct marketing or processing; and use urban organic wastes or wastewater.
- There is an increase of urban power groups and land-grabbing, invasions by urban poor seeking land for housing and subsistence farming, etc.
- Areas become part of the administrative city area and must comply to urban norms and regulations.
- Environmental problems (soil and water pollution) increase.

Other city dynamics

The city is in a constant process of building and decay. Open spaces get built on and their formal or informal temporary users become evicted (as is regularly happening to many urban farmers); they are forced to find an alternative location or give up farming. Meanwhile, degenerated residential, office or industrial areas are demolished, creating new open spaces that may stay vacant for a long time until given a new use and the required investments become

available. New roads and power lines are built, creating new vacant open spaces. Often, such newly created open spaces are gradually occupied by urban producers (informal occupation or temporary leases).

The above explains how, to a certain extent, UA can be characterized as 'shifting cultivation' (Drechsel *et al.*, 2006) since, although a permanent element of the urban system, its locations within the city may vary over time. Some cities even formalize this by making lease agreements with organized farmer groups, allowing temporary use for longer periods. They may also provide alternative lands (often also on a temporary basis) when these sites are needed for other purposes before the lease ends and encourage private and institutional owners of vacant open spaces in the city to do the same (e.g. through tax incentives). This dynamic puts a high value on continuous technological innovation to maintain or enhance productivity and sustainability (van den Berg and van Veenhuizen, 2005; Prain, 2006).

Pollution from urban traffic and industry may force UA to move to sites further away from the sources of pollution or make adaptations in the farming (e.g. crop choices, irrigation methods, etc.). A good example is shown by urban farmers along the Musi River in Hyderabad, India, where river water used for irrigation increasingly became polluted and within a short period, farmers shifted from vegetables and rice growing to fodder and tree crops (Buechler and Devi, 2006)

Other city dynamics that directly influence UA development, where and how it is carried out and by whom, result from: changes in access to organic wastes and wastewater produced by the city; new demands from urban citizens (e.g. the need for recreational spaces, new products); changes in urban zoning and related norms and regulations; and shifts in the urban labour market, among others.

Urban agriculture as a response to urban dynamics and challenges

UA is a response to the urban dynamics in three main ways:

- The urban poor and unemployed respond to these urbanization processes and the related growth of urban poverty and food insecurity/malnutrition by turning to UPA.

- The urban environment provides opportunities and relative advantages for producers: direct access to urban consumers and markets, availability of cheap inputs such as urban organic wastes and wastewater, closeness to institutions that provide market information, credit and technical advice. etc.

- Through conducive urban policies, norms and regulations, UA can fulfil certain functions required for sustainable city development (in addition to food supply and income generation: recycling, greening, buffer zones, land management, recreational services, mitigation of HIV-AIDS, social inclusion), depending on local needs and development priorities.

Despite urbanization, UA persists in the city, even in city centres, and adapts to new economic and spatial conditions. Consequently, there is a great variety in UFSs and the people

involved. These systems adapt to the city's continuously changing local conditions, and UA takes on new functions. Food supply and income generation remain a major function, but increasingly UA also operates in environmental management, landscape and biodiversity management, and provision of recreational services.

2.3 Classification of urban farming systems

Several authors describe local urban farming systems, but unsystematically, with localized definitions and descriptions, so that comparisons between cities cannot be made. A consistent typology and research approach is lacking. Most UA researchers have developed their own approach, leading to a large variety of definitions and subdivisions of local farming systems.

Mougeot (2000) indicates that most authors define UA in general terms only and rarely use their findings to refine the UA concept, refine typologies or analyse how this concept is related to urban development. Drechsel *et al.* (2005) point out that the selection of particular criterion is often based on the authors' discipline or on the use of the study.

One reason for the lack of a consistent research and typology is that UPA is relatively new and its study aims are diverse. Also, there is a lack of an institutional home for UA studies and planning in the various countries, hampering the systematization of research results. Another important factor, however, is the diversity in farming conditions within the urban setting and the high dynamism in UA, which makes it difficult to characterize and compare UFSs (see section 2.1).

An overview of the various approaches to classify urban production systems and the possibilities for developing an operational typology are explored below. The main challenge is to arrive at a typology that will form a sound basis for identifying adequate development strategies for each type of UA and related policy development and action planning.

Classification of UA systems differs in criteria used, such as location and size of holdings, production aims, predominance of crops or animals, or intensity of production. Most of these classifications only capture part of the reality and suffer from a lack of clarity and differences between regions or cities, and with an overlap among systems.

Single criteria classifications

Many studies differentiate between urban farming systems using single criterion to discuss important differences between different types of UA. Common determinants are shown below.

Location

The location where the activity is carried out is often used as an important criterion, since this points to specific constraints and opportunities such as degree of land access, the land tenure situation, costs and time related to travelling to and from the production site, closeness to markets and risks (e.g. theft, contamination by traffic and industry).

As seen above, there are efforts to distinguish between 'intra-urban' and 'peri-urban' agriculture on the basis of criteria such as distance to the city centre in kilometres or travel time by public transport, administrative boundaries, population density (Mougeot, 2000).

The activities may take place 'on-plot' (in the homestead: home-, backyard-, kitchen-, balcony- and rooftop- gardening) or on land away from the residence ('off-plot'), which influences the possibilities of combining agricultural tasks with non-agricultural tasks, e.g. household chores and other small businesses (Waters-Bayer, 2000).

Other authors (Dubbeling, 2004) distinguish between UA on 'private' land (owned, leased), 'public' land (parks, conservation areas, along roads, streams and railways), and 'semi-public' land (on yards of schools, hospitals, prisons, etc.). The land tenure situation influences the degree of formality of UA and the possibilities for its sustainability on this location as well as specific cultivation conditions, especially organizational (Mubvami and Mushamba, 2006).

Main crops produced and animals raised

The choice of what to produce and how, is determined by a variety of social, economic and physical determinants. In most cities the predominant crops grown in UPA are a result of often specific urban and peri-urban diets and food consumption patterns, which are influenced by culture, climate, soil conditions, socio-economic circumstances, proportion of expatriate market and political economy. The same applies to urban livestock, in addition to the influence of religion and the climate.

Food production may include different types of crops (grains, root crops, vegetables, mushrooms, fruits) and/or animals (poultry, rabbits, goats, sheep, cattle, pigs, guinea pigs, fish, earthworms, bees, etc.) or combinations of them. Often, the more perishable and high-valued vegetables and animal products and by-products are favoured. Non-food products include aromatic and medicinal herbs, ornamental plants, tree products (seed, wood, fuel, etc.) and tree seedlings. Production units in UA in general tend to be more specialized than rural enterprises, and exchanges take place across production units.

In urban production systems, crop production and livestock production tend to be taken up by separate households, and mixed crop-livestock systems tend to be less common than in rural agriculture, especially in intra-urban agriculture. Important linkages are often maintained between (often peri-urban or even rural) crop production systems producing fodder and other feed ingredients and sub- or intra-urban livestock enterprises (see Bradford *et al.*, 2002 on Hubli-Dharward, India; Buechler *et al.*, 2002 on Hyderabad, India; and Nsiah-Gyabaah and Adam, 2001 on Kumasi, Ghana).

Vagneron *et al.* (2002) identified three main production systems:

- *specialized production systems* devoted to a single crop or animal: rice, vegetables, fruit, fish, shrimp, chicken;
- *mixed production systems*, which combine two activities (two main crops or mixed crop-animal);

- *hybrid production systems*, which combine more than two main activities (crops and/or animals).

Kessler (2003) characterized farming systems in five West African capitals – Lomé, Cotonou, Bamako, Dakar and Ouagadougou – using crops cultivated and main cultivation practices (see Table 15 in Annex for an extensive overview).

Degree of market-orientation

According to Nugent (2000), UPA consists of two 'disparate and possibly segregated' subsectors: commercial horticulture and the livestock industry (mainly located in the peri-urban areas), and scattered subsistence production. Both types have a positive effect on food security (Armar-Klemesu, 2000, cited in Nugent, 2000).

In most cities in developing countries, an important part of UA production is for self-consumption, with traded surpluses. However, the importance of market-oriented UA, both in volume and economic value, should not be underestimated. Products are sold at the farm gate, by cart in the same or other neighbourhoods, in local shops, in local farmers' markets, or to intermediaries and supermarkets. In general, fresh products are sold, but some are processed for own use, cooked and sold on the streets, or processed and packaged for sale to one of the outlets mentioned above.

The distinction between subsistence and commercial UA is not as disparate as Nugent states, and many mixed types can be found in small-scale enterprises producing partly for the market and partly for home consumption, which is even the most common farming type in many cities. Segregation is stronger between the small-scale sector and the capital-intensive, large-scale enterprises.

Even if farming is undertaken on a slightly larger or fully commercial scale, the urban households often combine farming activities with other urban occupations, generating off-farm income. Indeed, agricultural production in urban areas is rarely the only livelihood activity of a household (Prain, 2006).

Scale and intensity of production

Schiere (2001) describes livestock systems in terms of subsistence small-scale, semi-commercial small-scale, and large-scale industrialized. He observes that the intensive industrialized systems in particular tend to concentrate the advantages of UA in a few hands (income, tax benefits, etc.) and disperse the associated disadvantages (odour, pollution, etc.). The less intensive, small-scale subsistence and semi-commercial systems provide income and food for households and tend to be important for social relations at the community level.

Coche's classification of aquaculture systems (FAO, 1982) is based on production intensity and management demands, and describes the transition from extensive to semi-intensive and intensive aquatic production systems as attributable to various factors. Greater demand from markets combined with improved marketing channels, increased competition for land, and access to production inputs (such as urban wastes and wastewater) and to

credit are other important factors stimulating intensification in urban (aquatic) production (Leschen *et al.*, 2005).

This intensification and specialization process creates shifts in the local farming systems. In Bangkok, Thailand, for instance, shrimp farming is by far the most rewarding activity, followed by fish farming, vegetable growing, and fruit trees and rice cultivation. Rice is therefore progressively displaced by horticulture, fish and shrimp cultivation, which require higher investment costs and hence wealthier city dwellers (see the FAO study by Vagneron *et al.*, 2003).

Further intensification of peri-urban and urban production systems is not always necessary, inevitable, or the most desirable. Increasingly, especially in larger cities in Europe, Latin America and Asia (notably China), a combination is sought in which the producers can make a good living and create pleasant landscapes for recreation that maintain biodiversity and possibilities (Deelstra *et al.*, 2001).

Intensification of production in urban horticulture, dairy and aquaculture not only increases profits for the producer, but may also be necessary for surviving in the urban setting and its strong competition from urban developers (Van den Berg *et al.,* 2005). Intensification in an urban setting needs maximization of output from an often minimal space (Prain, 2006), which often involves input technologies and labour.

The technological level of most UA enterprises in developing countries is still low because of often restrictive urban policies on agriculture in the past decades and the low level of attention to UA by agricultural research, extension and credit organizations (Mougeot, 2000), among other reasons. Once UPA is acknowledged and supported, however, the overall tendency is towards more technically advanced and intensive agricultural systems, various examples of which can be found in all cities.

Further research into the specific needs of urban farmers is urgently needed. Technology development efforts need to take into account the specific conditions for UA (e.g. limited plot sizes, proximity to people, availability of urban wastes as a resource, closeness to urban markets, etc). Standard rural technologies cannot simply be replicated for the urban setting and participation of the urban farmers in technology development is very much needed, also because of the high diversity and dynamics in urban farming systems (Prain, 2006).

Multiple criteria classifications; farming systems

Many other authors use a combination of the above-mentioned and additional determinants to distinguish the local production systems (see systems in Table 15 in the Annex, which use multiple criteria).

Danso *et al.* (2002b) use access to irrigation water and location next to crop choice as the criteria to distinguish the crop production systems in Accra, Ghana:

- rural or peri-urban rainfed maize or maize/cassava;
- peri-urban dry-season irrigated vegetables only (garden eggs, pepper, okra, cabbage);
- peri-urban dry-season irrigated vegetables and rainfed maize or vegetables;

- intra-urban year-round irrigated vegetable farming (lettuce, cabbage, spring onions).

Access to irrigation water turns out to be an important determinant of income raised in UA. In their study of dairy production systems in Addis Ababa, Ethiopia, Tegegne *et al.* (2000) use degree of market-orientation, size, and degree of crop-livestock interaction and intensity of production as the main criteria to distinguish the various urban livestock systems.

In United States, Chicago, the following three models were distinguished as most applicable and convenient to use in city planning and advocacy, based on the variables of location, size, type of management and degree of commercial orientation (Advocates for Urban Agriculture, 2004):

- *Home gardens* —They are usually small and adjacent to a house or apartment, managed by residents, with production primarily for home use. Small-scale income generation from produce or value-added products is possible.

- *Community-based gardens* – The large garden plot is subdivided into several small plots. They are located on other city or community-owned land or on grounds of schools, churches, community centres, food pantries and housing developments. They are either managed by members of the community (with production mainly for use by the members' households) or by the institution involved (for feeding school children, hospital clients or prisoners, or for income generation).

- *Commercial gardens and small farms* – Plots vary in size, but are usually larger than those in homes or community gardens worked by households. They are usually located in vacant lots in commercial or residential areas either owned or leased by the producer.

A study under the Urban Harvest Programme in Cameroon (see www.cipotato.org/urbanharvest) identified six major types of farming systems, with the use of the following variables: location/land tenure, crop mixture, technology used (open pollinated or improved varieties), degree of commercialization of products and intensity of production.

Other authors use similar combinations of variables and varying degrees of specification of farming systems identified (Drescher, 1999 on Nairobi, Kenya; Jacobi *et al.,* 2000 on Dar es Salaam, Tanzania; Zakariah *et al.,* 1998 on Accra, Ghana; and Buechler and Devi, 2002 on Hyderabad, India).

Moustier and Danso (2006) summarize different attempts to arrive at UPA typologies by using multiple criteria for four major types of UA:

- subsistence home intra-urban farmers;
- family-type (semi-) commercial farmers (intra- and peri-urban);
- intra- and peri-urban agricultural entrepreneurs (intra- and peri-urban);
- multi-cropping peri-urban farmers (mainly former rural producers who are influenced by the city, adapt their production system to the demands of the nearby city, and diversify their livelihood with other occupations).

The latter category refers to the group of former rural producers who have adapted to the city that took over their lands by diversifying their livelihoods with other occupations, but still grow food crops for themselves. The difference between the second and third group relates to the size of business and the use of salaried labour. The latter, the urban entrepreneurs, invest in intensive temperate vegetable production, poultry, fish farms, and fruit growing, etc.

Smit and Bailkey (2006) similarly distinguish between what they call community-based UA from other proactive forms of UA such as subsistence farming by individuals for themselves and their families; entrepreneurial, market-oriented UA, often consisting of privately-owned, profit-making businesses; and leisure or recreational gardening. Community-based UA is then seen as producing food, and other services as a shared activity focused on building communities.

Towards an adequate framework for the analysis of UPA

Most of the classifications reviewed only capture part of the reality and suffer from a lack of clarity (overlap among systems and differences between regions or cities). In addition, the different authors do not provide sufficient information for data comparison. It is helpful to group together those UA systems that enhance urban livelihood strategies and SUD. The main challenge, as mentioned, is to arrive at a typology that not only serves research purposes, but that will form a sound basis for identifying adequate development strategies, action planning and policy development.

Comparative research and local relevancy

Mougeot (2000) voices the need for an agreed typology of UA systems for thorough data gathering and comparative analysis, which was the reason for the above-mentioned FAO studies. But several authors, including Vagneron *et al.* (2002), discuss the difficulty in making generalizations on the urban farming systems distinguished and comparisons between them.

Schiere (2001) stresses the importance of establishing locally relevant criteria for characterizing locally relevant farming systems. He argues that urban farming in and around urban areas occurs in varying forms and has various functions. Perceptions on their relevance and occurrence differ between stakeholders (owners, neighbours, consumers, disciplinary trained officials, governments) and according to context (urban fringes vs. inner cities, cities in arid vs. wet zones, etc.). Such patterns require tailor-made attention and regulation/ incentives to ensure that maximum benefit is gained from agriculture in the specific local urban conditions. This does not exclude drawing from lessons learned. Principles elaborated in one place can be applied elsewhere, but it is generally a good idea that they be locally elaborated and adapted to specific local conditions. However, Schiere rejects a typology of farming systems to be used in all cities as not meaningful and impractical. Local characterization of urban farming seems to be the keyword rather than a uniform typology of different systems. He also states that more emphasis should be given to a dynamic assessment of farming systems, an analysis on how and why UFSs change over time in form and function, and an identification of ways to support the positive aspects, and cope or counteract the more negative characteristics of specific farming systems (Schiere, 2004; 2006).

As shown above, most studies on UA describe practices of crop cultivation and livestock raising, and classify UFSs with the help of a combination of variables mainly related to differential access to and use of productive resources by urban households engaged in farming activities. Although many authors acknowledge other associated activities and impacts, in most studies it is very difficult to get a complete picture of the situation of the farming households since their non-agricultural activities and sources of income are rarely described and analysed.

The concept of the farming system was developed in the 1970s and 1980s to capture the diversity in rural agriculture and to identify similarities between different systems in order to clarify issues for technological intervention and to strategize the development of rural agriculture. Although UA could be described in a similar way (identifying UFSs), the weakness of farming system analysis is its agro-centrism and the difficulty in characterizing feedback loops between the farm, farm household and wider urban systems (Danso *et al*,.2003, van Veenhuizen, 2006, Prain, 2006). The more recent emergence of the sustainable livelihoods approach takes a broader perspective.

Livelihood strategies; non-agricultural activities

Agriculture is most often not the only or even the dominant activity of urban households .The sustainable livelihoods approach (Farrington and Carney, 1999) focuses on the integral assessment and discussion of the major livelihood assets of the households concerned, the livelihood strategies they apply with the help of these assets, their vulnerability to stresses and shocks, the constraints and opportunities, and the support received from local institutions and policies (see www.livelihoods.org). Generally, five types of assets are distinguished: natural capital (such as land and water); physical capital (animals, equipment, animals); financial capital (money, infrastructure); human capital (skills and ability); and social capital (social networks, support by other households, etc). Constraints and opportunities may lie in each of these spheres. There are variations: Smit and Bailkey (2006), for instance, specify seven types of capital to point out the building up of urban community capitals. In addition to natural, human, social, physical ('built capital') and financial capital ('economic capital'), the authors add 'political' and 'cultural capital'.

The core principles underlying this approach are the focus on people and their strengths, a good understanding of local dynamics, and making links between local issues and wider concerns about policies, institutions and processes. The sustainable livelihoods approach may facilitate identification of competing and complementary non-agricultural activities within farm households and the recognition of alternative or complementary development options. Using this approach may result in a classification of urban farm-household livelihood systems that incorporates the non-agricultural activities of the farm-household and needs other than just food and income (e.g. access to basic services, empowerment). A growing number of publications use this approach in analysing urban farming, which is especially useful at the household level in a specific city. It remains difficult, however, to assess the economic impact of UA at the city level and compare typologies between cities.

Multiple functions of urban agriculture

The various classifications in the available literature are often related to the analysis of production and income levels in the distinguished urban farm systems and to the identification of production constraints and possibilities for improvement. Much less, if any, attention is paid to the design and use of classifications of UFSs that include other functions of UA that can be used to identify effective strategies. In addition to food production, UA can have other functions, such as enhancing social inclusion of marginalized categories of the population, providing recreational services, maintaining landscapes and biodiversity, and creating better living conditions in the cities. Urban farmers assume management of urban green and open spaces. With its multiple functions, UA adapts or should adapt to the needs of the city and its stakeholders (Berg van den and van Veenhuizen, 2005). Understanding of this will facilitate the development of new systems, institutions and policies.

Urban food systems

Another focus that might be of help in characterizing urban production systems is food system analysis, which is the analysis of all processes, formal and informal, involved in fully answering nutritional needs of a population: growing, harvesting, processing, packaging, transporting, marketing, consuming and disposing/recycling food, and also includes the inputs needed and outputs generated at each step (Brown and Carter, 2003). A food system operates within, and is influenced by, the urban social, economic and natural environment of a city. It can be analysed at the household, community and city level, and relates to the production, processing and marketing of food produced in and around the city, as well as food from other channels (rural areas, imports) and their linkages and relative contributions to the health and nutrition of the population and to the local economy and environment. In this way, strategies for the development of certain types of UA can focus on strengthening the urban food systems, complementing other components of the urban food system. Food system analysis is also particularly useful in including a wide range of stakeholders in the process of policy development.

Policy dimensions of urban agriculture

UA has multiple functions, which produces things of value to households or to the general urban public. Households and other stakeholders in cities may therefore emphasize its role differently in sustainable city development. In keeping with this concept, Cabannes (2004) and Dubbeling (2004, 2006) have developed a classification of UA focusing on its main policy dimensions (see Figure 1).

The social policy dimension refers mainly, but not exclusively to subsistence-oriented types of UA that form part of the livelihood strategies, particularly for the urban poor, and mainly focus on producing food and medicinal plants for home consumption. In addition, family expenses on food and medicines are reduced and minor cash income is generated from sales of surpluses. The households need additional income sources to survive, which include home gardening, community gardening, institutional gardens at schools and hospitals, open field farming with low levels of investment. These UPA systems show little direct profitability,

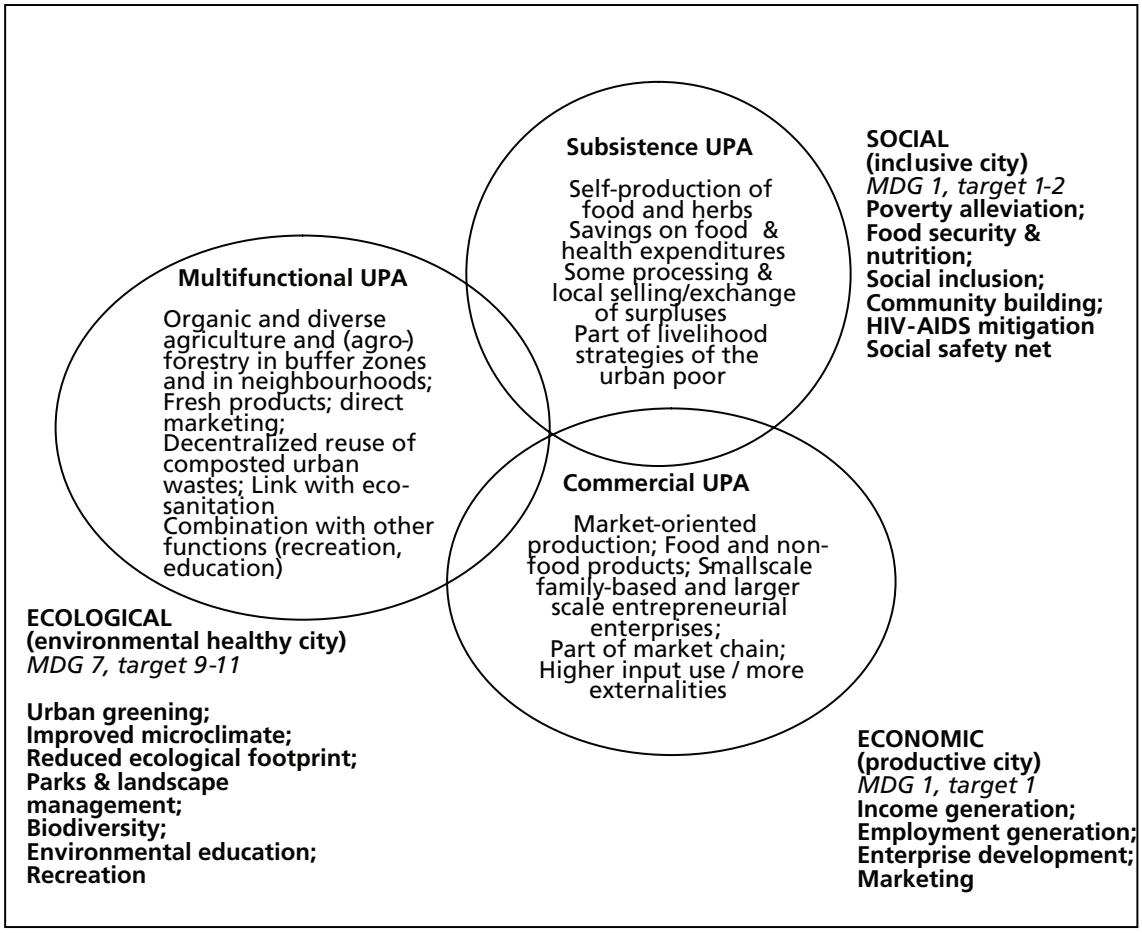
but have important social impacts such as social inclusion, poverty alleviation, community development and HIV-AIDS mitigation.

The economic policy dimension is related to market-oriented types of UA. Activities are undertaken by small-scale, family-based enterprises or larger-scale, entrepreneurial farms run by private investors or producer associations. The activities not only refer to food production, such as irrigated vegetable production and stall-fed dairy production, but also non-food products, such as flowers and ornamental plants. These commercial farms are embedded in a chain of small-scale and larger enterprises involved in inputs delivery (e.g. compost, fodder), processing and marketing enterprises. These types of UA have more economic impact and higher profitability, but their externalities for the city and urban population tend also to be higher (e.g. risk of contamination of soils and water caused by intensive use of agro chemicals, health risks derived from the use of contaminated water for irrigation and risks of zoonosis).

The ecological policy dimension refers to types of UA with a multifunctional character, in addition to providing food and generating income, they play a role in environmental management and provide other services demanded by urban citizens: decentralized composting and reuse of organic wastes and wastewater, including nutrients; urban greening and improvement of the urban climate (shade, oxygen, dust reduction, etc.); landscape management (parks, buffer zones, areas that are flood- or earthquake-prone, or ecologically valuable and that should be kept free from construction), providing opportunities for leisure and recreational activities, water storage. In order to allow such a combination of functions, multi-functional agriculture should adopt agro-ecological production methods linked with eco-sanitation / sustainable waste management, as well as with the planning and management of parks, nature and recreation areas.

With the aid of such a framework, the analysis of current UA systems can be directly combined with important urban policy discussions: Which of the three dimensions should be given the main emphasis, given the actual situation in the city and the current policy priorities? A local government concerned about growing food insecurity or the exclusion of certain categories of the population will probably focus on the social dimension of UA, another – mainly interested in LED – will focus on the economic dimension of UA or encourage subsistence farmers to move into the market sector. Local authorities mainly concerned about the poor urban living climate, growing waste management problems, or the negative environmental or health effects of market-orientated UA, may concentrate on the environmental dimension of UA, or promote a shift from high input commercial agricultural production towards sustainable and multi-functional agriculture.

Figure 1: Policy dimensions and main types of urban farming



2.4 Conclusions

A major feature of UPA is the diversity of the socio-economic profiles of actors involved, and their varying income and livelihood strategies. UPA can be seen as a form of urban shifting cultivation. Many different ways to classify UA have been discussed. The livelihoods approach allows for a dynamic analysis of urban households that practice UA by highlighting their strategies and identifying external influences and (needs for) linkages with urban and national institutions. Linking this understanding of UA livelihoods to the urban food system and to other multiple urban functions may further assist in developing a strategic perspective for UA and subsequent action planning and policy development.

• Within more localized characterization, it would be useful to characterize urban farming typologies in further research supporting urban farmers and in policy development. Moustier and Danso (2006) and Bailkey and Smit (2006) suggest differentiating according to the reasons for involvement in UA, its social and economic impact (at the household and city level), intensity of production, and its relation to SUD. The categories would then be:

- more socially-oriented urban farming (leisure, recreation, community-based, subsistence-oriented, often with greater variety, subsidized);
- more economically-oriented urban farming (market-oriented, entrepreneurial, which can be family-based or in (micro-)enterprises, with often one dominant commodity).

Drechsel *et al.* (2005) suggest examples in West Africa of how to differentiate between open space (usually market-oriented) production of high-value products (mostly subsistence), gardening in backyards of private houses, and livestock-rearing on or outside one's own yard.

Further research is recommended on these localized typologies and on commonalities between cities in function and potential. An interesting and important question in development assistance would then be if it were possible for urban producers to evolve from a predominantly subsistence type of production to a more commercial type, generating sufficient income and savings to increase the scale of business, becoming more entrepreneurial (Moustier and Danso, 2006) and adapting to the requirements of urban sustainable development (van den Berg and van Veenhuizen, 2005). Subsequently, the question arises whether this development is desirable and how it can be supported. For instance, Small (2006) developed a step-by-step development continuum for community-based agriculture based on his long experience in supporting the urban poor in farming in Cape Town, South Africa. Similarly, by studying UA in Sydney, Australia, Mason and Docking (2005) have developed a continuum of UA and examined implications for urban planning.

The initial aim of this study was to present the research findings separately for each of the main UFSs and to make a comparative analysis between cities; however, the review of classifications applied by various authors shows that they distinguish and study different UFSs (see also section 2.1). Deriving from this large variation in the classifications and/or lack of information, no comparisons can be made on profitability and sustainability between urban production and/or farming systems distinguished in the literature. Although a substantial amount of literature has been reviewed, it was not possible to edit and assess the available literature as originally suggested. Most available studies, including those analysed by Danso *et al.* (2003), provide a valuable source for evaluating the economic and market role of local UPA systems. In the next chapter, the reviewed data will be assessed according to sustainability and the economic impact of more socially- and more economically-oriented UPA.

3. Profitability and sustainability of urban agriculture

In a world increasingly dominated by cities, the international community has started to address the issue of urban sustainability with international meetings and agreements, such as Agenda 21 in 1992, the 1996 UN City Summit in Istanbul, Turkey, and in the World Summit on Sustainable Development (WSSD) held in Johannesburg in 2002. Urban sustainability issues are also included in the MDGs. Increasingly, UPA is seen as part of this SUD. Agriculture has always been part of the city. Its functions may change over time as well as the degree of policy attention it receives, but it has always been an integral part of the urban system. The question is whether it is sustainable under the present conditions.

UA is practiced in a very dynamic environment and with multiple stakeholder interactions. Because of competition for urban space from economic and politically more accepted functions, and different demands from urban inhabitants, UPA needs to be dynamic and continuously adapt to the rapidly changing conditions, in location and type of crops or animals produced and even people involved. This contributes to the perception that agricultural production in and around urban areas is unsustainable. But is this perception correct? UPA is increasingly accepted by municipalities as part of urban development.

According to Nugent (2001), sustainability in its essence refers to the ability of something to endure over time. Sustainability of UPA basically implies its ability to continue in the future and operate at the current or increased levels. In order to be sustainable, UPA should be profitable and economically viable, environmentally sound, socially just and culturally acceptable (see also Figure 1). Table 3 presents some quantitative and qualitative variables of sustainability indicators.

Upon reviewing the available literature, it becomes clear that the criteria and methods used to measure profits or economic impacts are lacking, vary substantially or show important gaps. More discussion on these issues is important for improving the quality and relevance of research on the impacts of UPA. This chapter will therefore first provide methodological considerations. The available literature on the economic impacts and profitability of UA at the household level is then reviewed. Subsequently, the third section discusses the economic, social and environmental impact of UPA at the city level. Further, the sustainability of UPA is reviewed and discussed. Conclusions are drawn in the final section.

Table 3: General indicators and parameters for sustainability assessment

Economic indicators	Environmental indicators
Yield trends	Bio-indicators (clean air, biodiversity)
Income per head and per ha	Pollution indicators
Modified GNP	Material and energy flows and balances
Value of total food produced	Heavy metals in crops
Value of land with UPA	Soil health (organic matter, etc.)
Productivity	Food miles: local food produced
Willingness to pay	Organic waste recycled
Local food production	Depletion
Hedonic price method	Pollution
Cost of depletion and pollution	
Social indicators	**Composite indicators**
Equity coefficients	Lists of indicators
Employment	Scoring systems
Disposable family income	Integrated system properties
Inclusion: no. of youth trained in life skills, patients, migrants or ex-convicts	
Participation, both men and women	
Property rights (tenure)	

Source: based on Becker, 1997; Danso *et al*., 2003

3.1 Measuring economic impacts and profitability of urban and peri-urban agriculture

Economic impacts at different levels

The economic impacts of UA can be distinguished at the following levels:

(i) *the household level*: the direct economic benefits and costs for the urban households involved in the agricultural production, including: self-employment, income from processing, sales of surpluses, savings on food and health expenditures, exchange of agricultural products for other economic goods;

(ii) *the city level*: the direct costs of the assistance supplied to the urban farmers (extension and training, quality control, etc.) that are not carried by the farmers, and the aggregate indirect costs and benefits of UA for the city (also called externalities) such as positive and negative effects on the social, health and environmental situation of the population. The positive effects, such as recycling of wastes, greening, less health problems derived from better nutrition of the urban poor, mitigation of the effects of HIV-AIDS, landscape care, and the negative effects, such as water pollution caused by agrochemicals, erosion, more health problems and associated risks, can be quantified and economically valuated. The positive effects bring an added value to the city (enhanced income or reduced costs) and the negative effects require extra investments or tax payments (Fleury and Ba, 2005);

(iii) *The macro level*: the contribution of UA to the gross domestic product (GDP) and its effects on the efficiency of the national food system: UA provides products that rural agriculture cannot supply easily (e.g. perishable products, products that require rapid delivery upon

harvest), can substitute for food imports and can release rural lands for export production of commodities (Mougeot, 2000).

Research on the economic impacts of UPA in the literature reviewed refers mainly to the household level; it is scarce concerning the city level and nearly absent for the macro level. This overview therefore focuses on the first two levels.

Lack of sufficient data

A main constraint identified by Danso *et al.* (2003) and others is the limited number of studies with sound economic analysis of UPA. Many sources mention profit, returns and other indicators without giving detailed information on how the data were obtained and/or descriptions of the UA system and households and their environment are general and incomplete. Moreover, most analyses are based on short time studies and 'snap-shot' approaches. But since production costs vary greatly between seasons (e.g. irrigation costs) as well as market prices, changes over the year (e.g. through trend analysis, or other simulations) should be considered.

This lack of sound economic data is owed to the fact that UA is a relatively recent field of research, with many specific methodological and practical problems still to solve. Moustier (2001) warns that actual figures on farmers' incomes are difficult to estimate because of the diversity of farmers' profiles, their unwillingness to give data on income, seasonality of crops, continuous harvesting and scattered plots. For instance, Danso *et al.* (2003) question how to assess the production of small vegetable plots with different sizes, multiple crops on the same bed, and multiple harvests per crop per year that are regularly visited by crop thieves. Researchers encounter difficulties in meeting farmers caused by their off-farm activities or homes far from agricultural plots or in their reluctance to share information. (In many cities, US is still considered an 'illegal' activity and they fear formal or informal 'taxes'.)

It is also difficult to determine the costs and benefits of the agricultural production process. Data on the amounts or prices of inputs used and on the quantities of agricultural production and prices obtained for products (often sold informally) are lacking or inaccurate. Some methods commonly used in agricultural economics, such as net present value, payback period and internal rate of returns, which consider inputs with a long lifetime, such as farm machinery, livestock and trees crops, are seldom used because of the short-term and often informal nature of many of the UPA enterprises: part of the land used is informally rented on a short-term basis only or for informal use of private, semi-public and public land that may be required later for other functions. Consequently, many farms shift from one location to another, if production at first is no longer possible or if a better one becomes available. In addition, other households engage in UA only temporarily, e.g. during certain periods of the year or during crisis periods.

At the city level, the assessment of the economic impacts of UPA suffers from a lack of clear and uniform indicators and data. Despite availability of new methodological approaches and tools (see Nugent, 2001 and Box 2 for methods developed in environmental economics), little effort has yet been undertaken to estimate the non-market costs and benefits of UA on the health and nutrition of poor urban citizens, city ecology (greening, micro-climates, recycling of wastes, energy reduction, etc.), community building and social inclusion of the poor.

Box 2 Economic valuation of environmental services of urban forestry

Economic valuation translates urban forestry services and functions into terms that enhance public value. Returns on investment are less easily calculated than direct management costs. Industrial forests are managed for market goods. Dynamics of supply and demand establish prices and revenues for resource products, such as timber. In contrast, many 'products' of urban forests are public goods. Multiple 'owners' invest in a city's natural capital, generating 'products' in the form of intangible functions and benefits for each resident, visitor and user. The experience of these benefits by any single person does not exclude others from experiencing similar benefits, both immediately and indefinitely. Economists have developed theories and methods for assessing public goods values.
The most direct valuation is to estimate marketable goods or the value of purchase substitutes. For example, urban agroforestry practices can produce human and animal foods and medicinal materials, thus contributing to urban food security. Localized food production reduces the costs of distribution systems needed if food is transported from rural areas.

Useable non-timber forest products include animal fodder, building materials, fuels and handicraft materials.

Other economic valuation approaches are:
- *Hedonic pricing:* The value of an amenity (such as the effect of a park on a home price) is determined as an increment of purchase price.
- *Travel cost method*: This method calculates the costs that people are willing to add to a trip to experience a desirable amenity or landscape.

Source: Wolff, 2004

Indicators and measuring methods

Indicators are key parameters showing and measuring change and impact. Moustier (2001) sees the following economic indicators as important in assessing economic impact of UPA at the household level: employment (population involved), income and income distribution, cash readiness, contribution to household food, added-value, relative contribution to urban food supply, and share in market(s). Clearly, the studies reviewed do not provide information on these indicators. (The indicators used in the studies reviewed are summarized in Table 4.)

In order to understand impact and household strategies with respect to UA, other factors that influence subsistence and/or income are important and must be analysed. The valuation of socio-economic impact will differ greatly according to the types of indicators used, and its omission may lead to differing estimates – for instance, researchers focusing on subsistence agriculture may underestimate the economic impact of commercial agriculture, and conversely, those focusing on commercial agriculture may underestimate the food security and livelihood roles of UPA.

Table 4: Indicators to assess profitability used in the studies reviewed

Profitability indicators and methods	Country or city: Author
Cost-benefit analysis	General: Nugent (2000, 2001); Itty (1992)
Payback period, net present value, internal rate of return	Nigeria: Afolabi *et al*. (2000)
Cost/return ratio or comparison with local poverty index, minimum wage or income of other stakeholders or farming systems	Vietnam: Jansen *et al*. (1995); Cameroon: Gockowski et al. (2002), Kumasi: Danso *et al*. (2002a); Ouagadougou: Gerstl (2001), Gerstl *et al*. (2002); Accra: Armar-Klemensu and Maxwell (2000); Harare: Mawoneke and Bowdin (2000); Hyderabad: Buechler and Devi (2002); General: Nugent (2000); Dakar: Mbaye and Moustier (2000), Jacobi *et al*. (2000); Jakarta: Purnomohadi (2000), Ezedinma and Chukuezi (1999); West Africa and General: Moustier (2001); Mena: Faraqui *et al*. (2006)
Income statement (profits or loss of the farm)	Kumasi : Fialor (2002); Accra: Danso *et al*. (2002b); Lomé, Cotonou, Bamako, Tamale, and Ouagadougou: Kessler (2002, 2003); Uganda: Nkegbe (2002); West and Central Africa: Moustier (2001); Nairobi: Mireri (2002); Haroonabad: Hassan (2002); General: Eaton (2002).
Mostly descriptive (without actual analysis)	Nairobi: Mboganie-Mwangi and Foeken (1999); Bangladesh: Talukder *et al*. (1999); Kumasi: Obosu-Mensah (1999); Addis Ababa: Tegegne (2003); Tanzania: Mougeot (2000); Shanghai: Yi-Zheng and Zhangen (2000); General: Nugent (2000).

Source: Based on Danso, 2003.

Gender

Gender-specific data and analysis are required for assessing the differential impacts of UA on women and men, as part of the farm household members and on the wider community. However, most studies do not differentiate between the economic costs and benefits for men and women separately, and related indicators and measuring methods are seldom gender-differentiated.

3.2 Economic impacts and profitability of UPA at the household level

The economic impact of UPA at the household level refers to the direct economic benefits and costs for the urban households involved in agricultural production. The literature reviewed will be presented according to information on crop production and animal husbandry. UPA is important in providing fresh perishable vegetables, mainly leafy vegetables, poultry and dairy.

Urban crop production

Drechsel *et al.* (2005) estimate that backyard gardening is widely practised by approximately 20 million urban dwellers in West Africa, mostly for subsistence. Market gardeners are mainly located in the open spaces in West Africa, and change crops according to seasonal supply and demand, and market prices. A key issue, especially for the market gardeners (the more entrepreneurial farmers) is whether the intensification strategies are sustainable, especially concerning their impact on environment and health. Intensification is sought through cultivating

high-value crops, increase in productivity on the same area of land (like rooftop gardening), and by maximizing the use of available resources, including wastewater (Prain, 2006).

Kessler (2003) analysed different farming systems in four West African capitals (Lomé, Cotonou, Bamako and Ouagadougou). The study revealed that differences in crops and inputs of the different farming systems are derived from different economic strategies adopted by the farmers. Mixed vegetable farming with watering cans and/or with pumps cultivate short- and long-cycle vegetables such as lettuce, cabbage, carrots and onions. The short-cycle crops are grown to ensure returns on inputs and salaries, while the long-cycle crops are used to maximize benefit and investment in infrastructure, or private or family life. The annual profit ranges from US$20 to US$700, depending on the management capacities and farm size.

Traditional vegetable farmers (mainly women) produce mainly short-cycle crops for home consumption and sale. They prefer short-cycle crops with regular cuttings (twice a month) to ensure regular income and high returns. They cannot afford to cultivate long- cycle crops such as carrots, which require several months' investment. But with low inputs these farmers are able to generate a monthly income, which adds up to an annual benefit of US$170 to US$200. Ornamental plant and/or flower producers – mostly full-time farmers – achieve an annual benefit of US$400 to US$5 000. Rainfed staple crop farmers mainly produce for home consumption.

In Ouagadougou, Burkina Faso, Gerstl (2001) analysed households engaged in open-space vegetable production (see table 15 in Annex). The author found that these households usually belong to the low-income group. Production heavily depended on water availability (Gerstl *et al.*, 2002). In the study period, income was not sufficient to cover expenditures and comparable to the low average monthly per capita income of US$20.

In Nigeria, Ezedinma and Chukuezi (1999) compared the returns of commercial vegetable production in Lagos with commercial floriculture in Port Harcourt. Commercial vegetable entrepreneurs engage in vegetable production as an off-season income-generating activity. By contrast, commercial floriculturists usually combine this with other well-paid occupations. Both production systems are profitable ventures since entrepreneurs get a net return of approximately 61-65 kobo on every naira invested (100 kobo is one naira). However, commercial floriculture requires larger variable investment costs than commercial vegetable production, where capital outlay is relatively small because of its temporary nature (see Table 16 in Annex).

Gockowski *et al.* (2002) studied the importance of traditional leafy vegetables in Yaoundé, Cameroon. Three main production systems were identified: (i) intensive intra-urban production on raised beds in inland valleys using high levels of inputs; (ii) semi-intensive peri-urban production; and (iii) extensive peri-urban production where traditional leafy vegetables are produced in association with staple crops without purchased inputs. Estimated monthly returns to land and management for a representative intensive enterprise producing *C. Olitorius* were roughly equivalent to the official minimum wage equal to CFAF 35 000 (US$1=590 CFAF) in the formal sector (Table 17 in the Annex). Returns to a representative semi-intensive enterprise growing *S. Scabrum* were lower, but when family labour is employed, overall returns also approach the minimum wage in the formal sector

(Table 18 in the Annex). The typical retailer had mean earnings (net of gross purchase and market tax) equal to CFAF 915 per day.

Danso *et al.* (2002a) carried out a costs and returns analysis in urban vegetable-growing systems in Kumasi, Ghana. Manual irrigation needs to be carried out with high frequency, which makes irrigation time-consuming and expensive (13 percent of total cost, excluding family labour, and 38 percent of time). Weeding was rated as the most expensive activity by the farmers, on average accounting for approximately 23 percent of the total cost. Comparing net incomes of different farming systems showed that irrigated urban vegetable farming reaches an annual income of US$400 to US$800 (see Table 5), which is two to three times the income earned on average in rural farming. Typical farm sizes range around 0.1 ha in Kumasi, Ghana. Urban farmers therefore earn at least twice as much as rural farmers on only about 20 percent of their farm area. However, being successful in this way requires careful observation of trends in market demand in order to properly plan production investment for a given year.

Fialor (2002) analysed the profitability of various types of cropping systems around Kumasi, Ghana (see Table 6). He concludes that regardless of the level of the cost of production, the most profitable investment is the one that yields the highest simple return on the invested amount during the year. He assumes that other sources of investment are not desirable alternatives since these have an estimated profit/costs rate of 30 percent per annum, which falls below those of all the vegetable-growing systems studied. Since UPA tends to focus on short-duration crops to take maximum advantage of the market, combination 9 in Table 6 (plantain followed by cocoyam/cassava/maize), which ranks first, might not be a feasible choice for most farmers because of the long gestation period and the larger land space required to achieve profitable returns from oil palm cultivation. Combination 6 (spring onion followed by pepper/garden-egg/okra) therefore ranks best even though cabbage as the main irrigated crop yields the maximum profit among all the crops in the year. Some other combinations are less favourable since they need very high investments in labour and fertilizer or manure.

For peri-urban farmers, dry season irrigated vegetables can add a significant amount of cash to their income, taking into account that rainfed maize and cassava harvest is mainly used for household consumption. Without these savings on expenditure, cash availability might actually be less than US$100 per year. Only a minority of peri-urban farmers shift to year-round vegetable farming (e.g. tomatoes in Akumadan). There are three reasons for this: the importance of maize and cassava for home consumption (mentioned by 52 percent of the farmers interviewed); the lower price of vegetables in the rainy season (40 percent); and the increased risk of pest attacks (8 percent) (Danso *et al.*, 2002a). Irrigated vegetable production has enabled a remarkable step forward over the poverty line. However, when ranked according to profit as a percentage of production costs, a disadvantage of irrigated vegetable farming for the urban poor is becoming visible: high profits also require more initial capital investments and higher risks for the households involved (Danso *et al.*, 2002a; Fialor, 2002).

Nkegbe (2002) investigated the profitability of vegetable production under irrigation in 15 urban and 15 peri-urban areas in Tamale, Ghana. In 10 out of the 15 cases, the average yields/ha produced in urban Tamale were higher than in peri-urban Tamale (see Annex, Table 20), but the production costs are much lower in the peri-urban areas. Here, labour costs are lower (no manual irrigation) since the farms are located in governmental irrigation schemes.

Table 5: Revenue generated in different farming systems in Kumasi, Ghana

Location	Farming system	Typical farm size (ha)	Net revenue (US$)/ha/year	Net revenue (US$)/ farm holding/year
Rural/ peri-urban	Rainfed maize or maize/cassava*	0.5-0.9	350-550	200-450
Peri-urban	Dry season vegetable irrigation only (garden eggs, pepper, okro, cabbage)	0.4-0.6	300-350	140-170
Peri-urban	Dry-season, irrigated vegetables and rainfed maize (or rainfed) vegetables)	0.7-1.3	500-700	300-500
Urban agriculture	All-year round irrigated vegetable farming (lettuce, cabbage, spring onions)	0.1-0.2	2 000-8 000	400-800

* A significant part of the maize/cassava harvest is used for home consumption. Subsistence production is converted to market values. There is no consideration of off-farm income sources.
Source: Danso et al., 2002ab

Table 6: Profitability of cropping patterns in UPA in Kumasi,Ghana

Combination type	Average cost of production/ ha	Average total profit (cedis/ ha) *	Profit as a percentage (%) of production cost	Ranking based on current profitability
1. Cabbage followed by lettuce/ spring onion, cabbage, sweet pepper	7 767 500	6 512 667	84	9
2. Cabbage followed by lettuce/ spring onion, cabbage, sweet pepper	2 600 000	4 058 125	156	7
3. Lettuce followed by cabbage/ spring onion	1 008 000	2 185140	217	4
4. Maize followed by cassava, plantain/cocoyam/cassava	1 945 000	4 165 000	214	5
5. Okro followed by tomato, cocoyam, cassava, garden eggs	2 625 000	3 940 000	150	8
6. Spring onion followed by pepper, garden egg, okro	2 540 000	9 969 480	392	2
7. Pepper followed by cabbage, tomato, garden egg	2 369 750	4 919 167	208	6
8. Tomato followed by cabbage pepper, okro	1 262 500	2 910 000	230	3
9. Plantain followed by cocoyam / cassava / maize	1 103 250	4 545 000	412	1
For comparison				
Cabbage only	5 017 849	2 960 834	59	12
Maize-cassava only	4 125 625	2 813 795	68	11
Tomatoes only	**5 634 816**	**3 965 184**	**70**	**10**

*Based on one crop year; 2001 prices (US$1=approximately 7 000 cedis).
Source: Fialor, 2002; Danso, 2003b.

A study under the Urban Harvest Programme in Cameroon, available at their website, found that among the commercial producers, enterprise budgets indicated monthly earnings of CFAF 36 000 (US$69 per month in 2004), which is above the minimum wage.

Eaton (2002) observed considerable differences in the economic performance of horticulture farms when comparing farms in Ouagadougou, Burkina Faso with those in Bamako, Mali. Gross margins per hectare were generally two to three times higher in the former (Table 19 in the Annex). In general, farmers in Bamako often cultivate on fertile Niger sediments with easier water access permitting a longer production cycle (year-round) and higher yields.

Buechler and Devi (2002) compare farming systems and income between urban, peri-urban, and rural agriculture in a case study from India. Table 21 in the Annex shows the gradual change of farming systems from urban to rural in Hyderabad. It also shows that para grass production in urban and peri-urban Hyderabad generates the highest annual income.

Moustier (2001) compares the revenues generated in UPA with alternative activities that require the same set of skills; retailers' income may be compared with simple handicraft work. Income can also be compared to minimum subsistence household budget, taking the average size of households per city into consideration (Table 7). For specialized vegetable growers, market gardening may generate enough income to cover basic household needs.

In addition, Table 8 shows that the differences in Brazzaville, Congo between producers, retailers and input suppliers are small, contrary to the common belief that traders draw high margins from product purchase and resale. The low value of traders' incomes despite high price mark-ups (commonly exceeding 100 percent) is explained by the small amounts that they sell daily because of low and fluctuating consumer purchasing power, together with lack of appropriate storage and packaging (Moustier, 2001).

In general, urban products are distributed through short marketing chains. In West Africa, women do most of the marketing. However, direct involvement of the urban producer in selling the products would increase profits; this is especially important in small-scale production. Moustier and Danso (2006) observe, however, that this contributes to fragmentation of the final supply, and suggest developing collective marketing.

Table 7: Estimate of average monthly income of commercial growers and retailers

City (year)	No. of producers and retailers investigated	Estimation of average monthly income (FF)	Estimation of minimum subsistence income (FF)
Brazzaville, republic of Congo (1989)	1 000 producers, 1 400 retailers	860 (producers) 750 (retailers)	600
Bangui, Central African Republic (1991)	300 producers 300 wholesalers 1 000 retailers	1 820 (producers) 1 900 (wholesalers) 810 (retailers)	400
Bissau, Guinea Bissau (1992)	2 000 producers	130 (producers)	400

Source: Moustier, 2001 (US$1=approx. 6 FF)

Table 8: Income and added-vale of UPA (vegetables), Brazzaville

	Income (FF)	Percentage (%) of total	Added value (FF)	Percentage (%) of total
Producers	1 075	40	1 035	40
Retailers	1 295	50	1 260	50
Input suppliers	135	10	135	10
Total	2,505	100		100

Source: Moustier, 2001 (US$1 = approx. 6 FF)

Homem de Carvalho describes this involvement of farmers and their families in the production-marketing chain under the term 'verticalization' (Homem de Varvalho, 2001). Verticalization in the PROVE Programme in Brazil is designed to promote small agricultural production, processing and trade, involving many urban and peri-urban agricultural systems, including vegetable-gardening, fruit-growing and livestock systems. The state intervenes at the individual and/or collective level. Low-income populations are the target audience. Central to the programme was the creation of some 500 small processing units with all the legal and sanitary requirements, and their own quality label. From 1995 to 1998 under the PROVE programme the monthly per capita family income of beneficiaries increased from US$25 to US$100 (Homem de Carvalho, 2001).

Jansen *et al.* (1995) carried out a study in peri-urban Ho Chi Minh City, Viet Nam on the profitability of peri-urban vegetable production systems (with rice and/or groundnut as additional crops); net income ha/year was calculated per household (see Table 22 in the annex). Across most species, significantly higher returns were achieved with higher levels of inputs. On average, farmers derive over 70 percent of their crop revenues from the sale of vegetables. Most vegetable crops require between 2 000 and 5 000 person-hours/ha/, which is about 2.5 to 6 times higher than labour hours in rice cultivation. Manual irrigation is the single most time-consuming factor. Net income per year at average prices varies between US$500 and US$1 500/ha for most vegetable species. Separate analysis for year-round vegetable farming revealed greater gross revenues, net incomes and income per person-day for crops (Table 23 in the Annex).

House *et al.* (1993) found that in Nairobi, Kenya, UA provided the highest self-employment earnings in small-scale enterprises and the third highest earnings in all of Kenya. The NRI (1999) found in the Kumasi case that backyard production of vegetables saves money otherwise used for food purchases. Investments and returns vary largely with the type and intensity of the backyard activities. All income groups kept backyards in Kumasi, particularly the low-income ones. In Kampala, backyard farming is also found in all income groups. These same findings are observed in most other studies on urban subsistence farming (Atukunda and Maxwell, 1999).

Urban animal husbandry

Throughout the developing world, and especially in Africa, animals are an important physical and financial capital for many urban households. Throughout Africa, broiler chicken, milk and eggs come from city farms or the suburbs (Moustier and Danso, 2006). As a regular source of income, they represent a form of savings. They may also generate additional physical capital in the form of manure (Prain, 2006).

In Addis Ababa**,** Ethiopia, 20 million litres of non-pasteurized milk came from backyard city farms and are sold directly to the consumer by the producer. Above-normal profits are earned with very low capital input by even the smallest-scale backyard owners of inner city dairy units, who are generally women (Tegegne, 2000).

Fialor (2002) analysed the profitability of various livestock systems around Kumasi, Ghana. Although the cattle enterprise yields the maximum profit per unit, this is only possible when herd size ranges from one to five animals (see Table 24 in the annex). Space requirements, waste disposal and feed availability are the major factors to consider for larger herd sizes. A similar situation is observed for pigs. However, the next best profit per animal is only possible for numbers above 100. In the poultry enterprise a flock size of about 1 000 birds is shown as the most profitable size to maintain within the UPA area, while sheep and goats are most profitable when the herd size exceeds 40 animals.

Mireri (2002) showed that commercial urban livestock keeping in Nairobi can generate a significant income. Urban pigs and poultry farming, in particular, are profitable ventures and guarantee a quick return on capital. He calculated that the minimum economically viable poultry farm requires 300 birds (compare Fialor, 2002 for Kumasi in Table 24 in the Annex) and that farmers can get a return on their investments within 18 months. A contracted poultry farm (with 3 000 broilers and credit support) can earn a net profit of about US$9 333 per year. A pig farmer with five breading mothers can earn a net profit of US$2 667 per year. Although most poor families rarely have sufficient space for profitable farming within their homesteads, a sizeable proportion of middle- and high-income families have adequate land for UA. As the sector has limited access to credit, the high start capital requirements result in most producers using these enterprises as secondary to others from which capital is derived, for example, trading or salaried employment (NRI, 1999).

Comparing capital requirements and returns in different animal production systems in and around Kumasi, Ghana, the following scheme was drafted by NRI (1999), modified by Danso, (2003). In the region, 14 percent of urban cattle owners derive more than 50 percent of their income from their cattle (Drechsel *et al.,* 2000).

Table 9: Capital requirements and returns in animal production systems

		Proportionate level of return	
		High	**Low**
Capital requirements	**High**	Cattle, dairy, poultry	Aquaculture
	Low	Small animals, sheep, goats	Backyard / subsistence agriculture

Source: Danso *et al.*, 2003

In Mexico City, Mexico, production of swine brings in 10-40 percent of household earnings; urban cowshed-based milk, up to 100 percent; and vegetable and legume production in sub- and peri-urban areas, up to 80 percent (Torres Lima *et al.*, 2000).

Around 30 percent of inland aquatic production is concentrated and produced intensively around Bangkok peri-urban areas, generating an income of nearly 3 000 million baht (US$250 million) a year (Ruangvit *et al.*, 2005). A study of marketing in fish and aquatic plants carried out in 2003 in Hanoi, Viet Nam, showed that ten percent of the freshwater fish sold in the city's wholesale markets are actually produced in Hanoi. In contrast, 100 percent of aquatic plants grown around Hanoi are consumed in the city and meet its demand (Nguyen *et al.*, 2005). The economic viability of tilapia culture in concrete tanks in homesteads in peri-urban Nigeria were tested and analysed by Afolabi *et al.* (2005), and showed an internal rate of return of more than 95 percent. The authors argue that tilapia can be successfully cultivated, but need proper management.

Is UPA profitable at the household level?

UA can thus be a profitable undertaking at the household level, especially when producing products that are high in demand and that have a comparative advantage over rural production such as perishable products (e.g. green leafy vegetables and milk), mushrooms, flowers and ornamental plants. Urban animal husbandry can also be a profitable business. Investments in commercial livestock production, however, require higher start-capital than other forms of informal UPA. This is often derived from other (primary) household ventures (NRI, 1999) or innovative arrangements (Mireri, 2002).

The above studies indicate that irrigated open-space vegetable production, especially peri-urban, allows significant profits and is one of the most productive farming systems in Africa despite its informal and seldom supported character (Danso *et al.*, 2003). Table 10 summarizes the data from these studies on net income generated in irrigated vegetable production (mainly peri-urban). Monthly net income figures from intra- and peri-urban open- space vegetable farming usually range from US$30 to $US70 per smallholding, but can go up to US$200 or more. These amounts normally exceed official annual minimum salaries (see Danso's comparison in Ghana (2003) by a factor of 1.6 to 10 and can lift households out of poverty, reaching incomes equivalent to the official minimum wage in the formal sector or to a basic government salary.

Ornamental plant and/or flower production appears to be the most profitable undertaking and can achieve an annual benefit of up to US$5 000 (in Lomé) if sufficient cash is available for labour and the purchase of seeds and seedlings (Kessler, 2002; Ezedinma and Chukuezi, 1999). Additional benefits can be obtained by the farm households through processing and marketing activities (e.g. ghee making, preparation of street foods, street cart or small local shop and cleaning/packaging food for sales to supermarkets, among others).

Backyard (on-plot, mainly intra-urban) farming is generally for subsistence production and especially helps the low-income group reduce expenditures on food and raise some additional income through surplus sales. Many cases demonstrate that urban farmers make rational decisions on their production system and strategies by taking up higher-risk intensive vegetable production or by obtaining better returns per dollar invested by maintaining diversity and using fewer external inputs.

Table 10: Monthly net income from irrigated mixed vegetable farming

City	Typical net monthly income in US$ per farm (if not mentioned otherwise) The highest income (if available) is given in brackets	Gross national income (GNI) per capita, US$/ per month
Accra, Ghana	40-57	27
Bamako, Mali	10- (300)	24
Bangui, Central African Republic	320 (producers), 330 (wholesalers), 140 (retailers)	22
Banjul, Gambia	30	26
Bissau, Guinea-Bissau	24	12
Brazzaville, Republic of Congo	80-270 (producers), 120 (retailers)	53
Cotonou, Benin	50- (110)	36
Dakar, Senegal	40- 66 (250)	46
Dar Es Salaam, Tanzania	60	24
Ho Chi Minh City, Viet Nam	40-80 (125)	n.a.
Hyderabad, India	30-70 (figures per ha)	n.a.
Freetown, Sierra Leone	10-50	13
Jakarta, Indonesia	30-50	n.a.
Kumasi, Ghana	35-85 (120-160)	27
Lagos, Nigeria	53-120	27
Lomé, Togo	30-25 (270-330)	26
Nairobi, Kenya	10-163 (279)	33
Niamey, Niger	40	17
Ouagadougou, Burkina Faso	14-70 (100);	25
Takoradi, Ghana	10-30	27
Yaoundé, Cameroon	34-67	53

Sources: Danso *et al.*, 2002a, 2002b; Kessler, 2002; Diop, 2002; Cofie *et al.*, 2003; Jansen *et al.*, 1995; Gockowski *et al.*, 2004; Moustier, 2001; Buechler and Devi, 2002; Jacobi *et al.*, 2000; Faraqui *et al.* (draft); Purnomohadi, 2000, IWMI (unpubl.); Cornish and Lawrence, 2001; Ezedinma and Chukuezi, 1999; Drechsel *et al.*, 2005.

Important factors influencing net income of an urban farm household are: degree of market- orientation, farm, size, labour availability in the household, choice of crops and animals; availability and cost of basic inputs (and especially the use of local resources such as organic wastes and wastewater); the opportunity for dry-season irrigation; available technology and capital; access to markets and prices obtained, ability to store, process and preserve products (Danso *et al.,* 2003). In addition, the impact of UA at the city level needs to be taken into account. After a discussion of the advantages of UPA, Moustier and Danso (2006) acknowledge UPA's multifunctionality, supporting farmer's organizations and their access to information, and labelling safe UPA products.

3.3 Economic impacts of urban agriculture at the city level

Rapid urbanization places a high demand on cities to provide jobs and adequate living conditions. The numbers of urban poor and people operating outside the formal sector are increasing throughout Africa, Asia and Latin America, and many of them incorporate agriculture as part of their livelihood strategies. UPA can be an important livelihood strategy providing nutritious food, savings and (additional or main) income, as has been shown above.

At the city level, the aggregate income and employment effects of UA have to be weighed against the costs of the assistance supplied to the urban farmers (extension and training, quality control, etc.) that are not carried by the farmers themselves. Further, the indirect costs and benefits of UA for the city (also called externalities), such as the positive and negative effects on the social, health and environmental situation of the urban population, must also be considered.

In order to enhance the positive impacts and to mitigate the health risks, it is paramount that adequate policies, legislation and support be available in the city. These positive impacts can be quantified and economically assessed. However, information needed to compare cities – let alone farm systems – is mostly lacking in the literature reviewed. Methods for economic valuation of impacts on sustainability are rarely applied and are still under development. Available data on the wider impacts of multifunctional UPA are presented and discussed below.

Aggregate economic and employment impacts of urban agriculture

The only known available studies on the aggregate value of UA at city level are by Mougeot and Sawio. In 1994, UA in Dar es Salaam, Tanzania, formed at least 60 percent of the informal sector and UA was the second largest urban employer – 20 percent of those employed (Mougeot, 1999). The annual gross output of over 10 000 UPA enterprises totalled US$27.4 million, with an annual value-added of US$11.1 million (Sawio, 1998). Regrettably, no further studies are found, nor studies that take into account additional economic impacts. Some authors (e.g. Anosike and Fasona, 2004; Nabulo *et al.,* 2004) indicate that improved access to food and additional income positively affects the capacity of the urban poor to work and invest, taking up other jobs or micro-enterprises.

Market-oriented agricultural production systems have the capacity to absorb workers from other urban sectors when needed. Farmland in peri-urban Beijing, China is owned by local rural collective units (village committees), but is primarily cultivated by migrants without local *hukou* (household registration), absorbing a high amount of labour (Liu *et al.*, 2004). However, in general there is relatively little use of wage labour in UA , except for peak activities.

Further, UA stimulates the development of related micro- and larger agro-enterprises, such as those related to agricultural inputs (for example production of compost from urban organic wastes, bio-pesticides, small-scale irrigation equipment), product processing (cooking, frying, drying and marmalades, etc.), packaging and marketing (street vending, of outputs and other services (for example animal health services, transport), and employment and income generation (Moustier, 2001).

Valuation of the contribution of UPA to urban food security and health

The contribution of UA to urban food security and healthy nutrition is probably its most important asset and relates to achieving the MDG 1 (see Figure 1). Food production in the city is often a response of the urban poor to inadequate, unreliable and irregular access to food, and the lack of purchasing power. Most cities in developing countries are not able to generate sufficient (formal or informal) income opportunities in urban areas. Lack of income translates directly into lower quantity and/or quality of food intake, more so than in a rural setting. The costs of supplying and distributing food from rural to urban areas or to import food for the cities are rising continuously, and urban food insecurity is expected to increase.

The quantity of food produced annually by urban producers for urban consumers (vegetables, poultry, milk, etc.) is substantial and represents an important economic value. Moreover, since production is close to consumers and direct marketing from producers to consumers of fresh products is possible, food costs are lower than the same foodstuffs brought from the rural areas. There is less transport, cold storage, losses, processing and packaging, leading to direct economic savings for urban residents. Further, there is improved access to food for the urban poor because of lower prices, accessible location and distribution.

Based on 1993 data, it was estimated that 15-20 percent of the world's food is produced in urban areas (Armar-Klemesu, 2000). Some outstanding and well-known examples are Shanghai, Dakar and Havana. In Shanghai, 60 percent of vegetables, more than half of pork and poultry, and more than 90 percent of milk and eggs originate from urban and peri-urban areas. The city administration manages 300 000 ha of land for food production. Over 800 000 citizens (one in six) are actively involved in production alone. Both solid and liquid wastes are well managed to maximize yields and keep the city clean (Yi-Zhang and Zhangen, 2000). The Niayes zone around Dakar, which constitutes only 3 percent of Senegal's land surface, produces nearly 80 percent of vegetables in the country, while poultry production amounts to over 65 percent of the national demand (Mbaye and Moustier, 2000). In Havana, Cuba, over 26 000 popular gardens cover 2 439 ha and produce 25 000 tonnes of food each year (Gonzalvez Novo and Murphy, 2000).

But these are not isolated cases, however (see Table 11). In many cities, intra- and peri-urban agriculture cover a substantial part of the urban demand for vegetables (especially fresh green vegetables), fresh milk, poultry, eggs and, often to a minor extent, pork, fruits and freshwater fish.

Table 11 also shows that UA complements rather than competes with rural agriculture, and has a strong focus on perishable products and niche products such as herbs, flowers and ornamental plants, while staple crops such as rice, maize and other grains, plantains, cassava and yams are mainly 'imported' by the cities from the rural areas or from abroad. In this way the efficiency of the national food production and supply system is enhanced.

Table 11: Food provided by urban and peri-urban agriculture

City	Products	Percentage (%)
Havana (Gonzalvez Novo and Murphy. 2000)	Rice	64
	Vegetables	58
	Non-citrus fruits	39
	Tubers	13
	Eggs	6
Dakar (Mbaye and Moustier, 2000)	Vegetables	70-80
	Poultry	65-70
Dar Es Salaam (Jacobi, Amend and Kiango, 2000)	Milk	60
	Vegetables	90
Jakarta	Vegetables	10
(Purnomohadi, 2000).	Fruits	16
	Rice	2
La Paz (Kreinecker, 2000)	Vegetables,	30
Addis Ababa (Tegegne et al., 2000)	Milk	70
Sofia (Yoveva, 2000)	Milk,	48
	Potatoes	53
	Vegetables	50
Shanghai (Yi-Zhang and Zhangen, 2000)	Vegetables	60
	Milk	90-100
	Eggs	90
	Pork	>50
	Poultry	>50
Nairobi (Foeken and Mwangi, 2000)	Food consumed by low income households	50
Kumasi (Cofie et al., 2000)	Lettuce, spring onions and milk	>90
	Tomatoes and garden eggs	60
	Poultry and eggs	>80
Accra (Drechsel et al., 1999)	Fresh vegetables	90
Hong Kong (Smit, 1996)	Fresh vegetable	45
	Live poultry	68
	Pork	15
	Vegetables	45
Singapore (Smit, 1996)	Vegetables	25
Hanoi (GTZ, 2000)	Fresh vegetables	80
	Pork	50
	Poultry	50
	Fresh water fish	50
	Eggs	40
Kathmandu	Livestock	11
	Vegetables	30

Sources: Nugent, 2000; Urban Agriculture Magazine, 2002

Access to healthy food is as important as availability of food. UA contributes to both availability and access, in particular of fresh and nutritious crops and livestock products. Self-production of food by the urban poor represents from 18 percent (Purnomohadi, 2000 on East Jakarta, Indonesia) to 60 percent (Mbiba, 2000 on Harare, Zimbabwe) of total food consumption in low-income households. In Harare and Kampala, Uganda, up to 60 percent of food consumed by low-income groups was (and probably still is) self-

produced (Mbiba, 2000; Maxwell, 1999) and the same percentage was found in Harare (Bowyer-Bower and Drakakis-Smith, 1996). In Kampala**,** urban producers obtained 40 to 60 percent or more of their household food needs from their own urban garden (Maxwell and Zziwa, 1992).

Self-producing households achieve greater food security and their nutritional status – measured by caloric and protein intake and anthropometric measurements (stunting, wasting) – is better than that of non-farming urban households of the same socio-economic status. In Kampala, children under five in low-income farming households were found to be significantly better off nutritionally (less stunted) than counterparts in non-farming households (Maxwell, 1998). In Cagayan de Oro**,** Philippines, urban farmers generally eat more vegetables than non-urban farmers of the same economic class, and more than consumers from a higher wealth class (who consume more meat) (Potutan *et al*., 2000). In Java, Indonesia, home gardens alone provide for 18 percent of caloric consumption and 14 percent of proteins of the urban population (Purnomohadi, 2000). In Harare, Zimbabwe, households involved in urban farming had more nutritious breakfasts and consumed more protein-rich food over longer periods of the year than non-farming households (ENDA, 1997). In Nairobi, an average energy and protein intake was higher in the farming groups than in non-farming groups, and percentages of malnourished, wasted and stunted children were much lower. The farming households produced between 20 and 25 percent of their food requirements, and are significantly less dependent on gifts and transfers (Foeken and Mwangi, 2000).

In addition to production for their own consumption needs, as indicated above, large amounts of food are produced for other categories of the population (in the city, in general), of which a substantial part is bartered or sold to other lower income households in the same neighbourhoods, as in food kitchens in the United States.

In addition to its contribution to food security, self-production of food reduces the monthly household expenditures on food, leaving more cash available for other basic household needs (health, housing, education, clothing). The potential of UA is increasingly recognized as an important component of HIV-AIDS mitigation programmes, especially in Southern Africa: undernourished people are more vulnerable to attract HIV-AIDS and the progression from HIV to full-blown AIDS and death develops more quickly. In addition, treatment with expensive antiretroviral medication will only be effective if patients are well-nourished, which is most often not the case, and food aid programmes are unsustainable and distort local agricultural markets. In North America, UPA is strongly tied to the growth of urban immigrant communities. Farming in and near cities with high concentrations of immigrants, serves as a vehicle for integration and productive activities, which complements other formal and informal livelihood strategies. In addition, there are increasing concerns of human health related to eating habits in poor urban areas. The rising costs of health services, the alarming rates of obesity among both children and adults, and the growing interest in organic foods grown without artificial fertilizers and pesticides open up opportunities for promoting UPA. Increasingly, local organizations are experimenting with building up local food production and consumption systems using various types of contracts (often prepaid) with cafeterias in schools, hospitals and government offices, with restaurants and with private individuals (through community-supported agriculture and at farmers markets).

The economic value of the above-mentioned contributions of UA to the urban system have rarely been estimated; one might, for instance, estimate what would be the costs of maintaining the urban food supply and distribution at the same level withoutUA: required food imports and/or investments in more transport and cold storage facilities and/or higher investments in health care services.

Health risks

An economic valuation of the impacts of UPA on food security, nutrition and health should obviously also consider the costs related to the eventual negative impacts of UPA on the health of the urban population and/or the costs to prevent such negative impacts (farmer education, product quality control, consumer education, zoning regulations). The main health risks associated with UA include potential impact of polluted irrigation water, pesticide use, soil nutrient depletion, and malaria (Obuobie *et al.*, 2006).

Contamination of crops with pathogenic organisms (e.g. bacteria, protozoa, viruses or helminths), due to irrigation with polluted streams or with insufficiently treated wastewater (Lock and de Zeeuw, 2000) and the unhygienic handling of the products during transport, processing and marketing of fresh products (Armar-Klemesu *et al.*, 1998).

Health aspects related to reusing wastewater are much debated (see Proceedings of the E-Conference on Wastewater Re-use (IWMI and RUAF, published on the www.ruaf.org). The use of wastewater and organic wastes makes good sense from the perspective of the poor urban farm-households: it secures the supply of irrigation water and nutrients, and, most importantly, lowers production costs. Often, there is simply no alternative available (Keraita *et al.*, 2003). However, there are important associated health risks. To protect farmers' and consumers' health, in 1989 the World Health Organization (WHO) published 'Guidelines for the safe use of wastewater in agriculture.' The application of the guidelines, however, has been difficult in many field situations in Africa, as wastewater treatment is not possible for a variety of reasons, and strict application would mean destroying many livelihoods that depend on UPA (Obuobie *et al.*, 2006). Many cities in SSA issued by-laws forbidding the use of drain water for vegetable irrigation, but they are seldom enforced (Danso *et al.*, 2002b). The guidelines were discussed during an expert meeting in Hyderabad organized by IWMI, IDRC and RUAF (UAM, no. 8, 2002). The new WHO Guidelines were released in 2006; they are more flexible and now consider wastewater treatment as only one component in integrated risk management (Obuobie *et al.,* 2006). Nonetheless, more activities should be undertaken in order to examine how wastewater is actually used, to find a better balance between safeguarding consumers' health and farmers' livelihoods, and to cater to improved management practices in UPA (Drechsel *et al.*, 2002).

In Middle Eastern and North African countries (MENA), water is the key development issue. Many countries in the region wish to increase fresh water supplies for domestic and industrial usage, and at the same time expand irrigated agriculture. These seemingly contradictory objectives can be reconciled through adequate water-demand management. The use of treated domestic wastewater for productive uses such as UPA can be an important component (Faruqui, 2002). About 80 percent of Israel's treated wastewater is reused in irrigation. In Tunisia, 18 percent of its treated effluent is used to irrigate around 4 500 ha of

orchards (citrus, grapes, olives, peaches, pears, apples, and pomegranate), fodder crops, cotton, cereals, golf courses and lawns. In fact, almost all of Jordan's treated wastewater is reused (Faruqui, 2002).

The Hyderabad/Secunderabad (India) urban and peri-urban areas, with nine municipalities, have a population of approximately six million. Treated sewage water together with untreated sewage water is diverted to the Musi River, which has become a perennial river because of this year-round inflow of urban wastewater. It has been estimated that a gross area of 16 000 ha is irrigated by the wastewater that flows from the city. Along the Musi River, thousands of men and women depend on its wastewater for a variety of different activities. Farmers have shifted to other crops that grow better on wastewater and tolerate high soil salinity, while peri-urban paddy farmers mix wastewater with groundwater (Buechler and Devi, 2006).

Lock and de Zeeuw (2000) and Obuobie *et al.* (2006) point out the main measures to prevent and reduce the above-mentioned risks: developing, prioritizing and applying risk management strategies. Other measures include:

- monitoring of the irrigation water quality used in UA and of the agricultural products produced/marketed;

- farmer education on management of health risks (for workers and consumers) associated with re-use of waste in agriculture, including;

- adaptation of crop choice in wastewater-treated land. It is not appropriate, for example, to grow fresh salad crops such as tomato, lettuce, parsley, cucumber and mint in poorly treated water; they could be replaced by fodder, fibre, wood and seed crops. Bradford (2002) suggested the use of untreated wastewater for producing rapidly growing pulpwood, such as eucalyptus, on public lands along canal banks, roads and greenbelts, etc. This form of urban forestry is a viable option with higher acceptance potential than (wastewater-irrigated) vegetable production;

- application of drip irrigation or other localized irrigation methods (rather than sprinkler, gravity or spraying). Irrigation with wastewater must be stopped three weeks prior to harvesting;

- consumer education (scraping and washing of fresh salads; eating only well-cooked crops, meat and fish from wastewater-fed crops, animals and ponds);

- exploration of alternative farm land, if available;

- establishment of adequate wastewater treatment facilities with appropriate water treatment technologies (e.g. waste stabilization pond systems rather than sludge treatment plants; the former are cheaper to establish and maintain and retain more nutrients) and reduction of wastewater disposal into streams used for irrigation;

- improvement of institutional coordination and development of integrated policies.

An economic valuation would have to consider the exposed farmers and the consumer. This is a very complex task since large groups of people are needed together with control groups of comparable culture and socio-economic status to verify that it is the wastewater only that makes a significant difference in the calculation of additional costs. This complexity prevents most authors from attempting an economic study. In general, the economic impacts of wastewater on crops may differ widely depending upon the degree of treatment and nature of the crops. From an economic viewpoint, wastewater irrigation of crops under proper agronomic and water management practices may provide higher yields through additional water and nutrients (Danso et al., 2003).

Contamination of crops and/or drinking water by residues of agrochemicals

Prolonged intensive use of agrochemicals (fertilizers, pesticides, fungicides) may lead to residues of agrochemicals in crops or groundwater and then to chronic illnesses (FAO and WHO, 1988; Tixier and de Bon, 2006). The crop risk level is higher in intensive commercial horticulture because of agrochemicals, especially for vegetables, and is very limited in traditional and subsistence farming (WHO Commission on Health and Environment, 1992). Such risks may be prevented/reduced by:

- farmer education on the proper management of agrochemicals;
- promotion of ecological farming practices, replacement of chemical pests, and disease control by integrated pest and disease management (IPM);
- introduction of cheap protective clothing and equipment (Lock and de Zeeuw, 2000).

Contamination of crops by uptake of heavy metals from contaminated soils, air and water

The main causes of pollution with heavy metals are air pollution from heavy traffic and industry, irrigation with water contaminated by industry, the application of contaminated organic wastes (e.g. by leaking batteries) and the use of former industrial land contaminated by industry. Heavy metal content in soils of most cities in developing countries are rarely so high as to cause acutely toxic symptoms. Moreover, Puschenreiter *et al.* (1999) conclude that urban soils with slight heavy metal contamination can be used safely for gardening and agriculture if proper precautions are taken. However, Birley and Lock (2000) indicate that still little is known about the effects of low concentrations of heavy metals in the human food chain over a long period. Measures to prevent and reduce the risks of heavy metals include the following (Lock and de Zeeuw, 2000):

- periodic testing of agricultural soils and irrigation water for heavy metals in areas where contamination is likely (close to industry, within short range of main highways, etc.);
- separation of wastes and wastewater from industry and hospitals and its treatment at the source;
- identification of quality standards for municipal waste streams and composts produced from them;

- Zoning: maintaining a minimum distance between agricultural fields and contaminating types of industry (especially in the area to which the winds are blowing) and between fields and main roads, or planting of boundary trees and shrubs;

- washing and processing of contaminated crops, which may effectively reduce heavy metal content – good results were obtained for lead, but less so for cadmium;

- treatment of contaminated soils with, for instance, lime for immobilization of heavy metals or growing of specific plants.

Transfer of human diseases from disease vectors attracted by agricultural activity in the city

These disease vectors include malaria, dengue, chagas and filariasis derived from the breeding of mosquitoes. In addition, poor disposal of animal manure, crop residues and other farm refuse may attract rodents and flies that may be carriers of diseases such as plagues. Scavenging by domestic animals (e.g. cats, pigs and rats), is further associated with food-borne diseases such as amoebic and bacillary dysentery. Irrigated UPA may create favourable habitats for insect disease vectors, especially malaria mosquitoes, since mosquitoes transfer malaria (anophelines) breeds in standing clean water (Birley and Lock, 1999). This could lead municipalities to withdraw support to UA while also hampering the promotion of clean water – rather than untreated wastewater – for irrigation (Danso et al., 2003). Such risks could be reduced through:

- properly designed water tanks and irrigation systems in peri-urban areas to prevent malaria;

- farmer education on the precise breeding conditions of anophelines.

The vectors for dengue and filariasis breed in standing water polluted with organic material and strongly depend on the local situation regarding solid waste management, water storage and use and sewerage (e.g. drains cloaked by refuse) in the urban settlements and their direct surroundings. Close cooperation between health, environmental and other institutions are necessary to reduce these vector-borne diseases (Lock and de Zeeuw, 2000).

Other prevention and control measures include:

- application of slow-release floating formulations to control the malarial vector; use of expanded polystyrene balls against mosquitoes breeding in latrines and stagnant polluted waters;

- farmer and citizen education on good farm waste management practices.

Transmission of certain diseases from domestic animals to people (zoonosis)

Bovine tuberculosis, pig and beef worm, trichinosis, anthrax, salmonella, campylobacter, and other diseases can be transmitted to humans by keeping livestock in close proximity, if proper precautions are not taken (Kathleen Flynn, 1999; Schiere and van Veenhuizen, 2000). Transmission may occur through the consumption of contaminated milk (bovine tuberculosis),

infected meat (pig and beef worm), scavenging animals (trichinosis), a cut in the skin (anthrax) and contamination of animal feed (Salmonella and campylobacter). Protective frameworks are required to deal with the upward trends in disease occurrence derived from increasing population pressure and densities, and the multi-dimensionality of health. Intensification of animal production in and around cities combined with changing food habits make food safety a priority issue (Schiere *et al.*, 2006).

Measures to prevent and control zoonosis include (Lock and de Zeeuw, 2000):

- consumer education on thermal treatment of all milk and dairy products,
- proper cooking or freezing of meat products;
- restriction of uncontrolled movement of livestock in urban areas and replacement by confined systems and stall feeding;
- improvement of the animal wastes management by collection and composting;
- strict control of animal slaughter; exclusion of pigs infected with tapeworms;
- simple laboratory antigen testing for anthrax infection;

Occupational health risks

Improper handling of agrochemicals may lead to health problems among urban farmers. Similar professional health risks are run by persons involved in handling urban wastes and wastewater.

Economic valuation of social impacts of urban agriculture

UA provides a good buffer against political or economic shocks, thus providing a good social safety net (Nugent, 2000). In periods of crisis, households can start this activity with relatively few barriers and thereby provide additional food or income for the household. With the proliferation of techniques such as organoponics, hydroponics, tyre and cage farming, vertical farming techniques, roof top farming, etc., even access to land is no longer a decisive factor to engage in farming when the need arises. In periods of crisis, a rapid increase in UA activity can be found. Well-known examples are Berlin in 1945, Havana (and other cities in Cuba) under the economic blockade in the nineties, or Moscow and other cities in Eastern Europe after the collapse of the former USSR, and more recently, cities in Eastern Congo because of armed struggles and the Gaza Strip during the Intifada. After surviving the crisis period owed to UA, many urban citizens reduce or stop such an activity and resume to 'normal life'.

The crisis is more or less permanent, however, for many other urban households such as, marginalized groups with little chances to improve their livelihood situation, the unemployed, pensioners, the handicapped, discriminated minority groups, HIV-AIDS affected households and orphans, and recent immigrants. Specifically, the critical role that women have in food procurement, preparation and distribution in and outside the household must be considered. Poor female-led households are particularly at risk of food insecurity because they have less access to rural and urban land and to credit resources. Their role in food security may be enhanced by their participation in UPA projects, especially if located close to home. For a growing number of urban youth, in the face of rising school costs and shrinking formal employment, market-oriented UPA and related enterprises provide a relatively accessible entry into the urban job market. They may be able to earn an income, learn a trade and set up a small business, when these alternatives are available.

Many city governments have realized that UA provides opportunities to involve specific vulnerable groups in the socio-economic city life (social inclusion) and an important strategy for poverty alleviation. They have therefore started UA projects, including the provision of access to municipal land, training, technical assistance and investment and marketing support for agricultural production and processing enterprises (see Garnett, 2000; Gonzalez Novo and Murphy, 2000).

A good example is the above-mentioned PROVE programme in Brazil designed to fight urban poverty by promoting small-scale agricultural production, processing and trade by marginalized households. In addition to changing productive practices, an unquestionable result of the programme, PROVE, has also paved the way for a gradual change in the mentality and raised social awareness of the producers. In most cases, they no longer perceive themselves as housewives, backwoodsmen and employees, and begin to think and act like rural entrepreneurs, that is, individuals who can more clearly understand the logic of the context that had previously excluded them (Homem de Carvalho, 2001).

The Community Patio project in Havana, Cuba encourages the practice of UA , utilizing permaculture techniques in home gardens to produce food, medicinal plants, spices and ornamental plants. It further includes environmental education and capacity building for neighbours, schools and hospitals for the elderly (Lazo and Barada, 2002).

A project in Brisbane, Australia involves unemployed youth who collect food wastes from restaurants within a half kilometre of an urban farm located on a roof in the city. After pulverization, the wastes are composted and fed to worms (vermiculture). The worms and liquid nutrients are again used to raise vegetables (hydroponics) and fish on rooftops. The produced vegetables, herbs, fish and crustaceans are subsequently fed to the same restaurants again (Wilson, 2002). Similar farms – not necessarily on rooftops – are part of social projects in the United States.

In the Dominican Republic, vacant open spaces in the neighbourhood – previously used as illegal waste dumps, attracting crime and violence – were turned into a positive and innovative experience , as wastelands were converted into community gardens and green areas by collective cleaning and production activities involving unemployed youth trained in organic agriculture (Acevedo Abinader, 2001). The participants in these urban gardening and greening projects regain self-esteem and a goal in their lives, and often feel enriched by the possibility of working constructively, building their community, working together and producing food and other products for consumption and for sale.

Community-based UA can make several contributions to community development. At the core it provides social interaction, which is a key attribute in building and re-building a community. Since food is basic to all the community members, it facilitates interaction. But food production is also an economic activity that links to other economic activities in a community, including credit, manufacturing and retailing. It also creates jobs, particularly for women, the elderly and youth, and may form the basis for wider processes of revitalizing and improving the whole neighbourhood.

Several cities in the Uinted States support the establishment of farmers' markets where urban and peri-urban producers can sell their organic products directly to consumers and

train underprivileged workers at urban community farms in marketing and consumer services. Linkages are deliberately developed between more social activities (youth and immigrant inclusion) and entrepreneurial UPA (food boxes, sale at farmer markets, etc.) in order to become sustainable at the programme level.

In more developed cities, UA may be undertaken for physical and/or psychological relaxation, rather than for food production per se. Urban and peri-urban farms may also take on an important role in providing recreational opportunities for citizens (recreational routes, regional food from the farm, visiting facilities) or educational functions (bringing youth closer to animals, teaching ecology).

When valuing the economic impacts of UPA, the above social impacts should be included. However, quantification and valuation of such impacts of UPA are rarely undertaken and adequate methods to do so are rarely available (Wolff, 2004).

Economic valuation of UPA's contributions to urban environmental management

UA is part of the urban ecological system and can play an important role in the urban environmental management system by protecting the environment, reducing the amounts of waste that need to be transported out of the city, reducing the city's ecological footprint, and contributing to greening of the city. The fast-growing cities produce more and more wastewater (Buechler *et al*, 2002) and organic wastes. Waste disposal has become a serious problem for most cities (Cofie *et al.*, 2006). UA can contribute to solving such problems by turning urban wastes into a productive resource. The use of fresh (untreated) wastewater offers an additional advantage for poor urban farmers, because it contains many nutrients, although often not in the proportions required by their soils and crops. In particular, in and around cities in arid and semi-arid zones, the use of urban wastewater can be very important (Buechler and Devi, 2002 on Hyderabad, India; Keraita *et al.*, 2002 on Accra, Ghana).

In most cities, most of the organic wastes, which often form more than 50 percent of the urban wastes, are often illegally dumped or burned (Cofie *et al.*, 2006). The provision of sufficient food and of basic sanitation services, two major challenges in (mega-) cities, are inter-linked because the urban food supply contributes significantly to the generation of urban waste (Drechsel and Kunze, 2001). In principle, therefore, recycling organic waste through composting could be a win-win situation for municipalities and farmers. The interests of urban waste recycling concur with the promotion of UA since urban and peri-urban farmers are in need of organic matter as a soil conditioner. Cities and towns, on the other hand, wish to conserve disposal space and reduce the costs of landfills as well as municipal solid waste management. For example, in Marilao, Philippines (Duran *et al.*, 2006), the municipality combined recycling of organic waste with a poverty alleviation scheme. Also important is the need for collaboration between informal waste collectors and the private sector contributing to urban waste management into this process. There is an increasing number of private or municipal initiatives to collect household waste and organic refuse from vegetable markets and agro-industries to produce compost or animal feed (Eaton and Hilhorst, 2003). Recycling waste and sewage sludge reduces the difficulty of disposing solid wastes, replaces the use of expensive and potentially polluting chemical fertilizers, and prevents soil degradation and erosion in the agricultural areas. Another example comes from Nairobi, Kenya, where Njenga and Karanja

(2006) report on 11 community-based organizations that compost about 0.6 percent, or 2 500 tonnes, of the total organic waste produced in the city daily. An increasing number of urban and peri-urban farmers use these urban wastes (composted, semi-composted or fresh) and urban wastewater (treated, partially treated and untreated) for fertilizing and irrigating their farms when access to other sources of water and nutrients is limited or when prices of such inputs are high.

Enhanced and decentralized reuse of urban wastes and wastewater reduce the city's costs for wastewater treatment plants, waste collection and waste disposal sites, *inter alia*, and decrease environmental problems that occur when the city cannot cope. This is the case in most cities in developing countries, leading to an often uncontrolled disposal of urban wastes and wastewater on vacant land and into rivers (Duran *et al.*, 2006, Cofie *et al.,* 2006).

UA and urban forestry may also positively impact on the greening of the city, improve the urban microclimate (wind breaks, dust and noise reduction, shade) and maintain biodiversity. They also contributes to reducing the ecological footprint of the city (Smit, 2000; Konijnendijk *et al.*, 2004). Comparisons can be made between UA and public parks, as well as their respective costs and benefits to city greening and landscape management. The advantage of UA over public parks is that UPA's operations are supported by market forces, even if these markets are imperfect (Moustier and Danso, 2006). It therefore costs less as a landscape producer than maintaining a public park. In addition, it provides food and income, and, especially in more advanced cities, may provide recreational and/or educational services for urban citizens. The multi-functionality of UA makes it a cheap producer of public goods (Kaufman and Bailkey, 2000).

On the other hand, it is necessary to consider the costs of some negative effects that urban farming may have on the urban environment:

- Monocropping may lead to hillside erosion (Bowyer-Bower *et al.,* 1996 on peri-urban rainfed maize production, Harare).

- Intensive irrigated vegetable production (with a high number of harvests per year) may lead to nutrient mining (Obuobie *et al.*, 2006). Farmers may balance this through high manure or fertilizer application, as shown in Ghana where high poultry manure application rates compensate for nutrient mining (Drechsel *et al.*, 2000a).

- Intensive use of agrochemicals over a prolonged period may also lead to contamination of underground water sources (Tixier and de Bon, 2006; Obuobie *et al.*, 2006). This may occur especially in peri-urban areas with intensive vegetable growing, whereas the risks are very limited in most other types of UA because of , *inter alia*, resource constraints of the farmers involved, the use of composted organic wastes and wastewater as source of nutrients, and the application of organic pest and disease management methods.

- Application of irrigation water contaminated by heavy metals or pathogens may lead to soils and ground water contamination (Simmons, in Buechler and Devi, 2006).

Many of these problems can be prevented by introducing agro-ecological farming practices and integrated pest management control. The environmental impacts of UPA can

be assessed by the contingent valuation method (people's-willingness-to-pay for an improved situation), the hedonic price method, and the travel cost method (Nugent, 2001). To date, however, no systematic attempts have been undertaken.

Productive use of open spaces

In most cities, urban land is unavailable or inaccessible to urban producers, and the areas that can be used for agricultural production are most often unsuitable (Mubvami *et al.,* 2003). There is high demand for land for residential, institutional, commercial and industrial development, among others. Many examples (see UAM no. 11, 2003 on Kano, Nigeria; Dar es Salaam, Tanzania; and Bamako, Mali, and Accra, Ghana) show that UA may face very stiff competition from other urban land uses. Availability refers to the land that can be utilized for UA in the short or medium term, or permanently. Accessibility refers the opportunity for actual use of available land by households or groups in need, taking into account administrative procedures and conflict resolution mechanisms in cases where conflicts arise. The suitability of the land for UA is a function of topography, soil texture and fertility, moisture and other environmental qualities. Access to suitable and adequate land within a conducive legislative framework will ensure sustainable UA.

No matter how crowded cities may appear, there are always open spaces that may be used for agricultural productive use. Whether on backyards, terraces, vacant public, semi-public or private lands, on temporary vacant land or along protected areas, these patches can be made more productive. Buffer zones between residential and industrial areas, flood-prone or earthquake zones, land reserved for building, but for which funding is not yet available, and land under speculation can also be made more productive. The main issue here is that the city is dynamic, and torn down, old residential or industrial areas very often lay idle, waiting for redevelopment. In the city of Rosario, Argentina, an analysis revealed that as much as 35 percent of land was vacant or partially vacant land. Under a multi-actor programme, 10 000 families have obtained access to part of these lands and improved their access to food (Dubbeling, 2003). In the Dominican Republic, a combination of problems, such as vacant spaces often used as illegal waste dumps in the city and poverty, were transformed into a positive and innovative experience through joint planning exercises, collective cleaning and the creation of community gardens converting wasteland in green areas. (Acevedo Abinader, 2001).

In the United States, Chicago has more than 70 000 vacant lots, an estimated half of which are tillable (Cohen, 2001). Communities have turned to use these lots into productive agricultural sites. The city of Chicago is now cooperating in identifying open spaces. The grassroots organization Ivy Crest removed 3 000 tires from a vacant lot, which now hosts a burgeoning and beautiful garden where youths are trained in organic agriculture, and more importantly, regain self-esteem and a goal in their lives. Other municipalities provide economic incentives and technical support to neighbourhoods and youth groups that take action to clean up derelict and deteriorated open public spaces ('no-man's land') and turn them into gardens for the production of food, flowers, ornamentals and herbs. In New York, community groups and volunteers, with the help of the Department of Sanitation, cleaned out derelict open spaces in their neighbourhoods and set up community-supported gardens (e.g. the Clinton Community

Garden). A recent study revealed that the opening of a community garden leads to an increase of the prices of residential properties within 1 000 ft of the garden, and that the impact increases over time; the greatest impact observed is in the most disadvantaged neighbourhoods (Kami Pothukuchi, 2006).

UPA has an economic impact at the city level, but is it profitable?

The review of the impacts of UA at the city level shows that UPA contributes to LED by generating (often complementary) income, micro-enterprise development and employment (mainly self-employment). UPA also contributes substantially to securing food security and nutrition of the urban population, especially the urban poor. It also serves as a social safety net in times of economic or political crisis and is applied by policy-makers as a strategy to promote social inclusion of disadvantaged categories of the population and community revitalization. Finally, UA contributes to urban environmental management by turning wastes into resources, contributing to a better urban climate and managing the urban landscape. On the other hand, UA may have negative impacts, especially on health, and to a minor degree, on the urban environment. As in the rural areas, UA needs proper management and support to minimize health and environmental risks.

Few attempts have been undertaken to quantify these positive and negative effects of UA at the city level, and even less, to estimate its economic value. Most researchers and practitioners on UA have anecdotal evidence, however, that the positive effects of UPA on health and environment far outweigh the negative. When the socio-economic benefits are taken into account, the balance is clearly in favour of UPA. Nevertheless, this is still difficult to substantiate because of lack of data and methodological issues.

3.4 Sustainability of UPA

A proper analysis of the sustainability of UA would need improved data collection and monitoring of indicators during a prolonged period of time. The interactions with other urban activities should also be included. Most of the literature reviewed does not satisfy such criteria. Several of the indicators mentioned (see also Table 4) have been used or referred to in the literature on UA studies. Table 12 gives some examples.

According to Fialor (2002), the sustainability of UPA hinges on the security of access to land input use and availability, output levels obtained and the prices received per unit of output, as well as capacity to achieve these prices without significant negative environmental consequences. For example, Fialor showed an increase in seasonal and annual demand (which cannot be satisfied) for UPA produce in Kumasi, Ghana. The environmental considerations in measuring sustainability in Kumasi showed a low but increasing threat from UPA, particularly with regard to pesticide use. In order to sustain UPA, there is a need to intensify production and to adopt production strategies that can minimize costs, while reducing risks for health and the environment. However, the author concludes, the main factor for sustainability seems to be improving the security of land access.

Table 12: Sustainability indicators used in studies on UPA

Indicators/criteria	Examples of studies
Productivity	Asia: Yeung (1986); Nairobi: Dennery (1996)
Land security	Kumasi and Accra: Flynn-Dapaah (2002); Drechsel et al. (1999)
Protection of environment and people	Manila: Angeles (2002); Bangkok: Burleigh and Blake (2001),
Economic viability	General : Smit et al. (1996, 2000); UAM, no. 1. 2, and 7: various articles. Moustier and Danso, (2006)
Acceptability (social, political)	Accra: Obosu-Mensah (2002); Harare: Mushamba (2002); West-Africa: Flynn-Dapaah (2002); North America: Kaufman and Bailkey (2000)
Ability to form cooperatives	Harare: Mushamba (2002); Manila: Angeles (2002)
Combined indicators, SWOT	Cape Town: Small (2002); General: Streiffeler (1987); Ouagadougou Gerstl (2001)

Source: Based on Danso *et al.*, 2003

Gerstl (2001) highlighted two major threats for the sustainability of urban off-plot farming (not on own plots): first, the fact that UPA is usually part of the informal sector, i.e. without formal recognition or legislation; and second, that most of the land or field is not owned by producers. This lack of secure tenure and access to suitable land is a major issue in the sustainability of UPA. Yi-Zhang and Zhangen (2000) state that in addition to land shortage, labour shortage can also limit the sustainability of UA. The production costs in the Shanghai area are on average 15 percent higher than in rural vegetable-producing areas. This could make UPA unsustainable unless other functions of UPA are appreciated.

Mireri (2002) showed that in Nairobi, Kenya, commercial UA is a viable economic activity, but criticizes the sector's limited credit and investment opportunities to effectively spur its growth and development. He concludes that the government has an invaluable role to play in promoting sustainable UA. The integration of UA into the urban land use system and the creation of a favourable policy environment are critical steps in the development of the sector. Furthermore, there is a need to form farmers' associations and marketing cooperative societies. A strong farmers' association can articulate and lobby for necessary government recognition and general development of the sector. Marketing of co-operative societies can effectively address marketing problems, thus enhance the profitability of urban farming. Also, urban farmers lack critical information on the best farming practices and available support services. Through appropriate farmer associations, avenues can be also created to disseminate information to farmers.

Obuobie *et al.* (2006) and Drechsel *et al.* (2006) point out that for 20 years on some sites in Accra, urban farmers have been cultivating several harvests per year on the poorest soils and without any fallow period, applying high amounts of organic inputs. This may be considered a sustainable and highly productive land use system in an environment that normally only supports shifting cultivation. The authors further argue that many other expressions of UPA may have to be considered temporary phenomena, or 'urban shifting cultivation' where farmers have to move to another site in the vicinity or to the peri-urban fringe: mobility is a crucial and

coping strategy of these livelihoods. UPA may bring perishable crops closer to markets (since refrigerated transport or open import markets are lacking); help towards saving money in low-income situations (via backyard production); and provide food in crisis situation, but as soon as these problems are solved, these UPA expressions might lose their significance. Danso *et al.* (2003) summarized their findings for the Ghana situation, as shown in Table 13.

In addition to such problems having the tendency to become structural (e.g. in western countries, many urban people are also impoverished), improving these conditions may take generations and such UPA expressions might take up other functions. Community gardens, for instance, may become less important for food production, but very important for social inclusion or for recreation.

Cabannes (2006) emphasizes that UA requires political legitimacy and financial support if it is to continue developing as a productive force. While political support for UA has been steadily increasing, financial support for urban growers has been more limited. Most urban producers lack access to credit and investment schemes, and a more systematic survey and evaluation of significant and diverse modalities of finance and investment provision to UA has been suggested.

Table 13: Sustainability of UPA in Accra and Kumasi (Ghana)

Indicators	Specific considerations for the sustainability of UPA in Accra and Kumasi
Maintained or increased productivity	Constant access to inputs (seeds, fertilizer, pesticides, irrigation water); access to finance; niche crops; intensification; demand fluctuations; organic production (and marketing).
Economical viability	Net income; niche crops; diversification; combining various functions.
Social acceptance	Political recognition and support; consumer recognition; community acceptance and involvement (by farmers, market women and consumer associations).
Environmental protection	Frequency of wastewater application; time before marketing; protective clothes
Alternative land use	Land value development; land availability; zoning; innovative tenure arrangements.

Source: Based on Danso *et al.*, 2003

It is recommended to promote the implementation of integrated impacts assessment studies of UPA at the city level, focusing in particular on socio-economic and health aspects, but also on the multi-functional use of UA in order to enhance SUD. Sustainable UA should be combined with landscape management and recreational functions, most of which are not yet included in economic analysis of UA.

In their review of African and Asian case studies, Van den Berg *et al.* (2002; 2005) concluded that UA can play many different roles and that UPA is highly dynamic, principally because of severe competition for urban space for other functions. The authors argue that the sustainability of UA in the long run depends on the degree of synergy and conflict between UPA and the city. The synergy of UPA with the city must be enhanced by adapting to the

urban circumstances – e.g. by producing specific products and by combining with other urban functions such as recreation (Jiang *et al.,* 2005) and landscape management. Conflicts must be remedied with the city by reducing negative externalities by changing to agro-ecological production methods with less associated health and environmental risks. Table 14 summarizes these aspects for three dimensions of sustainability.

According to de Zeeuw (2005), the main factors constraining sustainable development of UA are, inappropriate urban policies and regulations, limited access to productive resources and insecure land tenure, lack of support services and appropriate technologies and lack of organization among urban farmers (see Chapter 4).

Table 14: Synergies and conflicts in urban agriculture sustainability

	Dimensions of sustainability of urban agriculture		
	Environmental	**Economic**	**Social**
Synergy	Plant nutrients in urban waste and sewage; urban greening and micro-climate; landscape and biodiversity management;	Food production; access to inputs and markets; amenities employment and income generation.	Human needs for food and green (recreational) space; poverty reduction; community building;
Conflict	Urban pollutants affecting agricultural soils and irrigation water; agro-chemicals affecting urban environment.	Competition with other urban land uses; vandalism and theft.	Negative perceptions of UPA; UPA not yet adapted to urban demand, e.g. for recreation.

Source: Based on Van der Berg, 2002.

3.5 Conclusions

The above overview clearly shows the need for more systematic research on the economic impacts of UA using standardized indicators and measuring methods. The data collection and analysis should be gender-specific.

At the household level, in addition to cost-benefit analysis of the agricultural production, income derived from processing and marketing activities as well as other functions of UPA should be given attention. Further, it would be of interest to compare the relative contribution of UPA with income derived from other livelihood strategies employed by the family, as well as the estimated value of alternative uses of the labour/money now invested in UPA. Finally, a more dynamic analysis of the changes over time is needed (trend analysis and simulations). More attention is also needed for analysing the economic impacts and profitability of UA at the aggregate (city) level, making use of, for instance, contingency valuation and similar methods (Moustier and Danso, 2006).

The above seems to indicate that UPA is sustainable if it maintains its dynamism and flexibility, adapting to changing urban conditions and demands, intensifying productivity and diversifying its functions for the city while enhancing synergy and reducing conflict, and thereby gaining more social and political acceptability. In certain parts of the city, the present

forms of UA may fade away or change its form and functions drastically, while new forms of UA may develop in other parts. In the long-term, urban farming shows a significant level of resilience, dating back more than 100 to 150 years (Drechsel *et al.*, 2006).

Although UA occurs under varying socio-political conditions and policy regimes, this overview also indicates that urban policy-makers, and governmental and non- governmental support institutions can substantially contribute to enhancing its development and sustainability through these means, among others:

- formally accepting UA as an urban land use;
- the creation of a conducive policy environment;
- enhancing the security of access to vacant open urban spaces;
- supporting the establishment and strengthening of urban farmer organizations;
- enhancing the productivity and economic viability of UA by improving access of urban farmers to training, technical advice and credit;
- taking accompanying measures that ensure that the health and environmental risks of UA are reduced (farmer training on health risks and related management practices, zonification, quality control of irrigation water and products, etc.).

Multi-stakeholder participation in policy-making is paramount for enhancing UPA sustainability.

4. Policy development regarding urban agriculture

In the past, because of a dominant view on urban planning and a lack of access to research data, among other reasons, policy-makers often had a misconceived view of UA as a temporary phenomenon or a remnant from migration of rural farmers to the city that would fade over time. UA was seen as incompatible with urban development, a nuisance and risk factor; for that reason, policies on UA were mainly restrictive and at best, agriculture was temporally tolerated (mainly peri-urban) as a reserve area for future urban expansion.

However, research reveals that UA must be understood as a permanent and dynamic part of the urban socio-economic and ecological system, using typical urban resources, competing for land and water with other urban functions, influenced by urban policies and plans, and contributing to urban social and economic development.

Indeed, an increasing number of national and local authorities have come to understand the role urban farmers can play in various urban policy areas such as LED (production, income, enterprise development); health (food security and nutrition, food safety); urban environmental management (urban greening, climate and biodiversity; waste recycling; reducing ecological footprint of the city); and social development (poverty alleviation, social inclusion of disadvantaged groups, recreational functions). (These linkages are described in van Veenhuizen, 2006 and shown in Figure 1.)

Rather than merely prohibiting or temporally tolerating UA, many local and national governments are formulating policies that facilitate and regulate UA, seeking to maximize its contributions to the various policy goals, while actively reducing the associated health and other risks, for example, by involvement of the direct stakeholders in the analysis of problems and joint development of workable solutions.

According to Allen (2001), the most important aspect of a strategic urban planning (for example for the peri-urban area) is related to the participation of the urban poor themselves in the analysing the situation, in the definition of priorities, and in action planning and implementation. Such consultative multi-actor processes will not only make the results of policy development and action planning robust and comprehensive, but also accepted and sustainable. The variety of local conditions and the subsequent diversity of types of UA logically demand a careful analysis of the local context, and carefully designed and differentiated policy measures and action programmes for UA.

For sustainable UA development, multi-stakeholder participation is particularly important since it involves a great diversity of systems and related actors (e.g. input providers, vegetable producers, fish or livestock farmers, micro-entrepreneurs, middlemen

and vendors) and touches on many urban management areas (e.g. land use planning, environmental and waste management, economic development, public health, social and community development, housing programmes and management of parks and green structures). Adequate information on these issue and transparency in decision-making are crucial (Dubbeling and de Zeeuw, 2006).

Once municipal authorities understand that UA can contribute to some of their policy goals, they often seek to facilitate the development of UA by means of pro-active policies and intervention strategies that enhance the socio-economic and nutritional benefits of UA, while reducing the associated health and environmental risks. These issues and related policy measures can be categorized under the following headings:

- Creating a enabling policy environment for UA and its formal acceptance as an urban land use.
- Securing access to suitable vacant urban land and land tenure security.
- Enhancing the productivity and economic viability of UA.
- Taking measures to reduce the health and environmental risks associated with UA.
- Supporting urban farmers and their organizations with adequate services.
- Appropriate technology development.

Creation of an enabling policy environment

Formally accepting UA as urban land use and integrated in urban development and land use plans is a crucial step towards effective regulation and facilitation of UA development. Current policies and by-laws on UA will have to be reviewed in order to identify and remove unsubstantiated legal restrictions on UA and to integrate more adequate measures to effectively stimulate and regulate the development of sustainable UA.

A second important step might be the creation of an institutional home for UA. Traditionally, the definition of sectoral policies have generally assumed that agriculture refers to the rural sphere and is not governed by urban institutions, while most agricultural organizations do not operate in the urban sphere (Tacoli, 2001). As a result, UA has received little policy and planning attention and development support.

Municipal authorities can play a key role in filling this gap by, inter alia, selecting a leading institute in the field of UA with an UA office or department, and setting up an interdepartmental committee on urban food production and consumption. Dialogue and co-operation should be promoted among the direct and indirect stakeholders in UA , for instance, by setting up a multi-actor city working group or similar platform on UA that organizes a joint analysis of the presence, role, problems and development perspectives of urban agriculture, coordinates the process of interactive formulation of policies, and the planning and implementation of action programmes by the various actors.

Such a platform is of utmost importance since UA is a cross-cutting issue and requires a multi-sectoral approach with inter-institutional and public-private cooperation. In many countries, however, there are no mechanisms in place that facilitate, for instance, coordination between sectoral departments and between municipal authorities, NGOs, groups of urban farmers and other

stakeholders in urban food production and consumption (de Zeeuw, 2005). Single departments or organizations can develop and implement adequate responses to the many challenges in sustainable development of UA only through sustained, concerted action of the direct and indirect stakeholders, each contributing with their own knowledge and resources to an effective strategy.

Several cities, such as Nairobi and Accra, have created a municipal agricultural department. In Villa María del Triunfo, Lima, Peru, an UA subdepartment was created under the Department of Economic Development, while at the same time, UA was included as a priority area in the Concerted Economic Development Plan (2001-2010). In 2001, the City of Rosario, Argentina assigned the Secretariat of Social Promotion with the responsibility of coordinating the new Urban Agriculture Programme, and the staff involved grew from one to several full-time workers in the last five years. In Cape Town, South Africa, an inter-departmental working group was established in 2002 to coordinate the UA activities of various municipal and provincial departments and facilitate integrated policy development (de Zeeuw *et al.*, 2006).

Based on experiences in various programmes and cities (see Box 3; Dubbeling, 2001; van Veenhuizen, 2006; Dubbeling and de Zeeuw, 2006) a multi-stakeholder approach to policy-making and action planning on UA has been developed, which is adopted by an increasing number of municipalities.

Also, it would be instrumental to set up a database on UA at the city level with collected data and maps, and information on successful policies and projects, appropriate technologies for UA, effective and participatory planning, research methodologies and available expertise.

Box 3: Multi-stakeholder processes for policy-making and planning for UPA

Multi-stakeholder processes dealing with UA have been developed in the context of the implementation of the Local Agenda 21 and in the Sustainable Cities and Urban Management Programmes of UN-Habitat (Quito-Ecuador, Rosario-Argentina and Dar Es Salaam-Tanzania) as well as in North American and Canadian cities promoting sustainable food systems through Food Policy Councils (like in Toronto, Canada, Chicago, USA, and Vancouver, Canada). In most cases, a city working group or platform on urban agriculture or urban food issues is established, involving all direct and indirect stakeholders in urban food production and consumption. The working group serves as a platform for dialogue and consensus-building among the various stakeholders (municipal departments, NGOs, community organizations, farmers' groups, governmental organizations, private enterprises and others) on the present situation of urban food production and consumption in the city, key problems and development potential, target groups, available open spaces for urban agriculture and their suitability, adequate incentives and regulation strategies and instruments. The platform will coordinate the development of an appropriate legal framework and subsequent participatory planning, budgeting, implementation and evaluation of development actions. (More information on this approach and its application in various parts of the world can be found on the RUAF Programme website: www.ruaf.org.)

Securing access to land

Land is a very important resource for UA, and its availability, accessibility and suitability are of particular concern to urban farmers. City governments may carry out various activities to facilitate access by urban farmers to available urban open spaces (see UA-Magazine no. 11):

- Making an inventory of available vacant open land in the city (through participatory methods and GIS) and analysing its suitability for use in agriculture (see Drescher *et al.*, 2000 on Cienfuegos, Cuba; Piura, Peru; Dar es Salaam, Tanzania).

- Creating a municipal agricultural land bank that brings into contact those in need of agricultural land with landowners in need of temporary or permanent users (for example Rosario, Argentina). In Cape Town, South Africa, under-utilized land around public facilities, road verges, etc., are leased out to groups of urban poor households. NeighborSpace in Chicago, an organization independent from but close to the City Council, acts as a liaison between the city (as landowner) and community gardeners who wish to use the land. However, those in need of land are often unaware of such opportunities; information campaigns should therefore be an important accompanying measure.

- Formulating a city ordinance to regulate the (temporary) use of vacant land in the city, as in Havana, Cuba; Cagayan de Oro, the Philippines); Lima, Peru; Bulawayo, Zimbabwe; and Governador Valadares, Brazil (de Zeeuw *et al.*, 2006).

- Providing vacant municipal land to organized groups of urban farmers (as in Cagayan de Oro, the Philippines; Lima, Peru).

- Taking measures to improve the suitability of available tracts of land, for example by removing debris or providing access to irrigation water.

- Demarcating areas for UA as a form of permanent land use and its integration into city land use planning (as in Dar es Salaam and Dodoma, Tanzania; Dakar, Senegal; Maputo, Mozambique; Bissau, Guinea-Bissau; Pretoria, South Africa; Kathmandu, Nepal; Accra, Ghana; and Harare, Zimbabwe). These areas aim to support agriculture and/or to protect open green areas from development, create buffer zones between conflicting land uses (e.g. between residential and industrial areas) and reserve inner city space for future uses. In Beijing, China, specific UA activities are promoted in the different peri-urban zones (see UAM, no. 16, 2006). Such zones are normally more sustainable if located in areas that are unsuitable for construction or where construction is undesirable, as on flood plains, under power lines, in parks or in nature conservation areas, and if effective guidelines are developed with active farmer participation on the management practices to be adopted by each type of UA in the different location (de Zeeuw *et al.*, 2006).

- Providing assistance to reallocate urban farmers, especially urban farmers who are poorly located and where there are strong health and/or environmental risks.

- Including space for individual or community gardens in new public housing projects and slum upgrading schemes.

Enhancing the productivity and economic viability of urban agriculture

The creation of a lead agency on UA, the establishment of a city working group – or platform – on UA, and the multi-stakeholder policy formulation and action planning process may lead to a variety of measures. Part of these measures will need to focus on enhancing the productivity and economic viability of the various UFSs. Such measures need to be specified for each of the main farming systems present in the city since problems and development potentials of each farming type may vary substantially.

Taking into account frequent constraints encountered, important areas of intervention are:

- *Adapted research and technology development activities together with specific types of urban farmers* in order to solve current problems or to realize potential (space-confined technologies). Governmental organizations and the private sector should be encouraged to provide training, technical advice and extension services to urban farmers, with a strong emphasis on ecological farming practices, proper management of health risks, farm development (e.g. intensification and diversification), enterprise management and marketing.

- *Recently initiated UA programmes, including training and education activities* (de Zeeuw *et al.*, 2006). The Urban Agriculture Programme of Rosario, Argentina provides technical assistance and training to the producer groups. Similar initiatives are available in Governador Valadares, Brazil. In Cape Town, South Africa, the draft policy calls on the services of research, training and support organizations in and around the city to provide the urban farmers with training on business administration, technical skills, and marketing, etc.

- *Education and extension institutions,* which should be encouraged to include UA in their curricula and programmes.

- *Improvement of access to inputs* (for example urban organic wastes and irrigation water) and facilitating of decentralized production of such resources, for instance, by: establishing low-cost facilities for sorting organic wastes and producing compost, animal feedstuffs or biogas; implementing pilot projects with decentralized collection and treatment of household wastewater with a view to its re-use in local agricultural production; and technical and financial support (for example tax reductions) for enterprises producing ecologically-friendly inputs such as natural fertilizers, bio-pesticides, soil amendments and open pollinated seeds.

- *Farmer education and provision of technical assistance* on sustainable and safe farming practices, farm development (e.g. intensification and diversification), enterprise management and marketing, etc.

- Promotion of farmer organizations and strengthening of market chains.

- *Facilitation of access of urban farmers to credit and finance* (with an emphasis on women-producers and the resource-poor farmers).

- Establish special credit schemes for urban farmers (e.g. by creating a guarantee fund) or to allow their participation in current credit schemes for the informal sector, which often also requires revising the loan conditions.

- *Facilitated direct marketing by urban farmers*: access to existing city markets, creation of farmers' markets, linking farmer and consumer organizations, use of urban farmers in supplying food for school feeding, and support to the creation of local infrastructure for small-scale food preservation and storage facilities (i.e. canning, bottling, pickling, drying, smoking).

Taking accompanying measures to prevent and reduce associated health and environmental risks of urban agriculture

The above measures to enhance farm productivity and profitability must be combined with measures to reduce associated health and environmental health risks, as previously discussed.

Supporting the establishment and strengthening of urban farmer organizations

Most urban farmers are poorly organized if at all, and in a formal way, thus lacking channels and power to voice their needs. This limits the representation of their interests in urban policy-making and planning at the various levels and hampers their participation in development programmes. Well-functioning farmer organizations can negotiate access to land, adequate tenure arrangements and access to credit. Such organizations may also assume roles in farmer training and extension, infrastructure development, processing and marketing, and control/certification of the quality of the products marketed.

More research is needed to identify existing farmer organizations and informal networks of various types of urban farmers, and to analyse their problems and needs, and effective ways to further develop these organisations. Municipalities may also stimulate universities, Non-Governmental Organizations (NGOs) and Community Based Organizations (CBOs) in the city to actively support farmer organizations, capacity development and their linkages with other urban farmer groups, private enterprises, consumer organizations and support organizations.

Small urban producers participating in the PROVE programme were encouraged to establish a farmers' association (Homem de Carvalho, 2001) and their capacities were enhanced to gradually replace the PROVE government officers in their supporting role. In Rosario, Argentina, development of Red de huerteras y huerteros (the Network of Urban Producers) has been promoted by the municipal Urban Agriculture Programme for the same reason (de Zeeuw *et al.,* 2006). In Hyderabad, India, the Green Fodder Grass Farmers Association markets approximately 250 tonnes of fodder per day, making use of a piece of land temporarily rented from a mosque. At present, access to a public area of land is being negotiated with the Hyderabad Government for more permanent use. The Association is also pressing for official recognition of its members' trade, in cooperation with inner city dairy producers and milk consumers (Buechler and Devi, 2006).

These general categories of farming were:

- more socially-oriented urban farming (leisure, recreation, community-based, subsistence-oriented, often with more variety, subsidized);

- more economically-oriented urban farming (market-oriented, entrepreneurial);

- urban farmer (or producer) organizations, which could support these different type of organizations, and which could be developed according to specific needs roles in SUD. Currently RUAF partners and FAO are undertaking studies into urban producer organizations (UAM, no. 17, in press).

Appropriate technology development

Until recently, agricultural research has paid relatively little attention to agriculture in the urban environment. Most attention has been given to the larger-scale, more capital-intensive and fully commercial farmers, especially peri-urban irrigated vegetable production, poultry and dairy production and aquaculture.

Since urban conditions require other technologies than those used in the rural context, there is a need for adaptive research with and for urban farmers. Such specific conditions include, among others: limited space available and high prices of land; closeness to many people (and thus need for safe production methods); use of urban resources (organic waste and wastewater); and possibilities for direct producer-consumer contacts. Most available agricultural technologies need adaptation for use in these conditions and new technologies have to be developed to respond to specific urban needs (e.g. non-soil production technologies for use on roofs, in cellars; development of safe and economic practices for reuse of wastewater; prevention of zoonosis). The extent to which the policy and planning environment interacts with technology development also tends to vary between crop and livestock systems, and between these two types of production systems. Livestock-raising is subject to greater regulation and policy issues than crop production, and income-focused systems tend to be more policy-sensitive than small-scale, health and income support systems (Prain, 2006).

Prain gives a comprehensive overview of technology development in specific horticultural and livestock systems, such as container gardening, bio-intensive gardening (such as the pyramid gardens in Kampala, Uganda), hydroponics systems, and the use of methods such as farmer field schools or livestock groups (in Lima, Peru and Nairobi, Kenya). The author concludes that for UA to be viable and sustainable, innovation is needed in the context of urban livelihoods in which agriculture usually complements other employment. Technology development and innovation need to occur at the technical, institutional and policy levels, and involve households, communal organizations and city authorities. This need for multiple innovation seems to be more essential for urban than for rural agriculture (Prain, 2006).

The efforts of IDRC (Cities Feeding People), CGIAR (Urban Harvest), FAO (Food for the Cities) and the RUAF Programme, *inter alia*, international and national research institutes are gradually paying more attention to such new challenges. Municipalities and other local stakeholders could provide budgets and expertise to boost participatory problem analysis, develop research proposals, and voice the research and technology development needs of their urban farmers to research institutes and national governments. Moreover, better coordination between research institutes, agricultural extension organizations, NGOs and groups of urban farmers could be promoted. A significant number of (local) governmental institutes consider agro-ecological practices in their urban agriculture programmes. For example, the national

urban agriculture programme in Cuba prohibits the use of agrochemicals in the city and has two sub-programmes specifically geared to the development and stimulation of organic composting and agro-ecological integration to ensure that newly developed techniques do not harm the environment. In addition, one of the objectives of the Municipal Programme for the Development of Organic Agriculture in Rosario, Argentina, is to train the participating beneficiaries in the production and commercialization of organic vegetables and associated enterprises (see de Zeeuw *et al.*, 2006 for more examples).

There is vast potential for improving efficiency of urban farming, which tends to be highly dynamic but normally restrained by its limited access to training and extension services. Sectoral organizations, NGOs, farmer cooperatives and private enterprises should be encouraged to provide training and technical advice to urban farmers, with a strong emphasis on ecological farming practices. Cost-sharing systems (farmers, municipality, sectoral organizations, private enterprise) will be needed to ensure sustainability of the extension system.

5. Summary of main conclusions and recommendations

Characterization of urban agriculture

UPA can be defined as the growing of plants and the raising of animals for food and other uses within and around cities and towns, and related activities such as the production and delivery of inputs, and the processing and marketing of products.

The most important distinguishing character of UA is not so much its location, but the fact that it is an integral part of the urban economic, social and ecological system. It uses urban resources (land, labour, urban organic wastes, and water); produces for urban citizens; is strongly influenced by the urban conditions (policies, competition for land, urban markets and prices); and impacts on the urban system (effects on urban food security and poverty, ecological and health impacts). Although some forms of UPA are based on temporal use of vacant lands, UA is a permanent feature of many cities in developing and in developed countries, and thus an important component for sustainable city development.

UPA has a significant share in the food supply of many cities in the world, in particular, supplying perishable products such as vegetables, fresh milk and poultry products. Urban food production enhances urban food security and household diets, contributes to employment and income generation as well as to urban environmental management (urban greening, micro-climate, waste recycling) and social development (social inclusion, HIV-AIDS mitigation, etc.).

To a large extent, UA complements rural agriculture and increases the efficiency of the national food system. Important differences are found between urban and rural agriculture, which have important consequences for the design of policies and support programmes. UA is generally characterized by closeness to markets, strong competition for land, space-confined, their use of urban resources, such as organic solid wastes and wastewater, a low degree of farmer organization, mainly perishable products, and a high degree of specialization, among others.

In order to integrate UA into planning and policy-making for SUD, it is important to characterize the specific urban context and the different types of UA and urban livelihood strategies. Within this localized characterization, it would be useful in further research to support urban farmers and policy development to characterize broad urban farming typologies according to more socially-oriented urban farming and more economic-oriented urban farming. Subsequently, there should be more comparative research, preferably in different cities in different contexts, as is currently being carried out by the RUAF Partners, FAO and Urban Harvest.

UPA as a response to urban dynamics

Rapid urbanization is taking place in most developing countries. Increase in urban poverty, food insecurity and malnutrition, with a shift in their concentration from rural to urban areas is accompanying urbanization. Many cities cannot cope with the massive growth of its population, which leads to a decrease in urban shelter and security of tenure, backlogs in delivery of basic services, increasing inequality and segregation, degradation of the urban environment and increase in poverty, malnutrition and food insecurity. In many countries, an unstable macro-economic and/or political situation is aggravating this situation.

UA is linked to urban dynamics and a response to urban food insecurity, opportunities in the city, and conducive urban policies, norms and regulations. Despite urbanization, UA persists in the city, even in the centres, adapting to new economic and spatial conditions. Consequently, there is a great variety in UFSs, people involved, and their relations.

Future research should consider the multiple functions of UA. There is a need to explore the relationship between the levels of multi-functionality and sustainability. This involves the analysis of both environmentally positive and negative functions at both levels, as well as their compound effect. Main areas for further research and development are land tenure, legislation and urban land use planning (including agricultural activities). In many cities where men have traditionally been the holders of land titles, traditional tenure rights should be revised when there is inequality between men and women. Another research field is applicable methodologies in working with stakeholders in SUD, including agriculture. Working with planners to include agriculture in environmental planning as a part of greenbelts, city parks and open spaces can create mutually beneficial results since farmers can gain access to land protected from future urban sprawl and planners can justify the space as being productive. Institutional assessment and development of new institutions or new institutional arrangements are related areas. Development of specialised urban and peri-urban markets is relevant and support to commercial and subsistence horticulture, aquaculture and livestock systems are other fields of interest.

Profitability and economic impact of urban agriculture

Important variation is observed in how researchers classify UFSs and the various indicators and measuring methods applied to assess economic and other impacts of UA, which prevents discussions on the differential impacts and profitability of specific UFS.

UA can be profitable, especially when producing products that are in great demand and that have a comparative advantage over rural production, such as perishable products (green leafy vegetables and milk), mushrooms, and flowers and ornamental plants.

The studies reviewed indicate that irrigated, open-space vegetable production (especially peri-urban) allows significant profits and is one of the most productive farming systems in Africa despite its informal and seldom supported character, with monthly net income figures normally ranging from US$30-70 per smallholding, and with variations up to US$200 or more. These amounts normally exceed official minimum salaries by the factor 1.6 to 10. Ornamental plant and/or flower production appears to be the most profitable and can achieve an annual benefit of up to US$5 000 if sufficient cash is available for

hiring labour and the purchase of seeds and seedlings. Urban animal husbandry can be a profitable business. Investments in commercial livestock production, however, require higher start-capital than other forms of informal UPA. This is often derived from other primary household ventures.

Important factors influencing net income of an urban farm household are: degree of market-orientation; farm size; labour availability in the household; choice of crops and animals; availability and cost of basic inputs (in particular, local resources such as organic wastes and wastewater); the opportunity for dry-season irrigation; available technology/capital; access to markets; prices obtained; and the ability to store, process and preserve products. Additional benefits can be obtained by the farm households through their involvement in processing and marketing activities (for example ghee making, preparation of street foods, street carts or small local shops, and cleaning/packaging food for sales to supermarkets, etc.) and in farmer organizations.

The literature review clearly shows the need for more systematic research on the economic impacts of UA using standardized indicators and measuring methods. Data collection and analysis should be gender-specific and attention should be given to cost-benefit analysis of the agricultural production, as well as income derived from processing and marketing activities. The relative contribution of UPA to household budget should be compared to income derived from other livelihood strategies employed by the family. More dynamic analysis of the changes over time is needed, and sensitivity analysis of the results would be relevant.

The review of the impacts of UA at the city level shows that UPA contributes LED by generating (often complementary) income, micro-enterprise development and employment, mainly self-employment. UPA also contributes substantially to securing food security and nutrition of the urban population, especially the urban poor. It also serves as a social safety net in times of economic or political crisis and is applied by policy-makers as a strategy to promote social inclusion of disadvantaged categories of the population and community revitalization. Finally, UA contributes to urban environmental management by turning wastes into resources, contributing to a better urban climate and managing the urban landscape

On the other hand, UA may have negative impacts, especially on health and, to a minor degree, on the urban environment. As in the rural areas, UA needs proper management and support to minimize health and environmental risks.

Few attempts have been undertaken to quantify these positive and negative effects of UA at the city level and even less to estimate its economic value. However, most researchers and practitioners on urban agriculture agree that the positive effects of UPA on health and environment far outweigh the negative, and when the socio-economic benefits are taken into account, the balance is clearly in its favour.

It is recommended to promote the implementation of integrated impact assessment studies of UPA at the city level. New tools, developed in environmental economics, are available – but rarely applied so far – to estimate non-market costs and benefits of urban agriculture on the health and nutrition of poor urban sectors, city ecology (greening, micro-climates, recycling of wastes, energy reduction, etc.), community building and social inclusion of the poor.

Sustainability of urban agriculture

The literature reveals various approaches to and indicators for measuring the sustainability of UA, but to date, few systematic attempts have been made through monitoring its presence and impacts over a longer period of time in a given city or cities.

The available literature seems to indicate that UPA is sustainable if it maintains its dynamism and flexibility, adapting to changing urban conditions and demands, intensifying productivity and diversifying its functions for the city, while enhancing synergy and reducing conflict and thus gaining more social and political acceptability. In certain parts of a city, present forms of UA may fade away or change its form and functions drastically, while new forms of urban agriculture may develop in other parts.

Longer-term UA seems to be sustainable, especially when its potential for multi-functional land use is recognized and fully developed. This multi-functionality of UA makes it a cheap producer of public goods. Sustainability of urban agriculture seems strongly related to its contributions to the development of a sustainable city – i.e. one that is inclusive, food-secure, productive, and environmentally healthy (see also Figure 1).

Policy development and action planning regarding urban agriculture

Urbanization processes are leading to an 'urbanization of poverty' and increasing food insecurity and malnutrition of poor urban households. Under pressure of the urbanization process, municipalities increasingly encounter problems in providing employment for the growing population and in managing the growing low of wastes produced by the city.

The urgency of growing urban poverty and food insecurity requires innovative ways of managing cities and alternative strategies towards improving urban livelihoods, local governance, LED and waste management, as well as nutrition. An increasing number of municipalities have recognized the potential and risks of UA for realizing their policy priorities and MDGs with respect to social development (poverty alleviation, social inclusion of disadvantaged groups), economic development (income and employment generation, enterprise development), health (food security and nutrition; HIV-AIDS mitigation) and the environment (waste recycling, greening, micro climate, landscape management). They have initiated policy formulation and action planning processes, often involving multiple stakeholders in its design and implementation.

Although UA occurs under varying socio-political conditions and policy regimes (Bakker *et al.*, 2000), the literature review seems to indicate that urban policy-makers and support institutions, both governmental and non-governmental, can substantially contribute to enhancing its profitability and sustainability, *inter alia*, by:

- formally accepting UA as an urban land use and creating a conducive policy environment;

- enhancing access to vacant open urban spaces;
- supporting the establishment and strengthening of urban farmer organizations;
- enhancing the productivity and economic viability of UA by improving access of urban farmers to training, technical advice and credit;
- taking accompanying measures that ensure that the health and environmental risks of UA are reduced (farmer training on health risks and related management practices, zoning, quality control of irrigation water and products).

Multi-stakeholder efforts are needed to find effective ways to integrate UA into urban sector policies and urban land use planning, and to facilitate the development of safe and sustainable UA. To facilitate this, adequate institutional frameworks at the national, municipal and local levels must be created that give UA an institutional home and to ensure the active participation of direct and indirect stakeholders in the formulation and implementation of urban agriculture policies and action programmes. Several programmes and initiatives such as those supported by IDRC, FAO, RUAF, Urban Harvest, IWMI and UN-HABITAT are ready to support these processes with information, research, training and technical assistance.

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Annex

Table 15a: Characteristics of major off-plot farming systems identified in Lomé, Togo

Farming system	Mixed vegetable farmers	Traditional vegetable women farmers	Ornamental plant growers	Rainfed maize and cassava farmers
Area estimate for the city	60 ha	2 ha	18 ha	100 – 150 ha
Number of farmers	1 500 (82% male)	100 (15% male)	300 (all male)	
Crops cultivated	Onions, lettuce, carrots, cabbage, beet root	Eggplant, amaranth, gboma,	As many as 100 varieties per grower, flowers, bushes, trees	Maize, cassava
Inputs used	Seeds, pesticides, fertilizers, manure	Seeds, pesticides, fertilizers, manure	Seeds, branches, pesticides, fertilizers, night soils, waste, manure	Seeds, sewage, pesticides (tomatoes)
Irrigation practices	Motor pump, watering cans, tubs	Watering cans, buckets	Watering cans	None
Irrigation water source	Groundwater (2-5m)	Lakes, river, wells	Groundwater	None
Average farms size	34 a (13.77 ha)	2 a (0.81 ha)	6 a (2.43 ha)	n. d.
Beds or fields plus average size	36 beds: approx. 13 m2	26 beds, approx. 8 m2	-	-
Farmers' organization	Groups, unions, federation of unions	Groups	None	None
Gender roles, labour division	Women traders	None	No women involved	Both genders cultivate, women do processing
Main problem(s)	Poor marketing systems, pest and diseases, seed costs, funding,	Funding	Marketing	Lack of rain

Source: IWMI, unpublished

Table 15b: Characteristics of major off-plot farming systems identified in Cotonou, Benin

Farming system	Mixed vegetable with watering can	Ornamental plants	Rainfed staple food
Area estimate for the city	35.85 ha		2.5 ha
Number of farmers	567 (91% male)	200 (100 % male)	150 (all males)
Crops cultivated	Eggplant, amaranth, carrots, cabbage, lettuce	Trees, bushes, flowers for ornamental use	Maize, cassava
Inputs used	Imported and local seeds, pesticides, fertilizers	Imported and local seeds, pesticides, fertilizers, plastic bags, cement, sand	Local seeds and seedlings, household waste
Irrigation practices	Watering cans, motor pumps, pedal pumps, shallow wells, covered wells	Wells with fixed edges	None
Irrigation water source	Groundwater, swamps	Groundwater	None
Average farms size	632 m²	200 m²	166 m²
Beds or fields plus average size	80.7 m²	1	1
Farmers' organizations	6 co-operatives	None	None
Gender roles, labour division	Women dealers	No women involved	No women observed
Main problems	Land tenure, irrigation, input prices	Competition, input prices	-

Source: IWMI, unpublished

Table 15c: Characteristics of major off-plot farming systems identified in Bamako, Mali

Farming system	Mixed vegetable with watering can	Mixed vegetable with motor pump	Traditional vegetable farmers (women)	Ornamental plants	Rainfed maize, millet or sorghum
Area estimate for the city	250 ha	25 ha	2.5 ha	24 ha	
Number of farmers	1 700 (90% male)	30 (100 % male)	250 (approx. 100% female)	300 (99% male)	12 000 (95% male)
Crops cultivated	Lettuce, carrots, cabbage, beetroot, lady fingers, eggplant	Lettuce, carrots, cabbage, leek, beetroot, lady fingers	Lettuce, bean leafs, amaranth, rosella, eggplants	Ornamental plants, about 30 per farm	Maize or sorghum
Inputs used	Local and imported seeds, fertilizers, manure, waste, pesticides	Local and imported seeds, fertilizers, manure, waste, pesticides	Local seeds, manure,	Pesticides, duping heaps, imported plants, plastic bags	Local seeds, waste, manure
Irrigation practices	Watering cans	Motor pump and hose	Watering cans	Watering cans, 2 times/ day	None
Irrigation water source	Well	River water	River water or well water close to the river	water from open wells	None
Average farm size	0.1 ha	0.5 ha	0.01 ha	400 m²	2- 3 ha, peri-urban
Beds or fields plus average size	1- 2 m2	1 – 2 m2	0.8 – 1.5 m2	Plastic bags	-
Bed shape	Top or bottom bed	Top or bottom bed	Top or bottom bed	Plastic bags	Field
Farmers' organization	Members	Leaders	None	None	None
Gender roles, labour division	Women traders	Women traders	Mainly women	No women involved	n.d.
Main problem(s)	Land insecurity	Land insecurity	Land, funds	Seeds, marketing	Forbidden

Source: IWMI, unpublished

Table 15d: Characteristics of major off-plot farming systems identified in Ouagadougou (Burkina Faso)

Farming system	Mixed vegetable farmers	Traditional vegetable women farmers	Ornamental plant growers	Rainfed millet, sorghum, cow pea
Area estimate for the city	20–25 ha	3–6 ha	2 ha	5,284 ha
Crops cultivated	Temperate and local vegetables	Mainly local vegetables	Ornamental flowers, bushes and trees	Cereals, cow pea, groundnut pea, groundnut
Inputs used	Fertilizers, manure, pesticides, imported seeds	Fertilizers, manure, local seeds,	Fertilizers, manure, waste, seeds,	Local seeds, waste, sewage,
Irrigation practices	Watering cans, motor pump, canals	Watering cans, canals	Watering cans	None
Irrigation water source	Tanks, wells in the tank area, wastewater	Wastewater	Wastewater, wells close to the wastewater canals	None
Average farm size	800 m2	125 m2	375 m2	2–8 ha
Beds or fields plus average size	90 beds	19 beds	2 – 3 fields	-
Farmers' organization	Co-operatives by site	None	None	None
Gender roles, labour division	Male farmers, women dealers	Mainly women farmers, mainly marketing	No women involved	No data
Main problem(s)	Water shortage, starting fund after the rainy season, seed quality	Water quality, water shortage, land insecurity,	No problem mentioned	No problem mentioned

Source: IWMI, unpublished

Table 15e: Characteristics of major off-plot farming systems identified in Dakar (Senegal)

Farming systems	Vegetable market gardening (Dakar)	Vegetable market gardening (Rufisque)
Area estimate for the City	Approx. 147 ha	Approx. 32 ha
Crops cultivated	Tomatoes, lettuce and cabbage, okra, pepper, onions, beans, eggplants and sweet potatoes; strawberries, sweet pepper and carrots, mint, fruits (papaya and citrus – orange, lemon, grapefruit)	Bitter eggplants, okra, cabbage, green beans, eggplants, sweet pepper, pepper, tomatoes, carrots, onions, lettuce, fruits (mainly citrus fruits)
Irrigation practices	Watering cans, flooding, drip	Watering cans, drip irrigation
Irrigation water source	Wells, ceane (shallow wells), Senegalese Water Company (SDE)	Wells, shallow wells (ceane), Senegalese Water Company (SDE)
Average farm size	0.04 and 2 ha; 6m2 /bed and farms 450 m2	1-7 ha 6m2 /bed and average farm is 2,500 m2
Farmer organization	Economic Interest Group (GIE) – Pikine and Rufisque	2 of the 4 zones in Rufisque visited (Economic Interest Group (GIE in French);
Gender roles, labour division	Women play a predominant role in the marketing of urban agricultural products; men are essentially involved in production activities.	Women play a predominant role in the marketing of urban agricultural products. Men are essentially involved in production activities
Inputs used	Fertilizers, poultry manure, pesticides, seeds,	Fertilizers, manures and pesticides are used-
Major problems mentioned	Problems of availability of water resources and wastewater, financing production; high cost of inputs, land insecurity, theft of products, heavy workload resulting in extreme fatigue, malaria	unavailability of water resources and its high cost, transportation to the working place, inadequate funds, run-down and inadequate agricultural equipment,

Source: IWMI, unpublished

Table 16:Factor shares in urban agricultural enterprises, Nigeria

	Vegetables		Flowers	
	Value (N)	**% Contribution**	**Value (N)**	**% Contribution**
Fixed costs:				
Land rent	1 555	10.3	2 030	0.3
Equipment/tools	3 088	20.5	1 539	0.2
Total fixed costs	4 643	30.9	3 569	0.6
Variable costs:				
Labour costs	4 438	29,5	8 090	1.3
Seed/seedling costs	492	3.3	584 710	94.8
Manure costs	1 832	12.2	1 642	0.3
Pesticides/Insecticides costs	723	4.8	3,296	0.5
Other costs	2 919	19.4	15 449	2.5
Total variable costs	10 396	69.1	613 188	99.4
Total cost	15 039	100	616 756	100
Net farm income	9 739	-	377 512	-
Returns per naira				
Invested	0.65	-	0.61	

Note: 80 naira=US$1

Table 17: *S. olitorius* enterprise budget for intensive urban production, in CFAF (on a 392 m^2, 75-day production cycle including nursery)

Item	Unit	Unit price	Quantity	Value
Chicken manure	30-kg sack	1 100	28	30 800
Pesticides				1 800
Labour	Person-day	1 500	23	34 500
Capital (sprayer, hand tools				5 000
Cost subtotal				72 100
C. olitorius production	kg	132	1 294	170 800
Net return to land and management				98 700

Table 18: *S. scabrum* enterprise budget for semi-intensive peri-urban production, in CFAF (On a 552 m^2, 75-day production cycle including nursery)

Item	Unit	Unit price	Quantity	Value
Chicken manure	30-kg sack	1,100	28	21 600
Pesticides				1 320
Labour	Person-day	1,500	23	20 400
Capital (sprayer, hand tools)				5 000
Cost subtotal				48 320
S. olitorius production	kg	132	1 294	99 160
Net return to land and management				50 840

Note: 1US$ =590 CFAF in 1998
Source: Gockowski *et al*., 2002

Table 19: Major horticultural crops cultivated in Bamako and Ouagadougou

Most important crops	# Farms	Total ha/yr	Average ha/farm	Average gross margin (CFAF/ha)
Bamako	20	9.593	0.480	4 354 000
Lettuce	17	4.368	0.257	4 642 000
Carrot	14	1.706	0.122	4 426 000
Cauliflower	10	0.487	0.049	5 126 000
Beet	11	0.316	0.029	5 233 000
Celery	13	0.253	0.019	6 211 000
Ouagadougou	26	2.398	0.092	1 613 000
Lettuce	17	0.820	0.048	1 437 000
Strawberry	12	0.347	0.023	3 891 000
Cauliflower	12	0.212	0.018	17 66 000
Oseille (sorrel)	4	0.142	0.036	64 000

Source: Eaton, 2002

Table 20: Benefit-cost ratios of crops produced in urban and peri-urban, Tamale

	Yield (t/ha)	Cost (cedis/ ha)	Revenue (cedis/ha)	Profit (cedis)	B/C ratio
Cabbage (urban)	8.3	6 067 554	16 178 000	10 110 446	2.7
Cabbage (peri-urban)	11.52	3 832 400	16 500 000	12 667 600	4.3
Okro (urban)	5.13	6 200 000	13 775 000	7 575 000	2.2
Okro (peri-urban)	2.21	2 135 000	4 150 000	2 015 000	1.9
Corchorus (urban)	4.46	5 292 000	15 180 000	9 888 000	2.9
Corchorus (peri-urban)	1.44	2 573 000	5 250 000	2 677 000	2.0

Note : 8,000 cedis = approx. US$1
Source: Nkegbe, 2002

Table 21: Costs of production and income generation from main urban, peri-urban and rural farming along the Musi River in Hyderabad

Activity	Cost of production	Income (Rs)	Average annual income (Rs)
I Urban agriculture			
Leafy vegetables (Rs/ha/month)	3 750/ month	5 000/ month	40 000/ year
Banana (for 100 plants)	7 200/ year	22 500/ year	22 500/ year
Coconut (for 100 palms	7 200/ year	10 000/ year	10 000/ year
Para grass per ha	45 000/ year	90 000-180 000/year	135 000/ year
Para grass (rent collected Rs/ha/month)	n.a.	2 500/ month	30 000/ year
Livestock (for one milk buffalo)	300/ month	2 000/ month	16 000/year
II Peri-urban Agriculture			
Leafy vegetables (Rs/ha/month)	3 750/ month	5 000/ month	40 000/ year
Para grass (rent collected Rs/ha/month)	n.a.	2 500/ month	27 500/ year
Para grass per ha	45 000/ year	90 000-180 000/year	135 000/ year
Jasmine garden per ha	4 000/year	8 000/year	8 000/year
Livestock (for one milk buffalo)	500/ month	2 000/ month	16 000/ year
Toddy tapping (palm wine)	10,000 per year	30 000/year	30 000/year
III Rural agriculture			
Paddy per ha	11 250 per crop	23 750/crop (2-3x/year)	47 500-71 250/ year
Livestock (for one milk buffalo)	300 per month	1 440/ month	16 000/ year
Toddy tapping (for 8 palms)	10 000/ year	30 000/ year	30 000/ year
Aquaculture (Rs/year/fisherman)	500/year	1 500/ year	1 500/ year

Note: Indian Rs 48 = US$1

Source: Buechler and Devi, 2002

Table 22: Revenues, costs and income per farm ('0000 dong/ha/year, n = 98)

	Mean	Min	Max	Coeficient of Variation (CV)
Revenues (gross)				
Vegetable sales	1 024	36	6 800	0.87
Other crop sales	375	0	2 160	1.12
Total crop revenues	1 399	115	6 800	0.67
Share of vegetables (%)	72	11	100	0.34
Costs				
Input costs for vegetables				
Seed	15	0	107	1.27
Organic materials	146	12	600	0.83
Chemical fertilizers	61	5	288	0.86
Pesticides	56	0	410	1.21
Tractor	2	0	24	2.31
Oxen	7	0	53	1.29
Hired labour	6	0	471	8.24
Marketing	4	0	45	2.7
Land rent	11	0	252	3.43
Miscellaneous'	10	0	70	1.17
Total vegetable-specific input costs	307	32	1,426	0.71
Production costs of other crops	230	0	1,186	1.09
Non crop-specific input costs				
Land taxes	30	0	54	0.5
Irrigation facilities	58	7	218	0.63
Loans	1	0	23	3.22
Equipment	22	0	240	1.59
Income (net)				
Total agricultural income	741	-101	5 093	1.03
Other income	159	0	1 200	1.71
Total household income	900	-101	5 093	0.96

Note: 10,800 dong = approx. US$1
Source: Jansen et al., 1996

Table 23: Average input costs, revenues and returns of vegetable crops ('0000 dong)

Name of vegetable	Gross revenues/ha/year		Net returns to family labour, land and management/ha/ year	Added value (hired labour day)	Added value (growing day)
	Mean	Input cost	Mean	Mean	Mean
Cabbage	2 209	788	1 416	3.94	21
Common bean	1 081	547	534	1.42	6
Cauliflower	2 319	665	1 656	5.42	35
Tomato	1 849	524	1 325	4.49	18
Other vegetables	4 357	799	3 558	4.32	-
Cucumber	1 061	586	474	1.93	7
Lettuce	1 686	284	1 402	3.02	40
Indian spinach	1 313	310	1 002	2.07	24
Leafy amaranth	1 062	292	770	1.73	18
Mustard	1 115	211	904	1.98	30
Yardlong bean	987	392	595	0.88	8
Okra	1 431	589	843	1.39	15
Bitter gourd	1 236	680	557	1.26	8
Angled loofah	631	532	99	0.11	1
Garland chrysanth	2 893	397	2 496	6.80	62
Indian cabbage	1 027	216	811	1.81	19
Radish	1 078	336	742	3.96	16
Bottle gourd	1 234	497	738	4.65	11
Eggplant	6 164	1 220	4 944	4.65	18

Note: 10,800 dong = approx. US$1
Source: Jansen et al., 1996

Table 24: Size and profitability ranking of livestock and poultry enterprises in peri-urban agriculture

Animal type	Herd size	Average annual profit per farmer, in cedis	Minimum profit per unit, in cedis	Ranking within enterprise
Cattle	1-5	6 000 000	1 200 000	1
	6-10	4 800 000	480 000	2
	11-15	4 500 000	300 000	3
	16-30	4 000 000	133 333	4
	31-50	2 620 000	52 400	5
	51-70	2 000 000	28 571	6
Pigs	5-20	3 140 000	157 000	1
	21-40	2 040 000	51 000	4
	41-60	3 500 000	58 333	3
	61-80	4 000 000	50 000	5
	Above 100	9 000 000	90 000	2
Poultry	Up to 100	1 650 000	16 500	2
	101-300	1 062 500	3 542	8
	301-500	2 670 000	5 340	7
	501-800	6 833 250	8 542	6
	801-1,000	24 000 000	24 000	1
	1001-2,000	28 000 000	14 000	3
	2001-5,000	43 181 820	8 636	5
	Above 5,000	69 500 000	13 900	4
Sheep and goats	1-20	494 444	24 722	2
	21-40	500 000	12 500	3
	41-60	1 500 000	25 000	1
	Above 100	2 500 000	25 000	1

Note: 2001 prices (US$1= approx. 7 000 cedis)

Table 25: Average annual income from different UPA enterprises

Type	**Average annual income**	**Notes**
Backyard gardening	Below 200,000 cedis	
Small animals	150 000–300 000	Grass cutter most profitable
Sheep or coats	200 000–350 000	
Cattle (milk excluded)	2 500 000	Milk sold by herdsmen
Poultry	10-25 000 000	
Aquaculture	Up to 6 000 000	

Note: 3 750 cedis = 1 pound sterling
Source: NRI, 1999

Table 26: Potential environmental implications of urban agriculture

Category of environmental impact	Examples of environmental effects	Study results	Implications of effects
Change in the hydrological regime of the area	More run-off and land surface flooding; less infiltration	Run-off increases by 350% on average; infiltration reduced 28.5% on average	Flooding, damage to property, transport; routes and infrastructure
Soil erosion	Lowering of the land surface; deposition of eroded sediment; small dust particles in the air	Soil loss on 40% of cultivated sites exceeds tolerable levels; high levels of deposition of eroded sediment; air pollution	Logging of city drains, nuisance to transport; health problems increased costs of maintenance
Ecological changes	Changes in species types; reduced biodiversity; loss of soil cover; loss of tree cover	High High High	Loss of species habitat loss of biodiversity soil erosion
Chemical pollution	Lead uptake of crops from exhaust fumes; vegetable toxicity from industrial effluent; reduction in water quality	High Probable Probable	Algae blooms, potential health hazard to consumers; threat to wildlife; increased costs of water purification
Landscape and aesthetics	Loss of scenery and diversity of environment	Indeterminate	Loss of recreational space; increased costs to access alternatives
Diseases	Vector-borne diseases	Indeterminate	potential for disease related to water, refuse, manure and animals; costs of monitoring, control and treatment

Source: Bowyer-Bower & Drakaki-Smith, 1996

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Profitability and sustainability of urban and peri-urban agriculture

Urban agriculture (UA) is a dynamic concept that comprises a variety of livelihood systems ranging from subsistence production and processing at the household level to more commercialized agriculture. It takes place in different locations and under varying socio-economic conditions and political regimes. The diversity of UA is one of its main attributes, as it can be adapted to a wide range of urban situations and to the needs of diverse stakeholders.

Despite UA is increasing in cities in developed countries as well as in developing countries, many urban farmers around the world operate without formal recognition of their main livelihood activity and lack the structural support of proper municipal policies and legislation. Appropriate policies and regulations are required to enhance the potential of agriculture in cities and mitigate its potential risks. The challenge is for UA to become part of sustainable urban development and to be valued as a social, economic and environmental benefit rather than a liability.

This paper aims to provide pertinent information on profitability and sustainability of UA to a wide audience of managers and policymakers from municipalities, ministries of agriculture, local government, Non-Governmental Organizations (NGOs), donor organizations and university research institutions. It aims to highlight the benefits of linkages between agriculture and the urban environment, leading to a more balanced understanding of the conflicts and synergies. It examines how UA can contribute substantially to the Millennium Development Goals (MDGs), particularly in reducing urban poverty and hunger (MDG 1) and ensuring environmental sustainability (MDG 7).