Health Risks and Benefits of Urban and Peri-Urban Agriculture and Livestock (UA) in Sub-Saharan Africa

Resource Papers and
Workshop Proceedings

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Introduction

A. Boischio

Food security and income generation, in the context of current and prospective increased urbanization, are some of the positive outcomes related to the widespread practice of urban agriculture (UA[1]) as a poverty alleviation strategy. An inclusive definition of urban agriculture, which is under consideration in this current document, describes UA as “an industry located within (intra urban) or on the fringe (peri urban) of a town, a city or a metropolis, which grows or raises, processes and distributes a diversity of food and non food products, (re-) using largely human and material resources, products and services found in and around that urban area, and in turn supplying human and material resources, products and services largely to that urban area” (Mougeot, 2000).

During the period of 1997 to 2004, the Cities Feeding People Program Initiative (CFP PI), within the Environment and Natural Resource Management Program Area of the International Development Research Centre, supported development research aimed at promoting urban agriculture, with the purpose of improving food security, income generation, and public health, with special attention to the management of waste, water and land for the benefit of the urban poor. The relevance and challenges of UA have been published in the context of CFP PI activities, available on line[2]. In brief, there are indications that in Kampala, for example, people involved in UA have a better nutritional and health status than those who are not involved (Maxwell et al., 1998). At the urban level, UA does provide a significant amount of food for local consumption. In spite of the difficulties of measuring the food contribution of UA for urban consumption, there is indication, for example, that UA activities produce around 70% of vegetables and 70% of poultry consumed in Dakar, where UA is heavily practiced (Nugent, 2000). The health and economic benefits of UA are well recognized among scholars, urban farmers, and international development agencies, including those linked to the United Nations, such as FAO[3] and UNDP, which have been involved in supporting activities for promotion of benefits and mitigation of adverse consequences.

Further reflections on and evaluations of CFP PI activities have indicated that in spite of UA’s benefits, there are challenges, such as land tenure and health risks, that must be addressed at the development research level. In fact, health risks associated with UA very often constitute a barrier for policy support to UA development. It was suggested by external reviewers that CFP should support health risk mitigation research, in order to facilitate the policy influence of UA. In 2005, CFP evolved into the Urban Poverty and the Environment (UPE) Program Initiative, which has a comparatively broader scope, addressing the mitigation of urban environmental burdens on the urban poor, considering issues from UA to water and sanitation; from solid waste management to natural disaster vulnerability, and considering land tenure and gender as cross cutting issues. Research on the mitigation of health risks in UA has been included in the UPE agenda.

Health risks associated with UA vary according to the specific activity and context. A few examples of risks include hazardous biological and chemical exposures among farmers and consumers as a result of wastewater use on vegetable crops; transmission of zoonotic diseases in the context of (usually confined) livestock activities; and malaria transmission possibly increased due to irrigation and drainage schedules.

The purpose of health research activities supported by UPE is to promote the production of knowledge and actions that mitigate UA health risks and enhance its benefits, with policy support, based on multi stakeholder participation. A set of activities has been implemented. These began in 2003, with a workshop on “Health Risks and Benefits of Urban and Peri-Urban Agriculture and Livestock (UPA) in Sub-Saharan Africa”. This workshop took place in Nairobi, with the participation of academics, policy makers and non governmental organizations.

Health risk mitigation and benefits enhancement activities have been supported by both CFP/UPE and Ecohealth Program Initiatives. Methodologically, recommended frameworks for these research activities are Ecohealth (ecosystem approaches to human health) and risk analysis. The Ecohealth framework is designed to promote a holistic view of human health and environmental sustainability, based on a transdisciplinary, participatory and equity/gender sensitive methodology. Transdisciplinarity refers to the integrated form of carrying out research by teams of scientists from various complementary disciplines, in dialogue with local knowledge systems and experts. Transdisciplinarity

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[1] The terms Urban Agriculture and Peri-Urban Agriculture are used interchangeably in this document

[2] See www.idrc.ca/en/ev-23584-201-1-DO_TOPIC.html

[3] See www.fao.org/unfao/bodies/coag/Coag15/X0076e.htm

characterizes a collaborative working process that allows researchers to go beyond the limits of individual fields and expertise in order to generate new logical frameworks, new methods, new intuitions, and new insights, all born from the synergy that ensues from the collaboration. Participation of community representatives and stakeholders is envisaged here as a process whereby the research beneficiaries influence and actively participate in making decisions related to the research and ensuing development initiatives. Addressing issues of gender and social equity in the research agenda permits the building of a framework that allows for a better understanding of local knowledge systems and of differences that characterize the way in which men and women cooperate, divide responsibilities and resources, and control them.

Risk analysis includes the components of risk assessment, perception, communication and mitigation, where stakeholders, policy makers and researchers share the same data production, analysis and interpretations. Risk assessment can be defined as a process for describing and quantifying the risks associated with hazardous substances, processes, actions, or events. The four steps of risk assessment include: hazard identification and/or assessment, exposure assessment, toxicity assessment (dose-response), and risk characterization or risk estimation.

The compatibility of these two different methodological approaches, Ecohealth and risk analysis, and the need to understand the links between human activity, socio-ecological conditions and human health, for the purpose of implementing actions to enhance benefits and mitigate health risks of UA, thus addressing poverty alleviation, constitute the basis of the health risk mitigation activities in UA.

This Publication

This document sums up results from an IDRC-supported workshop held in Nairobi in 2003, where UPE activities related to health risks in UA were initiated (following up on previous CFP PI research experiences[4]). Part I of this document includes six resource papers prepared by specialists working in various areas related to the health risks and benefits of UA. Part II contains the proceedings of the workshop activities in Nairobi, where academics and decision makers discussed the risks and benefits of UA from different perspectives.

After this initial workshop in 2003, three pilot projects were implemented in 2004: Smallholder dairy production in Nairobi, Kenya; Safeguarding public health through control of food borne diseases, in Morogoro, Tanzania; and Providing fresh vegetables to the city, in Dakar, Senegal. Team members from these pilot projects had the opportunity to meet and share their research goals, methods and experiences on two occasions - an inception workshop at Lake Elementaita Lodge in Kenya, in 2004, and a final workshop in Bagamoyo, Tanzania, in 2005. Proceedings of these workshops are available upon request. Currently, the Kenya project is under implementation[5].

Part I - Resource papers

These papers have been produced with the purpose of identifying the opportunities to enhance the benefits of UA, and to mitigate its associated health risks, based on risk assessments. The combination of different research topics aims to cover the diversity of issues that need to be considered in supporting UA development research.

The paper on health impact assessment, risk mitigation and healthy public policy by D. Cole and colleagues provides several methodological concepts and strategies to further elaborate on the knowledge that links hazards, exposures and health effects, in the context of urban agriculture. The paper gives several examples of the way individual decisions for risk mitigation are based on subjective perceptions which stem from knowledge and culture. The paper concludes with useful recommendations for risk mitigation by identifying priorities in terms of critical hazards and counterfactual scenarios where benefits and risks are balanced.

F. Yeudall's paper on nutrition perspectives in UA gives an interesting picture of different patterns of diet, nutrition and health conditions, at different levels, in the context of worldwide urbanization processes. For example, according to some studies, there is increased access to diversity of food in urban areas as compared to rural settings, although this may be counterbalanced by under-nutrition due to poverty conditions. Opportunities for community food security are considered in the context of health risk mitigation requirements. A useful summary of the factors involved in the status and evaluation of nutritional status is provided. The paper concludes with recommendations related to the health risks and the nutritional benefits of UA, through participatory community food security strategies.

Increased malaria transmission due to irrigation techniques has been considered an UA health risk. Background information on vector ecology, breeding sites and transmission-related factors is offered in the paper on malaria and UA

[4] For examples, please see www.idrc.ca/en/ev-23584-201-1-DO_TOPIC.html

[5] For more information on this project, please see www.idrc.ca/en/ev-81999-201_103075-1-IDRC_ADM_INFO.html

by E. Klinkenberg and F. Amerasinghe. Community malaria risk factors are addressed in relation to vector ecology and the urban and rural features of water ponds as breeding sites. An interesting typology of different irrigation methods and malaria transmission risks is presented. Biological control, management of breeding sites, and use of bednets are suggested as options to control increased risks of malaria in the context of UA. Engagement of stakeholders, including affected communities, decision makers, and researchers, is considered key for the implementation of these malaria control measures.

Livestock production in Kampala has been addressed by G. Nasinyama and colleagues. Interesting notes on behavioural exposures to the transmission of zoonotic diseases (by keeping livestock in the living places to avoid thefts, for example), and especially the difficulties of managing animal waste are quoted among the challenges to be overcome in UA. The benefits of livestock at different levels (household, community, government) include food security, nutritional improvements, and income and job generation, which can be translated into improved well-being. The paper recommends major attention to streamlining the regulation of UA, based on joint collaboration among researchers, policy makers, urban farmers and non governmental organizations, and other stakeholders.

Some major concerns in UA relate to wastewater use and solid waste recycling, some of the most challenging issues linked to UA. The paper by B. Keraita and colleagues provides a helpful typology of wastes, contents, practices and health issues. Transmission of pathogens is affected by factors that influence exposure. Policy guidance frameworks are discussed, especially in terms of feasibility and perspectives – such as the WHO guidelines for wastewater use in agriculture. The paper provides evidence about the links between disease transmission and UA practices with the purpose of management with policy support. Insights on risk perception for participatory approaches are given with several experiences derived from projects developed in urban areas of Ghana.

Finally, a gender perspective on the health risks and benefits of UA, based largely on field research experience, is provided by D. Lee-Smith. Differences in risk perception in UA, based on the different roles and responsibilities of men and women, are highlighted. It is interesting to note that several of these roles and responsibilities are culturally sensitive. Examples are given of how the same crop in different cultures may be charged to men and/or women, accordingly. Gender differences are presented in the context of risk perception regarding solid waste management, wastewater re-use, and livestock keeping. The roles of women in disaster mitigation worldwide, and opportunities to act on risk mitigation in the context of UA are considered in terms of resources, as well as knowledge, and perception of current health risks.

The context in which these papers were produced and discussed can be seen in Part II of the document – the proceedings of the workshop and associated activities.

Part II - Workshop proceedings

In June 2003, researchers and policy makers came together in Nairobi to share knowledge and ideas about the risks and benefits to human health of UA in a workshop held at the International Livestock Research Institute (ILRI). They gave presentations, held plenary discussions and smaller working group discussions, and carried out site visits.

Presenters were academics, representatives of development agencies, and decision makers. Very often, decision makers highlighted the challenges of UA, whereas academics and development agency representatives were considering the benefits of UA. From decision makers' experiences, UA challenges were very often related to the consequences of the actions of urban farmers, such as wastewater use, technical problems (such as diverting wastewater pipes into their cropped lands) and health risks. It was also interesting to note the wide diversity of experiences, in terms of problems and solutions, from different countries. For example, in Kenya although UA is practiced, participants have recognized the need to formulate policies and interventions, so that UA support can alleviate the negative consequences of UA practice.

UA in the context of poverty alleviation was discussed. Information has indicated that in Tanzania, there are many professionals in the public sector, who are not poor and practice UA as a secondary income generation activity, showing that UA is not only an activity of the poor.

Workshop participants were divided into groups (zoonosis and malaria; solid waste and wastewater use; and nutrition and diet) in charge of discussing and refining their discussions to foster further debates for the plenary. The group working on zoonosis and malaria indicated the specific needs for different livestock and crop irrigation schemes, and highlighted the need for education among urban farmers regarding health risks and best practices for safe UA. They also mentioned the need for policy support, listing policy gaps and mitigation strategies for each health risk. The group working on solid waste and wastewater assessed the types of hazard different groups are exposed to, and provided several strategies for evaluating a wide range of different hazards. They also addressed major challenges in the use of solid waste and wastewater, which were mostly related to policy support, land tenure, and technological needs. The group working on nutrition and diet emphasized participatory approaches for food security at the community level, based on a community's perceived needs (as opposed to the researchers' agenda) and resources to act. This group went beyond food and nutrition to address the economic benefits through community empowerment. The technical and scientific complexities that must be addressed in different contexts indicate the need to support participatory, action-oriented research work, to promote a dialogue for policy support.

Finally, the workshop participants attended two site visits: the SOS Children's village, a home for orphaned children, where wastewater is used for UA; and a collective farm at the Komarok-Kangundo road, where wastewater is used and distributed on an interesting schedule among farm plots, owned by different farmers. Benefits and challenges encountered at these two sites were under discussion as a workshop wrap-up.

We hope that this summary provides you with an understanding of the way in which this report has been produced. Thanks are offered for the contributions of all workshop participants, including those who authored the enclosed resource papers, those who provided relevant inputs for the workshop discussions, and those who assisted with the workshop organization and implementation, especially Diana Lee-Smith and Peter Kingori. Special thanks to Dali Mwagore for working on the workshop proceedings (Part II of this document), and to Alison Clegg for organizing and reviewing this current document.

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Dr. Ana Boischio received her PhD in Environmental Science from Indiana University, U.S., and her Masters of Science in Environmental Health from the University of Dundee, Scotland. Dr. Boischio has based her research work on mercury pollution among the riverside people in Amazonian ecosystems, and heavy metal pollution in coastal fishing communities in Bahia, with support from the Brazilian National Research Council. Her major academic interests are related to improvements in human health based on ecosystem management. She has also been involved in undergraduate and graduate teaching on topics related to quantitative and qualitative analysis in environmental health at public universities in Brazil.

PART I – RESOURCE PAPERS

Health risks and benefits associated with UA: impact assessment, risk mitigation and healthy public policy

D.C. Cole, K. Bassil, H. Jones-Otazo, M. Diamond.

Abstract

Urban farmers, agricultural extension workers, public health officials, and municipal policy makers face a complex mix of potential health risks and benefits associated with agricultural activities carried out in cities or in close proximity to cities i.e. in urban and peri-urban agriculture (UA). To examine this complex suite of factors we apply four transdisciplinary frameworks to health and UA: (1) project-based environmental health impact assessment, (2) regulatory-based health risk assessment, (3) environmental justice-based risk management, and (4) healthy public policy-based health promotion. We demonstrate their utility for understanding the multiple relationships among conditions, practices and health status in urban populations. We delineate the need for: clearer descriptions of the range of agricultural practices in different settings; better data on hazardous conditions and health-promoting practices among specific populations; evidence of relationships between conditions or practices and health status in particular populations (with attention to gender and socioeconomic differences); attempts at estimates of likely avoidable health burdens and achievable health gains; and further evaluation of interventions that mitigate risks and promote benefits. Together, such transdisciplinary research, conducted with community participation, should provide multiple stakeholders with sounder guidance on the trade-offs inherent in pursuing different opportunities, considering equity issues, for the improvement of urban ecosystems, consistent with the Ecohealth frameworks, i.e. ecosystem approaches for human health.

Introduction

Urban and peri-urban agriculture (UA) comprises a broad set of agricultural activities carried out in cities or in close proximity to cities. With increasingly permissive approaches to diverse livelihood strategies and open markets in agricultural inputs, services and products, urban dwellers are engaging in a range of agricultural practices. These practices, which occur in vastly different geographic contexts, engender a complex mix of potential health risks and benefits, both for urban agriculturalists themselves and for their suppliers, neighbours and clients (Brown and Jameson, 2000; Flynn, 1999). Multiple factors can either increase (risk factors) or decrease (protective factors) the probability of adverse human health outcomes (WHO, 2002).

UA poses different types and magnitudes of health risks and benefits to farmers compared with rural agriculture. Urban areas are characterized by high population densities and consequently, high energy use, resource consumption, and generation of waste. Resource use may be comparable between urban and rural dwellers on a per capita basis, but the geographic concentration of resource use and discharge within the city leads to greater environmental degradation. In addition, there are competing uses of resources within the confines of urban areas, and thus UA is more likely to be juxtaposed with industrial and commercial activities that consume resources (e.g., clean water) and contribute to environmental degradation (e.g., solid and liquid waste discharge). The consequences of the geographic concentration of people and activities within urban areas can include greater exposure of urban agriculturalists to physical, chemical, biological and psychosocial hazards. Although hazardous exposures also occur in rural areas, they are intensified in urban areas, where there are many diverse land demands and juxtaposed land uses. There are also numerous benefits derived from UA that must be weighed against risks in a holistic overview of the activity. Potential benefits are wide-ranging and include increased food security and improved nutrition for the urban poor (see Yeudall, this volume). Due to the complex nature of these tradeoffs, an examination of the methods used to assess the health risks and benefits associated with UA is needed.

With ever more people living and working in cities, public health managers, community organizations, agriculturalists, and urban planners are seeking to maximize economic, social, and health benefits of UA while minimizing the health risks. Human health, construed in terms of positive well-being and capacities as well as negative conditions and impairments, remains central to their concerns, particularly for the poor (Hardoy and Satterthwaite, 1997). A number of useful approaches, drawing from different disciplines, have been developed to assist in the joint analysis of human health risks and benefits. This paper addresses four of these: (1) project-based environmental health impact assessment, (2) regulatory-based health risk assessment, (3) environmental justice-based risk management, and (4) healthy public policy-based health promotion.

Here, we briefly describe these approaches, illustrate their application to UA, and discuss their utility for improving human health by minimizing risk. The implications of specific UA practices in different urban contexts are left to more ample treatment by other papers in this volume. We conclude with recommendations for improved UA policies and conditions for UA. In accordance with an Ecohealth approach, we believe that work on UA should be carried out in a transdisciplinary manner, by researchers, community UA participants, and urban policy makers.

1. Project-Based Environmental Health Impact Assessment

Environmental health impact assessment (HIA) has been an important instrument for consideration of health concerns in designing projects in the developing world (Listorti and Doumani, 2001). Birley (1995), a notable practitioner of HIA in the field, defined it as the "prospective assessment of the change in health risk [positive or negative] reasonably attributable to a project, programme, or policy." Approaches to HIA for urban and peri-urban resource development projects have included UA (Birley and Lock, 1999). A number of HIA guidelines have been developed, usefully reviewed in Birley (2002), with plans to share experience with HIAs underway (WHO, 2003). Most HIAs include a core set of components: identification of potential health hazards, assessment of potential health impacts, and suggested implementation of health safeguards or risk mitigation measures.

The first step of an HIA is to identify potential health hazards. This is a broad scoping exercise aimed at examining all potential health hazards and narrowing the possibilities to those of greatest concern. This scoping process may involve discussion with multiple stakeholders to draw on their knowledge and perceptions. This exercise is necessary in order to make the HIA tractable and relevant, as the factors that should be included may not be self-evident. The potential health hazards considered would include those in common with rural agriculture as well as those unique to UA.

Potential health hazards are often classified as physical, chemical, biological, or psychosocial (see Table 1). Physical hazards involve some direct transfer of energy to the body, as in a violent attack on a farmer irrigating her/his field at night, with the resultant injury.

Table 1. Potential health hazards associated with urban and peri-urban agriculture (UA)

Type of hazard	Relevant exposure groupings	UA Example
Physical	Internal External	- repeated bending forward to weed plot - noise from small millet grinding mill
Chemical	Direct Indirect	-upstream waste discharges into irrigation water -lead and polyaromatic hydrocarbons (PAHs) from vehicular exhaust in roadside vegetables
Biological	Directly transmitted Via carrier Vector borne	-swine fever among pigs -salmonella species multiplying in eggs -malaria breeding in pools of water
Psychosocial	Overload Insecurity	-long hours of work with multiple demands -unclear land tenure, fear of theft or assault

Chemical hazards can involve direct exposure such as skin contact with chemicals in irrigation water that has received upstream discharges of hazardous chemicals from other urban activities, or a child having access to pesticides or pharmaceuticals for livestock in a farming household. As mentioned above, a particular concern with UA is the numerous types and sources of hazardous discharges in urban areas, leading to multiple exposures through indirect routes. For example, many chemicals can also travel through environmental media, such as lead from gasoline traveling through air, accumulating in soil, and then being taken up by market-destined vegetables. Some chemicals emitted to the urban environment can bio-accumulate from food sources into animal tissue, such as the transfer of lipid-soluble polychlorinated dioxins and furans, organochlorine pesticides and industrial solvents into the fatty part of milk. Some chemicals can also biomagnify through species in a food chain, culminating in higher concentrations at higher trophic levels, such as the concentration of methylmercury in top predator fish to about a million times greater than that in water (Boischio and Henshel, 2000).

Biological hazards can be passed to human beings directly, as with swine fever, or indirectly through media such as water (*Cryptosporidium sp* in drinking water) or food (Salmonella in eggs). However, these biological hazards are often part of a complex set of relationships among different species, both domestic (e.g. cattle and dogs) or domiciliated (e.g. mosquitoes), which may act as vectors (carriers) of particular illnesses (see Klinkenberg & Amerasinghe, and Nasinyama et al., this volume).

Finally, the work involved in managing one's household and farming activities can make for long days or overload, resulting in adverse psychosocial effects, particularly for women (Avotri and Walters, 1999; see also Lee-Smith, this volume).

Identification of each of these hazards usually builds on a combination of the perceptions of those exposed to them, what is known about particular practices in UA (literature and expert knowledge), direct observations of particular situations, and measurements of contaminants in media or people (see the section on exposure assessment below). A good example of integrating sources of data into a profile of potential biological hazards was that conducted for irrigated vegetable production and marketing in Accra, Ghana (Sonou, 2001). Using a community participation approach, interviews were conducted with farmers about the source of water for irrigation – as many as 60% confirmed using wastewater, with 23% using pipe-borne water, and 17% using piped water stored in a ground reservoir. Other interviews with women sellers found that all reported washing vegetables prior to bringing them to the market to sell. In addition to documenting practices, the interviews found that neither group associated their practices with any potential health hazards. Parallel data collection efforts measured bacterial counts in irrigation water and on vegetables from two different market sites in Accra. High levels of contamination of market vegetables by *Escherichia coli, Pseudomonas, Salmonella*, and nematodes were observed. Based on these observations, suggestions for training and education campaigns for farmers and market women were developed, as well as a proposal for designing a water quality certification program based on levels of contamination.

Potential health impacts can be classified in various ways: by the organ system involved (e.g. musculoskeletal for back and shoulder pain associated with biomechanical loads of agricultural work); by the type of effect (e.g. neurological effects or congenital malformations associated with pesticide exposure); or by whether they are communicable or non-communicable (e.g. infection vs. cancer) (ILC, 1998). Data on morbidity and mortality may be available from health service records (e.g., malaria incidence in areas where UA is practiced), but additional data may need to be collected via surveys. A good example is the complex set of vector density and parasite load measures mapped geographically that may assist in identifying variations in urban malaria prevalence (Robert et al., 2003) and hence marginal attribution to UA through examination of distance from irrigation sources, nature of those sources and other malaria transmission related factors (Afrane et al., 2002; and Klinkenberg et al., this volume).

Clarifying which are the potentially affected populations is also a key part of HIA. Urban populations may be more likely the objects of assaults due to the higher concentration of people and greater socio-economic disparities in cities. Focusing on behaviour is a way to identify heterogeneous populations. *Working* with animals or toxics can lead to exposure to occupational hazards for workers (ILC, 1998). *Playing* close to parents irrigating with wastewater or in yards where animals defecate exposes children to biological hazards. *Consuming* chemically or biologically contaminated foods is likely one of the major pathways of exposure for urban residents.

Classification of populations by life stage is also important. *Young* children have underdeveloped detoxicification systems for chemicals. Women and men of *reproductive age* can be affected by a variety of exposures that impair fertility or can affect the fetus (Paul, 1993). Consideration of susceptibilities is another lens. The urban *poor* are more vulnerable than the *rich* due to poorer housing and sanitation in slum areas, reduced access to nutritious foods, and more difficult access to health care (WHO, 2002). Those with *existing health conditions* are more susceptible, e.g., asthmatics' greater response to vehicular air pollutants; and anemic children's greater susceptibility to lead exposure, particularly relevant in the case of roadside plots. *Gender* differences may combine several of these ways of considering greater vulnerability (see Lee-Smith, this volume). Poor women are more often responsible for environmental management so they are more likely to experience exposures associated with UA waste (Hovorka, 1998) while at the same time being more prone to anemia (van den Broek 2003).

2. Regulatory-Based Health Risk Assessment

Health risk assessment (HRA) focuses on particular chemical hazards of concern and builds on extensive exposure assessment, population susceptibility and dose-response information, to provide quantitative estimation of risks. HRA is most extensively developed for chemical and radiation hazards where dose-response toxicity data from toxicological and epidemiological studies is most available. In the absence of measured environmental and toxicity data, mathematical models may be used to provide approximations, e.g., fate and transport models to estimate environmental concentrations of organic air pollutions such as polyaromatic hydrocarbons (PAHs).

Exposure assessment models may begin with data on chemical emissions that result in concentrations in different media (e.g., Priemer and Diamond, 2002). Alternately, exposure may be estimated using measured amounts in various media, including foods, such as DDT/E in dairy products (Cole et al., 1998). A more detailed assessment is obtained by quantifying chemical concentrations in different media, e.g. fruit, vegetables, drinking water (see Figure 1), and by different routes of exposure (ingestion, inhalation and dermal). The health risk assessor will then combine media concentrations with media and population-specific intake rates and numerical estimations of the intensity and time pattern of exposure, to produce an estimate of likely intakes and eventual doses on a daily basis (Figures 2, 3 and 4).

The challenge of assessing exposure in UA lies in identifying the numerous chemicals directly and indirectly related to UA and the multiple populations likely to be exposed. The multiplicity of sources, uncertain emission rates and diverse

population behaviours make it difficult to model contaminant concentrations, exposure and intakes. Nevertheless, based on current knowledge, metals such as lead and cadmium, combustion products such as PAHs and dioxins, and pesticides applied in UA, such as organophosphate insecticides, all appear to be important in the pathways set out in Figures 1-4.

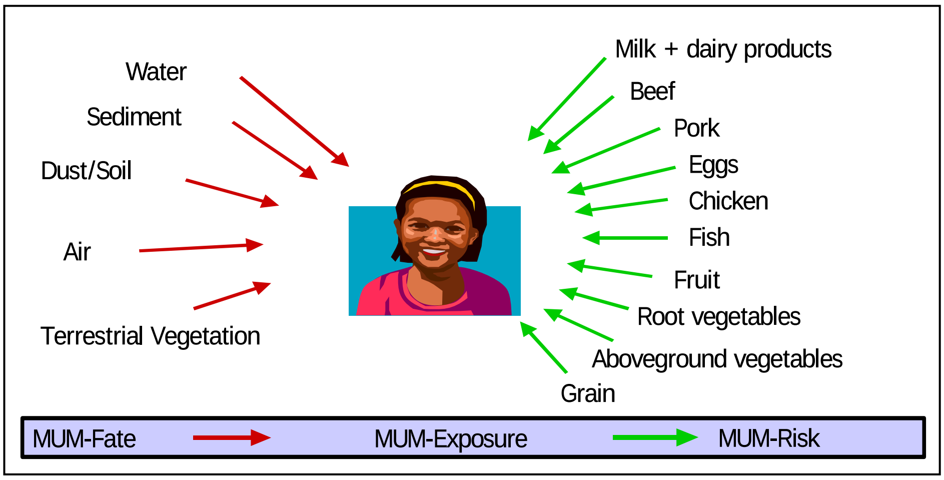

Figure 1. Multimedia Urban Model (MUM) – Chemical Exposure Pathways

$$Dose = \frac{C * IR * EF}{BW}$$

C = concentration
IR = intake rate
EF = exposure factor
BW = body weight

Where:

$$EF = \frac{ED * EFr}{AT}$$

EF = exposure factor
ED = exposure duration
EFr = exposure frequency
AT = attenuation time

Figure 2. Generic Dose/Intake Calculation

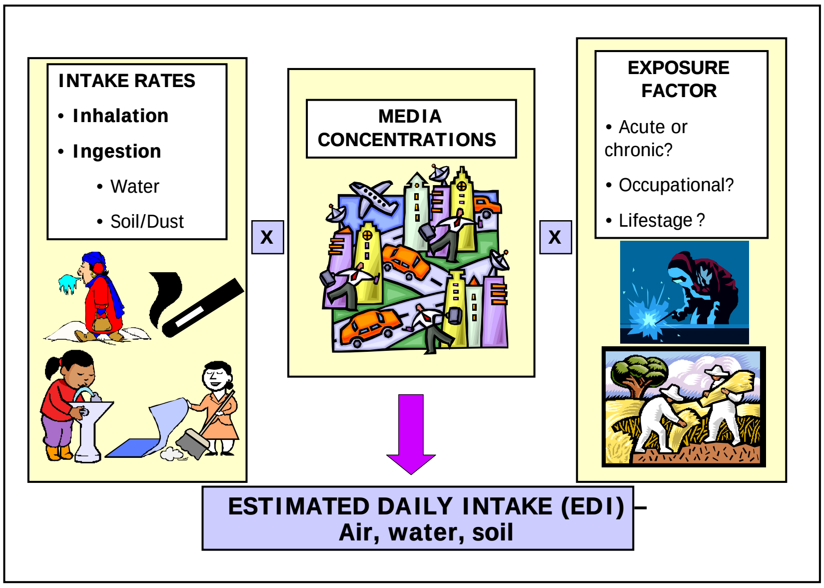

Figure 3. MUM Exposure – Air, Water, Soil

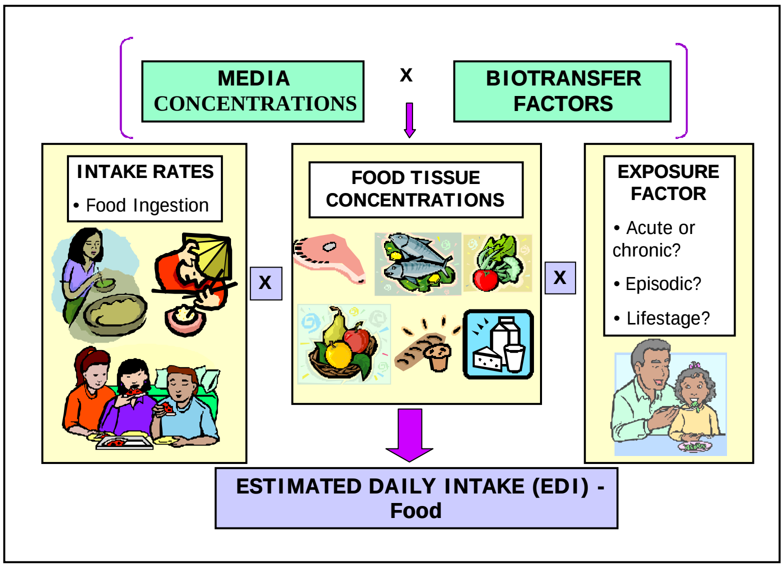

Figure 4. MUM Exposure – Food

For many health risks associated with UA, exposure is likely to be chronic, though fluctuations may occur due to the seasonality of some UA practices, e.g., insecticide application to vegetables at certain stages of growth. Similarly, levels of contaminants in soil and the uptake of contaminants into vegetables may vary markedly across UA locales, possibly due to geographically variable emissions, site soil characteristics, or differences between particular crop species. For example, available lead was found to be higher in more acid, lower clay soils associated with former municipal dump sites in Kampala, and lead uptake was greater in the leaves of dicotyledonous species like okra, than in those of monocotyledons like maize (Nabulo, 2002). In addition, contaminant bioavailability for humans ingesting UA crops is likely highly variable, although there is a distinct lack of bioavailability estimates in the literature for most contaminants.

Improving exposure assessment for UA may require more systematic observations of: urban horticultural practices (e.g. selection of crops that have lower rates of contaminant accumulation); inorganic waste disposal practices (e.g. batteries buried in plots or in latrines acting as sources of soil lead and cadmium - observed in Kampala); or activity patterns of the populations of interest (e.g. children's movement among pigs and chickens or along the side of the road while parents are working plots). Greater precision in exposure assessment may be achieved through clearer documentation of the sources of different foods in the diet, for example, UA household produce or UA marketed produce, as well as through better documentation of food preparation practices by particular populations e.g., boiling of milk to reduce bacterial contamination prior to consumption (see paper by Nasinyama et al., this volume). Laboratory analysis of contaminant concentrations in crops will provide more accurate ranges of variation (Nabulo, 2002), as compared to predicting media concentrations through use of fate, transport, and uptake models. However, obtaining such detailed quantitative information on a very wide range of potential hazards can pose considerable technical challenges and obtaining accurate analytical results can entail substantial expenses.

Screening-level risk assessments are an attractive option to guide future observation, research and analyses in a more cost-effective manner. For example, a screening-level approach is currently being used by Environment Canada and Health Canada to assess the ecological and human health risk associated with thousands of existing substances presently on the Canadian domestic substances list, recently mandated for assessment under the Canadian Environmental Protection Act in 1999 (Cureton et al., 2001). UA in developing countries is a germane field in which to apply such approaches.

Risk characterization for chemical, radiological and biological hazards involves comparing the predicted/measured concentration or dose to a benchmark, to see if an exceedance occurs. Concentrations in exposure media, such as foodstuffs, can be directly compared with regulatory media benchmarks that already incorporate general elements of dose-response relationships and health impacts e.g., Codex Alimentarius of FAO for pesticide maximum residue limits. However, for more detailed and specific analyses, the estimated dose should be compared to a toxicological benchmark. Toxicological studies in laboratory animals, observational studies on wild animals, and epidemiological studies of people either working or living in an exposed environment all inform the quantification of dose-response relationships.

For non-cancer outcomes, "No or a Lowest Observed Adverse Effect Level" (N/LOAEL) is usually calculated. Combined with adjustments for the uncertainty of variations within species, across species and across studies, a reference dose (RfD) is estimated. For cancer outcomes, a non-threshold toxicity model is generally assumed, and a cancer slope factor is calculated based on the dose-response relationship. Best estimates of such associations should be obtained from systematic reviews via searches of the literature (using, for example, PubMed), if available. Alternatively, synthesized and peer-reviewed estimates across species and types of studies are available via websites such as the United States Environmental Protection Agency's (USEPA) Integrated Risk Information System (IRIS) (www.epa.gov/iris). It is important to note that human toxicity benchmarks are generally developed for healthy Caucasian adults, though efforts are underway to develop benchmarks for children. Most benchmarks and toxicity assessments do not address ethnic/racial variability nor other sources of differential susceptibility such as population illness prevalence, except around air pollution and cardio-respiratory illness.

Risk characterization can be carried out in different ways, based on different exposure and dose-response information. Risk for non-cancer outcomes is estimated by calculating a hazard quotient, which is the ratio between predicted dose and the reference dose (see Table 2). A hazard quotient greater than one is generally considered by regulatory agencies to exceed a tolerable risk level, although some agencies may choose a lower "action level" depending on specific circumstances. Incremental increases in lifetime cancer risk due to a particular exposure may be estimated by calculating the ratio between predicted cancer risk and a tolerable cancer risk level (usually ranging between 1 in 1,000,000 to 1 in 100,000 excess cancer burdens attributable to an exposure. See Table 3).

Table 2. Risk characterization model - Non-cancer disease endpoints*

Toxicological Benchmark	Tolerable Daily Intake (TDI) = $\frac{\text{NOAEL or LOAEL}}{\text{Uncertainty Factors}}$
Risk Calculation	Hazard Quotient (HQ) = $\frac{\text{Estimated Daily Intake (EDI)}}{\text{TDI}}$ EDI is for all media, one route of exposure
Risk Interpretation	HQ 1 Action level of some regulatory agencies 0.2 HQ 1 Action level of other regulatory agencies HQ 0.2 Risk level considered "low"/tolerable by most regulatory agencies

* e.g. reproductive, nervous system, digestive system, skin, kidney, liver effects

Table 3. Risk characterization model - Cancer endpoints

Toxicological Benchmark	Cancer Slope Factor (CSF) Unit Risk/Increase in exposure (as no threshold exists)
Risk Calculation	Risk = EDI x CSF EDI is for all media, all routes of exposure
Risk Interpretation	Set tolerable cancer risk, typically 1×10^{-6} (1 in a million) or 1×10^{-5} (1 in 100,000) If risk > 1×10^{-6}, represents excess cancer burden attributable to exposure

The entire set of calculations, from exposure estimation to risk characterization, can be carried out either deterministically via functions and spreadsheets, or probabilistically through use of simulation software, e.g. @Risk (www.palisade.com) or Crystal Ball (www.crystalball.com). In the former, uncertainty analysis is conducted using "high" and "low" as well as "best estimate" inputs to estimate the likely range in risk. An example of a deterministic risk assessment is provided by the predicted increases in cancer risk from PAH and nitro-PAH exposure estimated for consumption of food items grown in the Los Angeles basin (Yaffe et al., 2001). For a probabilistic risk assessment, the frequency distributions of intakes and concentrations (either measured or assumed) are statistically sampled on a repeated basis to estimate likely distributions of persons experiencing adverse health impacts. Examples of probabilistic risk assessments include a study that estimated mercury exposure and risk from dental amalgam using Monte Carlo methods to generate probabilistic distribution models (Richardson et al., 1996) and one conducted using @Risk for mercury neurotoxicity among those consuming fish in the Amazon (Boischio and Henshel, 1996). Probabilistic models incorporate effects on distributions of both parameter uncertainty, e.g. exposure estimates, and model uncertainty, e.g. linear vs. curvilinear vs. threshold approaches (Hertwich et al., 2000).

Detailed regulatory guidelines and handbooks for conducting human health exposure and risk assessment are available from several sources. One example is Health Canada's "Handbook for Exposure Calculations" (www.hc-sc.gc.ca/ehp/ehd/catalogue/bch_pubs/95ehd193.htm) and the United States Environmental Protection Agency's (USEPA) "Risk Assessment Guidelines for Superfund" (www.epa.gov/superfund/programs/risk/ragsa/). Whereas the methods are general, the assumptions made and data used (e.g. intake rates) need to be specific to UA, the particular location, and the specific populations being considered. The specificity of the analysis to UA must be consistent with details specified in the scoping exercise. Unfortunately HRA is largely limited to consideration of single chemical, radiological or biological hazards, in contrast to the complex chemical mixtures combined with multiple, non-chemical hazards to which urban farming populations are exposed.

3. Environmental Justice-Based Risk Management

Results from health risk assessments can provide important information on which to base risk mitigation and management decisions. The results can aid in prioritizing which risks to mitigate, and also in suggesting ways to mitigate them. However, although a health risk assessment provides a "best estimate" based on empirical data, these estimates of risk may not coincide with perceptions of risk among exposed communities. In particular, different social groups have different perceptions of the intensity of risks (Elliott et al., 1999; Boischio and Henshel, 2000) which, in turn, can differ from risk as estimated by a risk assessment.

Documentation of perceptions or social constructions of risk can provide additional important input to the risk management processes, and can guide education efforts. For example, a group of South African farm women thought that storage of pesticides was risky to the environment, but not linked to health, and that pesticide containers were not a health risk if the pesticide container was washed before being reused (Rother, 1999). This demonstrates that knowledge of both perceived and actual risk must feed into a risk management framework, particularly when health impacts may be occurring that farmers are not aware of, as in neurotoxic effects of pesticides (Cole et al., 1997). Even when actual risks are known, willingness to take on or assume risks, both in production and in pesticide use decisions, varies across farming styles, as has been observed among small-holder potato farmers (Paredes, 2001).

Variation in willingness to assume risk is most apparent in cases raised as human rights travesties, such as the construction of large dams in India and China, which are opposed by many in the rural population who are forcibly displaced. Similar human rights concerns are raised as a result of efforts of municipal authorities to clear urban farmers away from hazardous sites such as roadside verges or wastewater channels. Hence, activities that work with communities to foster dialogue on risks and explicitly discuss different points of view are required. Such community participation is exemplified by multi-stakeholder consultations and UA participatory urban appraisals (see presentation by Twazebe et al., this volume). During focus groups on health in Kampala, women UA farmers spoke eloquently about their concerns with food contamination from human excreta and industrial pollution in wetland farming (David et al., 2003). They were less clear, however, about the nature of exposure to chemical and biological contaminants. Environmental, health and social scientists from the research team discussed the different possibilities of exposure from their perspectives as part of plenary dialogue in the meetings in Kampala. This sharing of perspectives is an essential part of a transdisciplinary, participatory study, as different stakeholders share both their assessment of different risks and willingness to assume them.

For comparisons across risks, quantification to a common metric is often useful e.g., quality- (Ponce et al., 2000) or disability- (WHO, 2002) adjusted life years. These measures take into account *when* an adverse health impact occurs during a life, as well as its impacts on the *quality* of life experienced. Alternatively, in retrospective assessments, health economists have estimated economic burdens of illness, both indirect and direct, considering, for example, lost workdays, and transport and clinical/treatment costs associated with pesticide poisoning in farm households (Cole et al., 2000). Labour economists haven used existing cross-sectional and prospective studies to estimate the productivity impacts of risk reduction, e.g., improvements in work capacity among farm workers with treatment of parasitic infections and concomitant anemia (Horton et al., 2001). Comparison of risk arising from multiple disparate factors is difficult, though particularly germane to UA, and has been identified as an important area for method development in food safety (Taylor et al., 2003)

Tradeoffs (balancing of benefits and risks) also occur. Among those urban households experiencing recurrent hunger, "food on the table" to allay hunger may have higher priority than avoiding the longer-term risk of chronic diseases such as cancer due to PAH exposure from air pollutant contaminated vegetables. Sometimes subtle adverse effects may not be perceived. Often, win-win situations can be highlighted. For example, reduction of neurotoxic insecticide use among potato farmers was estimated by agricultural economists using a Tradeoffs Analysis tool (Antle et al., 1998) to produce increased farmer neurobehavioural scores (better health) and higher farm productivity. Sometimes, however, constraints may generate inter-group tradeoffs. In Kumasi, Ghana, use of cheap poultry manure for vegetable production is common. However, in high demand seasons, manure producers shortened storage times prior to sale to such a point that pathogens were no longer killed, thus exposing vegetable farmers and eventually consumers to risk from pathogens (Drechsel et al., 2000).

Risk management may be influenced by the kinds of health hazards identified, the extent and appraisal of health risks among different populations, the differential valuation of health risks and benefits, and the differential distributions of tradeoffs. In addition, the viability and impact of mitigation strategies are relevant, as discussed in an e-conference on options for health risk mitigation for different disease risks (Lock and deZeeuw, 2001). For example, is disease screening and treatment of urban livestock a better method of improving benefits to urban farmers and reducing health risk to urban consumers than inspection of produce, which may be uneven and ineffective in controlling risk for neighbourhood consumers? Or is use of partially treated wastewater for irrigation of UA crops and clean water for washing market produce more feasible than trying, but failing, to provide clean water for all activities? In democratic societies, broad discussions on the pros and cons of mitigation options should be 'part and parcel' of risk management decisions. Joint health risk assessment and management processes involving scientists, managers and active communities have been a hallmark of Remedial Action Plan processes in the Great Lakes Basin (Health Canada, 1995). Such approaches strive to ensure that risk management is based on an acceptable *process* (procedural justice) through community participation and achievement of acceptable *outcomes* (distributive justice), consistent with standards of environmental justice (Cole et al., 1998b).

4. Healthy Public Policy-Based Health Promotion

Increasingly, risk management is moving "upstream" on presumed causal pathways of health impacts and location of responses to broad determinants of health, such as the way UA is managed and carried out (Corvalan et al., 1999; WHO, 2002). For example, better household, community and industrial waste management can obviate the practice of depositing waste in drainage channels. This can reduce blockages and flooding during the rainy season and reduce levels of fecal bacteria in water. As a consequence, diarrhoeal disease morbidity and mortality should decline. Grappling with the 'driving forces' and 'pressures' leading to environmental degradation may be the most effective way to control potential health hazards associated with UA. In urban design terms, dealing with "driving forces" leads us to consider revised urban forms (e.g. designated safer locations for UA); infrastructure provision, (e.g. wastewater treatment); transportation design (e.g. more collective transport to reduce air pollution); and better stewardship of city resources and resource consumption (e.g. recycling of organic waste into UA as is conceptually laid out in urban metabolism studies by Sahely et al., 2003). Such aspects are often central to concerns of multi-sectoral healthy public policy movements such as "Healthy Cities" (www.who.dk/healthy-cities.)

Upstream approaches also force us to consider the multiple levels of social structures that contextualize processes of generating health (or illness & injury) (MacIntyre and Ellaway, 2000). For example, work has focused on community capacities developed through UA at different social levels (Moskow, 1999) including: self-efficacy of individual farmers; livelihood of the farming household, often via reductions in the amount spent on food (Gerstl et al., 2002, and see Yeudall, this volume); and social capital development in, and empowerment of, communities through their participation in approaches to urban food system or "Hunger-Proof Cities" (Koc et al., 1999). Although research on such positive aspects of UA remains limited, analogies may be drawn from the encouraging agricultural development literature. For example small farmers involved in community participation schemes with technological, financial and training supports have been able to achieve substantial increases in productivity through relatively simple innovations based on low external inputs (Pretty et al., 2003).

Recommendations

To develop improved UA policies and conditions for UA, we should start with clearer descriptions of the range of agricultural practices in urban areas located in different settings. This work seemed to be underway in a number of cities represented at this workshop, and in parallel work on UA in Sub-Saharan Africa. Alongside such descriptions would be more accessible data on hazardous conditions and health-promoting practices among specific populations engaged in UA. In accordance with an Ecohealth approach, this work should be carried out by transdisciplinary teams, and should incorporate community participation and an awareness of issues of gender equity. It should also build on recent efforts to increase the availability of environmental data and accessibility through environmental mapping exercises that employ geographic information systems (GIS) (Briggs, 2000).

Ideally, transdisciplinary teams could generate information on the kinds of *environmental health indicators* needed, as advocated by the World Health Organization's Sustainable Development and Healthy Environments group (WHO, 1999), and distributions of *health risk or health protective factors* as described in the World Health Report (WHO, 2002). With such information and existing data on factor/health status relationships, estimates of the likely burden of illness or injury (based on risk factors) or extent of well-being advantage (based on health promoting factors) would be possible. However, additional human epidemiological work may be required to assess these relationships in particular populations e.g. the benefits of farming for the self-esteem of widows of the HIV-AIDS dead. Such additional information could better inform HIA and HRA that is relevant to UA.

To arrive at an understanding of likely avoidable health burdens and achievable health gains by population sub-groups including children and women, as recommended in the World Health Report (WHO, 2002), we need to take several additional steps:

First, valuing health outcomes is required by communities suffering health impacts and by UA producers and consumers, in conjunction with transdisciplinary teams of health and economic practitioners and researchers.
Second, estimating the relative contributions of different types of UA to morbidity and well-being must be distinguished from the contributions of other aspects of urban living conditions, e.g., poor general waste disposal and sanitation that are likely to contribute to a huge burden of existing gastrointestinal infectious disease in poor urban communities that is not directly attributable to UA.

Third, priorizing hazards specific to UA for mitigation must be conducted through multi-stakeholder processes involving communities engaged in UA, municipal policy makers that must manage cities for the benefit of all urban citizens, and transdisciplinary research teams.

Fourth, constructing feasible counterfactual scenarios of better agricultural practices and urban conditions where risks would be mitigated and benefits maximized using different approaches. These latter scenarios would form the basis of estimates of avoidable burden of disease/injury and achievable health gains associated with improvements in UA.
Fifth, more systematically evaluating interventions in UA that mitigate risks and promote valued benefits, e.g., simple wastewater treatment pond systems constructed with, and maintained by, urban farmers.

The results of these types of research should provide community members and other stakeholders with better guidance in the pursuit of effective and efficient opportunities for improvement. As urban farmers and city managers improve practices in UA, we urge them to engage in ongoing monitoring and evaluation of their joint programs through sets of key indicators relevant to urban conditions in general, and UA in particular.

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Nutritional perspectives in urban and peri-urban agriculture

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Abstract

Unless urban poverty and malnutrition are reduced at a rate commensurate with the increase in urban population, we will see increasing proportions of urban dwellers at risk of food and nutrition insecurity. Although the potential for Urban Agriculture (UA) to improve the nutritional and food security status of individuals and populations is widely assumed, there is limited empirical data to support this assumption. This paper focuses on nutritional perspectives related to UA, including a discussion of nutrition issues relevant to Sub Saharan Africa (SSA) such as the relationship of nutrition to health, nutritional requirements in contaminated environments and characteristics of urban diets and the Nutrition Transition. This is followed by a discussion of the application of a risk assessment framework in nutrition research. The focus is on methodologies for capturing nutritional benefits and the discussion addresses food security, dietary intake, anthropometric and biochemical indicators of nutritional status, and identification of resources to assist in data collection and analysis.

Introduction

Migration from rural to urban areas is increasing in sub-Saharan Africa (SSA). An estimated 54% of the SSA population will inhabit urban areas by 2030 (UN, 2002). Unless urban poverty and malnutrition are reduced at the same rate as the urban population increases, we will see increasing proportions of urban dwellers at risk of food and nutrition insecurity (Haddad et al., 1998). The practice of producing crops and/or raising livestock within urban and peri-urban areas is one strategy to contribute to improving the food and nutritional security status of individuals and populations (Ruel et al., 1998). Potential benefits of engaging in urban and peri-urban agriculture (UA) include increased quantity and quality of food available for consumption. In addition, research in Uganda has demonstrated that mothers have more time to spend on child-care activities when their primary source of livelihood is agriculture as opposed to other forms of employment (Maxwell, 1998).

Ruel and colleagues (1998) in their review of urban challenges to food and nutrition security noted a limited amount of empirical data regarding food security benefits associated with UA practices. The organizers of this workshop have recognized the importance of setting a research agenda that includes quantifying benefits in addition to mitigating risks associated with the practice of UA. The following paper focuses on nutritional perspectives related to UA. First there will be a discussion of nutrition issues relevant to practitioners of urban agriculture in sub-Saharan Africa, followed by a discussion of the role of nutrition in the assessment of benefits and risks. The final discussion will present methodologies for the measurement of benefits of UA related to nutrition, and will identify resources to assist in data collection and analysis, according to the Ecosystem approach to human health (Ecohealth). The three methodological pillars of Ecohealth are transdisciplinarity, participation, and equity of gender and social class (Lebel, 2003). The importance of community participation and incorporating gender perspectives in all aspects of research described in the following paper cannot be underestimated. An in-depth discussion of these issues is beyond the scope of this paper, however readers are referred to the paper by Lee-Smith.

The Relationship of Nutrition and Health

The 2002 World Health Report estimated that protein-energy and micronutrient malnutrition contribute to approximately 20% of the global burden of disease. The same report identified the primary determinants of under-nutrition in pregnant women and children were identified as underweight, lack of breastfeeding, and deficiencies of the micronutrients iodine, iron, vitamin A and zinc (WHO, 2002). With the exception of breastfeeding and possibly iodine deficiency, UA has the potential to contribute to the alleviation of disease burdens by reducing the prevalence of diseases related to under-nutrition.

Over half of the major nutrition challenges identified in the UN report ‘Ending Malnutrition by 2020’ involved reducing the prevalence of micronutrient malnutrition (ACC/SCN, 2000). Of particular concern is the relationship of several nutrients, primarily vitamin A, zinc, and to a lesser extent iron, to the ability of humans to mount a successful defense against infectious disease. In addition to direct effects of certain nutrients on immune function, observational and intervention trials have observed, for example, increased morbidity and mortality from diarrhoea in the presence of mild and severe vitamin A deficiency (Beaton et al., 1993; Huttly et al., 1997), and increased incidence of diarrhoeal disease coupled with sub-optimal growth in children with marginal zinc status (Hambidge, 2000). The downward cycle of infection and malnutrition is well recognized. Inadequate nutrient intakes lead to impaired nutritional status and increased vulnerability to infectious diseases. Nutritional status can be further compromised as a result of anorexia (loss of appetite), reduced food intake, increased intestinal losses of nutrients, and increased nutrient requirements associated with infection (Martínez and Tomkins, 1995).

In addition to effects on the integrity of the immune system, deficiencies of vitamin A are associated with blindness and anemia, deficiency of iron with anemia, adverse birth outcomes, and reduced physical work capacity, and deficiency of zinc with sub-optimal growth (ACC/SCN, 2000). These deficiencies are more common amongst populations consuming largely plant-based diets with limited foods of animal origin. Clearly, interventions to mitigate transmission of infectious disease as a result of UA activities, in addition to increased consumption of foods of animal origin rich in highly bioavailable micronutrients, have the potential to intervene at two points in the malnutrition and infection cycle to enhance the health of urban populations.

Nutritional Requirements in Contaminated Environments

Research by Campbell and colleagues (2003) examined the role of chronic low-level stimulation of the immune system in growth failure of Gambian infants. The authors concluded that a portion of growth failure observed in infants in developing countries can be attributed to chronic stimulation of the immune system related to increased permeability in the small intestine as a result of living in an unsanitary environment. Chronic infections such as diarrhoea can also lead to the diversion of nutrients to support immune responses instead of anabolic processes, including growth (Solomons et al., 1997). Thus, even if nutritional deficiencies contributing to growth failure are corrected, unless the level of sanitation in the environment is improved, achievement of full growth potential is unlikely (Campbell et al., 2003). This suggests that those planning interventions aimed at reducing the risk of infections from raising livestock in an urban environment should consider including children's growth as an outcome measure in monitoring and evaluation

With respect to nutritional requirements, there is increasing interest in examining alterations in nutrient requirements as a result of living in a polluted environment, and the potential to mitigate toxic effects of environmental contaminants by nutritional means. For example, antioxidants such as beta carotene - found in orange and dark green vegetables and fruits - are known to prevent damage from reactive oxygen species and free radicals, which are produced from exposure to airborne pollution. Several nutrients, including selenium, calcium, and zinc, are known antagonists of environmental contaminants such as mercury, lead and cadmium (Furst, 2002). Recent work presented at the IDRC-sponsored International Forum on Ecosystem Approaches to Human Health reported that high consumption of certain fruits (such as bananas) appeared to be partially responsible for a reduction in absorption of methylmercury among inhabitants of the Amazon region in Brazil (Passos et al., 2003).

Characteristics of Urban Diets and Nutrition Transition

There is a general belief that the prevalence of under-nutrition and micronutrient deficiencies is lower in children dwelling in urban environments than in their rural counterparts (Ruel et al. 1998). Observational studies suggest that urban diets are more varied, with higher concentrations of micronutrients, because of reduced reliance on plant based staples and increased inclusion of foods of animal origin (Popkin and Bisgrove, 1998). A controlled clinical trial demonstrated that given a choice, healthy Mexican volunteers consumed more of a typical urban diet compared to when they were offered a typical rural diet (Rosado et al., 1992). The authors proposed that the relative monotony and high satiety (attributed to the high fibre content) of rural diets were in part responsible for the differences observed. Increased access to income and availability of food, and greater ethnic diversity, which exposes residents to a wider range of dietary patterns, have also been proposed as explanations for the increased quality of urban diets (Ruel et al., 1998). Exploration of the contribution of these factors to the composition of urban diets remains an area for further investigation.

At present, under-nutrition remains the primary contributor to ill health in the sub-Saharan Africa region (WHO, 2002). However, increasing income and urbanization have been shown to lead to a change in food and activity patterns that contribute to higher risk of development of chronic diseases. This shift to a dietary and activity pattern that predisposes individuals to developing chronic lifestyle diseases such as cardiovascular disease is referred to as 'Nutrition Transition', in recognition of its relationship to demographic transition and globalization. The World Health Report (2002) highlights both the rising prevalence of overweight, and the phenomenon of a co-existence of under- and over-nutrition within populations, in some cases within the same household. This emerging pattern of increasing chronic disease will place further stress on health care systems struggling to cope with the burden of infectious disease. Of particular concern to developing country populations is the link between perinatal and childhood under-nutrition and increased susceptibility to chronic diet-related diseases such as cardiovascular disease and diabetes in adulthood (ACC/SCN, 2000). It is clear that UA activities, which lead to increased vegetable and fruit intake, in addition to providing additional opportunities for physical activity, have the potential to mitigate the negative effects of this trend, and deserve further investigation.

Using a Risk Assessment Framework in Nutrition Research

Risk assessment can be used to estimate and compare the burden of disease resulting from various risks. Risk assessment frameworks generally identify hazards, assess exposure and dose-response relationships, and characterize risk. The World Health Report (2002) recommends the use of disability-adjusted life years (DALYs) as the common metric to assess death and disability associated with various risk factors, and has calculated DALYs associated with deficiencies of iodine, iron, vitamin A and zinc. For example, in SSA, fortification of staple crops with iron is estimated to save 29 million DALYs over 10 years globally. Evaluation of UA activities that lead to a reduction in these micronutrient deficiencies can thus be framed in relation to DALYs saved when presented to policy makers.

Food is one of the major vehicles for human exposure to environmental contaminants, and therefore a reliable estimate of dietary intake is essential for accurate exposure assessment and risk characterization (Kroes et al., 2002). There is increasing recognition of the value of including an examination of benefits in risk assessments, and examining risk in relation to benefits. For example, the hazards associated with consuming vegetables grown in contaminated soil can be examined in relation to the benefits of increased dietary diversity (Tsuji and Robinson, 2002, WHO, 2002). There remains, however, considerable difficulty in quantifying the benefits of general dietary patterns and exposure to specific foods, because of a lack of data with respect to dose-response relationships and the multiple factors mitigating the effects of exposure to contaminated foods on health outcomes.

Community Food Security and UA

Increased access to food and improved food security are frequently cited as benefits of participating in UA activities. The term food security, while widely used, lacks a single, universal definition. Most definitions, however, have in common the concept of the ability of individuals to maintain access to adequate and acceptable food, obtained in a manner that maintains human dignity, for a healthy and active life (World Food Summit, 1996). The components of food security can also be considered in four broad categories: availability, access, adequacy and acceptability. Some organizations have added a fifth category, agency, in recognition of the importance of institutional support for policies, such as support for urban agriculture, that contribute to food security (www.ryerson.ca/foodsecurity/centreFSDefined.html).

Food security has traditionally been examined in relation to individuals and households. Recently the concept has expanded to include community food security. Community food security encompasses the concepts of individual and household food security, as well as examining underlying social, economic and institutional forces that affect the quantity, quality and affordability of food within a given community (Hamm & Bellows 2003, OPHA, 2002). A defining feature of community food security assessments is a commitment to participation of community members in all phases of research, program planning and evaluation. Framing the benefits of UA in relation to community food security is more comprehensive than only focusing on nutritional benefits. This approach includes UA’s potential to enhance the livelihoods and food access of urban dwellers in general, not only those who practice UA. Although this paper focuses on nutritional perspectives, assessment of food resource accessibility, distribution, availability, and affordability should also be considered an important area for examination. Traditional participatory methods, including community mapping, transect walks, focus groups and key informant discussions, can all be used in mapping community socio-economic and demographic characteristics and food resources. For a more in-depth discussion of these methods, see Bergeron (1999), and Slack and Morris (1999).

Amongst the earliest works systematically examining UA was work conducted by the Mazingira Institute in Nairobi, Kenya (Lee-Smith et al., 1987). A comprehensive examination of the role of UA in household food security was also conducted by Maxwell and colleagues in Kampala, Uganda (Maxwell et al., 1998). For an overview of evidence see Egziabher et al. (1994) and Ruel et al. (1998). Although there is general consensus that UA will contribute to improved food security, there are few readily available studies quantifying food and nutritional security benefits (Ruel et al., 1998).

Conceptual Frameworks for the Determinants of Nutritional Status

The UNICEF model of causes of under-nutrition in children identifies the importance not only of an adequate diet but also of a healthy physical environment and care behaviours in achieving optimal nutritional health (UNICEF, 1990). Children as a group are more vulnerable to the effects of compromised access to food and nutrients because of their increased requirements to support growth. In our project in Kampala, Uganda, we have decided to examine children, as opposed to more vulnerable household members such as infants under two years, because they eat more food and thus are more likely to benefit from increases in dietary quality (Cole et al., 2003). Adaptations of the UNICEF model have in common a recognition that increased access to food will not necessarily improve the utilization of nutrients in individuals unless factors such as adequate knowledge regarding care practices, an environment free from undue disease burden, and a lack of competing demands for limited financial resources are also present (ACC/SCN, 2000, Ruel et al., 1998). When examining the benefits of increased availability of food in relation to household or community food security, influences such as intra-household distribution of food and income earned from the sale of produce can also be taken into account. Capturing the contribution of any or all of these factors is thus essential in order to attain a true indication of the range of potential benefits from participation in UA activities.

Household and Individual Food Security Measures

Maxwell and Frankenberger (1992) proposed a series of indicators to assess household and individual food security. These included indirect measures such as agricultural production, the use of coping strategies to overcome food deficits, and nutritional assessment measures related to food consumption such as height for age. Direct measures included household and individual food consumption data. Building on this work, the International Food Policy Research Institute (IFPRI) proposed the use of four major outcomes when examining food security; individual intakes, household caloric acquisition, dietary diversity and coping indices (Hoddinott, 1999).

Nutritional assessment methods are invaluable in quantifying food security benefits and assessing risks associated with the practice of UA. Data can be obtained from dietary, anthropometric (growth and body composition), biochemical (biological samples such as blood) and/or clinical (functional changes such as night blindness) measures. These methods have in common that they quantify aspects of health influenced by the intake and utilization of nutrients (Gibson, 1990). Given the diversity of potential outcomes related to food security, a major methodological challenge involves the selection of appropriate indicators.

Dietary Assessment - Individual Intake Measures

Dietary assessment methods can examine food consumption patterns of individuals, households and/or populations. Analysis of food intake patterns encompasses both qualitative and quantitative methods, and can be expressed in relation to intakes of nutrients, foods and/or food groups. Qualitative methods such as the food frequency questionnaire typically ask respondents to recall the frequency of consumption of specific foods or food groups of interest over a specified time period. Respondents can then be ranked in relation to their consumption patterns. If standard portion sizes are added, then a rough estimate of nutrient adequacy can be calculated. There are a wide range of food frequency questionnaires available, but it is important that they have been validated locally to ensure that data produced are reliable (Cade et al., 2002).

Quantitative methods ask respondents to recall or measure foods and portion sizes consumed. The weighed record, whereby participants (or interviewers) weigh and record all foods and beverages consumed over a specified time period, is the most precise method, with the highest respondent burden. This method has the tendency to have respondents change their habits to make measurement easier, or food consumption to appear more socially acceptable (Gibson, 1990). The 24-hour recall method, whereby respondents are asked to recall the foods they consumed the previous day, has less tendency to cause a change in habits, provided the aim is well explained, and interviewers are well trained in order to elicit accurate responses and avoid leading respondents to provide answers that are perceived as more socially acceptable (Gibson et al., 2003).

The most commonly used recall method is the 24-hour multiple pass recall, in which a list of all foods and beverages consumed is obtained by means of a series of questions followed by probing for information on preparation methods and portion sizes, and finally for commonly forgotten foods and ingredients. The method has been modified and validated for use in African countries including Ghana and Malawi (Ferguson et al., 1994, Gibson and Ferguson, 1999). Modifications include the use of a picture calendar to aid recall of foods, and food models (either actual foods or foam models), that are used to assist in portion size estimation. For a complete discussion of the modified recall method, readers are referred to Gibson and Ferguson (1999). The publication provides practical guidelines and procedures for conducting the recall, and is targeted to nutritionists, health professionals and program planners.

One of the requirements for reliable dietary intake data is high-quality food composition data. Because of variations in growing conditions, transportation and food preparation methods, local data is preferred (Scrimshaw, 1997). In recognition of the high cost and limited existence of high-quality local food composition data, the WorldFood 2.0 Dietary Assessment System, developed by the University of California at Berkeley, is recommended for use in converting food-to-nutrient intakes. This program is available for download from the International Network of Food Data Systems (INFOODS) unit of the Food and Agriculture Organization (FAO) (www.fao.org). The software program provides a series of six international food composition tables (Kenya, Senegal, Egypt, Mexico, India and Indonesia). Users can import and export their own food composition databases, and the program also provides a platform for entering food intake data. The program developers recommend that if country-specific food composition data is lacking, users utilize WorldFood databases in their analysis.

When an in-depth study of individual food consumption is not feasible or available, a rough estimate of nutrient availability can be obtained from food balance sheets. Food balance sheets are available at the national level, and include accounts of supplies (including production, imports and exports) of food and food disappearance data. This data provides an extremely rough estimate of food availability when expressed per capita population. Food balance sheets generally do not take into account factors such as wastage due to spoilage or the distribution of food within populations or households (Gibson, 1990). National food balance data by country are available from the FAO website (www.fao.org/es/ess/fr/list.asp).

Household Food Acquisition Measures

A variety of methods can be used to collect information regarding food consumption at the household, as opposed to individual or national level. Collection of household-level indicators can be less resource intensive than examining individual food consumption patterns, and provide a more precise estimate than national food balance data. In contrast to national-level data, household methods involve collection of socio-demographic and economic information, and thus data can be examined in relation to income level, region and family characteristics. Data can be collected retrospectively by recall, or prospectively by recording (by the householder or interviewer). All food entering a household (including food produced, received as gifts or purchased) is recorded over a specified time period. Methods vary in the degree of precision of estimates (weighed vs. estimated), in whether correction factors are estimated or calculated for factors such as plate waste, in food preparation methods, and in accounting for foods consumed outside the home (Gibson, 1990).

Dietary Diversity Measures

Dietary diversity, or the number of different foods an individual or household consumes, is based on the observation that more diverse diets are more likely to include a wider variety of nutrients, and thus reflect a higher quality of dietary intake than more monotonous diets. Several methods have been proposed for assessing dietary diversity. One involves compiling a list of potential foods from data collected during rapid urban appraisals, from discussions with key informants, or from previously collected data. The list is then presented to the participant, and either a sum of the number or different foods, or a weighted sum reflecting frequency of consumption is calculated (Hatloy et al., 1998; Morris, 1999). This type of method has been shown to correlate with caloric intake and identify seasonal variation in intake. The method is well suited where diets are relatively uniform, and where resource limitations do not allow or justify the more precise assessment of dietary intake from methods such as the 24-hour dietary recall. For an in-depth discussion of dietary diversity as a measure of dietary quality, readers are referred to Hoddinott and Yohannes (2002).

Coping Index Measures

Several questionnaires have been developed to examine perceptions and behaviours of household members with respect to their food security status. In general, food insecure households or individuals move along a continuum from anxiety regarding the adequacy of household resources to procure food, to reductions in the quality and/or quantity of food consumed. The final stage is when food intake of younger members of the household is compromised (Bickel et al., 2000). The validity of a food security questionnaire developed for use in US national surveys has been rigorously studied, however validity for use in sub-Saharan Africa remains to be determined (Radimer and Radimer, 2002). In contrast, Maxwell and colleagues (1999) have compared indicators based on frequency and severity of coping strategies (e.g. eating fewer meals, or selling household assets to pay for food) to more traditional indicators, such as dietary and anthropometric indicators, in several African countries. The authors concluded that measures of coping strategy provide a less expensive means of identifying food insecure households than dietary and anthropometric measures. Tools based on coping strategies, however, entail some limitations in correctly identifying food insecure households, so it is suggested that these measures should complement, as opposed to replace, more resource-intensive methods such as anthropometric measures and food consumption surveys.

Anthropometric and Biochemical Indicators

It is recommended that dietary results be examined alongside anthropometric or biochemical measures because of the many factors influencing the absorption and utilization of nutrients, independent of dietary intake. Anthropometry refers to a portable, widely used, inexpensive and non-invasive set of methods to assess the proportion, size and composition of the human body (WHO, 1995). Research has demonstrated that anthropometric measures can reflect health, particularly where chronic imbalances exist. The main limitations of anthropometry are the inability to determine the precise causes of disturbances in growth or body composition, and the lack of sensitivity to changes over short time periods (Gibson, 1990).

Anthropometry can assess growth (height, weight) and body composition (mid upper arm circumference, skinfold thickness). Measures can be examined on their own, however it is more useful to compare to a reference population to determine the degree of deviation from the reference and to standardize for the effects of age and sex. Some of the more widely used indices include height-for-age, which can be used to determine the prevalence of stunting, or low height-for-age and weight-for-age, which can be used to determine the prevalence of underweight in the population. Measures can also be combined, as in the case of body mass index (weight/height^2) to determine indices related to specific health outcomes such as underweight. Finally, measures can be used in prediction equations to estimate body fat and fat-free mass (WHO, 1995).

Having a common worldwide reference population has been useful in order to permit comparison of data across different populations. Evidence supports the claim that the influence of the environment is greater than that of genetics on achievement of optimal growth, and that elite populations in developing countries follow similar growth patterns to populations where growth is not constrained by high disease burdens or sub-optimal nutrient intakes (de Onis and Habicht, 1997). Concerns that the current reference population, which is based on the population of the United States, is not representative of children being fed according to current infant feeding guidelines led to a multi-centre study of growth by the WHO. Seven diverse geographic regions, including sub-Saharan Africa, are involved in the study (Garza and de Onis, 1999). Until the new growth charts are available, WHO recommends the use of the current reference population based on the population of the United States (de Onis and Habicht, 1997). The NUTSTAT program of EpiInfo allows users to compare height, weight and arm circumference to the international reference population. EpiInfo is a database and statistics program available for download from the Centers for Disease Control and Prevention in the United States (www.cdc.gov/epiinfo/). The program allows the user to design, enter, validate and analyze questionnaires, and the EPIMAP program allows for data to be combined with GIS functions for mapping of data.

In addition to anthropometry, functional outcomes of various nutritional deficiencies can be examined. Functional outcomes reflect responses to the body's supply of nutrients, and provides a measure of the biological consequences of deficiency. One example would be night blindness, which can occur in vitamin A deficiency. The main limitation of functional outcomes is their lack of specificity – for example, zinc deficiency can impair the body's ability to produce retinol binding protein which interferes with vitamin A metabolism, and thus can lead to night blindness (Solomons, 2002).

More specific measures of nutritional deficiencies can be obtained from biomarkers, or measures that provide a predictive response to a dietary component of interest. Biomarkers are most commonly measured in blood or urine, and less commonly from hair or buccal cells. Numerous methods appropriate for use in field studies have been developed for capillary (fingerprick) blood samples directly or following collection on filter paper including retinol, retinol binding protein and hemoglobin. For additional discussion readers are referred to Solomons (2002) and to the website of the Program for Appropriate Technologies in Health (www.path.org). All measures to be conducted with populations need to be selected based on resources, technical feasibility, cost and performance, but of particular importance in biochemical tests is the acceptability to the population being studied. Utilizing a participatory approach, whereby the community is involved in all aspects of the research and program development, can facilitate this acceptance (Gibson et al., 1998).

Sources of Secondary Information

Budget limitations do not always allow collection of original data, and with the increased use of the worldwide web, data relating to food security outcomes are more accessible than ever before. Food production and nutritional status indicators are available through the Vulnerability Analysis and Mapping (VAM) project established by the World Food Program (www.wfp.org/operations/vam). The Famine Early Warning System (FEWS) is operated by the United States Agency for International Development and provides information regarding indicators related to risk of famine (www.fews.org). Finally, the series of Demographic and Health Surveys (DHS) are available for the majority of countries in Africa. These nationally representative surveys are a rich source of data collected at the household and community level relating to health and demographic topics including anthropometry and various socio economic status indicators (www.measuredhs.com). For a complete discussion on web-related resources related to food security, see Slack (1999).

Conclusions and Recommendations

Key areas for research activity include further refinement of methods and publication of results that quantify the benefits and contribution of UA to improved food security. In particular, more precise estimates of food and nutrient intakes of urban farmers, their families, and their customers, would provide valuable information for examining both the risk and the benefits. Research results suggest that under-nutrition may be less prevalent in urban areas because of increased incomes, access and availability of food, however additional research regarding how these factors interact in the urban setting to impact malnutrition would also be valuable (Ruel et al., 1998). Finally an exploration of the exact typologies (subsistence versus income generation, crop and livestock combinations) associated with better food and nutritional security would assist in supporting UA activities with the greatest potential benefit to health.

It is clear that UA provides an important coping strategy when food resources and access are compromised, and can contribute positively to food security. Increased agricultural production alone, however, will not necessarily overcome the effects of major constraints such as infectious disease and inadequate care-giving practices (e.g. inequitable distribution of food at the household level). This must be kept in mind in both the planning and evaluation of UA activities (Morris, 1999). A major challenge that remains is to examine and disseminate results of the positive contributions of UA activities to food and nutritional security of communities, households and individuals. An accurate accounting of the benefits will allow researchers, program planners and policy makers to make decisions regarding the most beneficial combination of UA activities, which mitigates risk and promotes benefits. A number of data collection tools exist, and selection should be based on resource availability, research objectives and acceptability of data collection procedures to community members.

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Risk assessment: malaria in urban and peri-urban agriculture

E. Klinkenberg and F.P. Amerasinghe[6]

Abstract

This paper presents the available knowledge about the connections between malaria vector mosquitoes, *Anopheles*, and urban agriculture (UA) in sub-Saharan Africa (SSA). Factors that affect the spread of malaria are discussed, including urbanization, availability of clean water, irrigation methods, preventive practices, and agricultural policies. These risk factors are divided into three categories: Community, environmental, and institutional. Epidemiological and entomological approaches to assessing malaria risk are explained. While many risk factors are known, no simple conclusion can yet be drawn about the impact of UA on mosquito densities. More research is recommended, to ensure that UA is not summarily banned because of unfounded fear of malaria increase. The paper lists options for malaria control, and recommends an inclusive approach to solutions, involving community and farmers as well as health and agricultural authorities.

Introduction

According to conservative United Nations projections, Africa's population will almost triple by 2050. This boom will happen primarily in urban and peri-urban areas, which have already experienced a doubling in population size between 1985 and 2000. In Africa, the current urban population growth rate of 3.5% is more than thrice the rate of the rural population growth and by 2015 (2030) there will be 25 (41) countries in Sub-Saharan Africa with higher urban than rural populations (UN-Habitat, 2001). The increasing population will require increased food supply, and urban and peri-urban agriculture (UA) has been promoted as a means to increase food security in cities and at the same time improve nutrition and alleviate poverty (UNDP, 1996). However, there is a concern that UA could result in increased human health risks.

In many cases, untreated or partially treated urban wastewater is used to irrigate high-value vegetable crops. This poses important health risks to farming communities and to consumers of products irrigated with the wastewater. In addition, urban agricultural areas may create favourable habitats for insect disease vectors, especially malaria mosquitoes. This potential risk was described by Birley and Lock (1999) in their assessment of health impacts of natural resources management, and was highlighted in the Resource Centre on Urban Agriculture and Forestry's (RUAF) e-conference on health impacts of UA as an area where actual figures are urgently needed (Lock and de Zeeuw, 2001). If UA increases the malaria risk through anopheline mosquitoes breeding in the introduced clean water sources, this could lead to municipalities withdrawing support for UA, which would hamper the promotion of clean water for irrigation, leading to the continued use of wastewater/ sewage with its associated health risks. Therefore there is a need to establish what the possible malaria risks are, and, if necessary, to develop risk reduction measures.

Urban agriculture can be broadly defined as all agricultural activities taking place in or around a city, including livestock rearing. For the purposes of this paper, UA is defined as all cultivation of crops in or around a city. There are different types of urban agriculture, and a main division can be made between irrigated and non-irrigated UA. Non-irrigated UA consists of rain-fed cultivation of staple crops such as maize and cassava on open spaces, on temporary fallow land, or in back yards. Irrigated agriculture is mostly cultivation of vegetables irrigated from streams, drains or wells. The types of crops can vary between countries but often are perishable vegetables for which markets need to be in close proximity to the production sites. For example, in Ghana, the most cultivated crops in UA are lettuce, carrots and spring onions.

This paper will identify the risk factors for malaria in UA settings (focussing on irrigated UA), and discuss methods of risk assessment, the current status of information on this subject, and possible options for control and prevention of increased risks.

Malaria: vector and parasite

Malaria is transmitted by the bite of an infective female mosquito. Only mosquitoes of the genus *Anopheles* can transmit malaria. There are about 400 species of *Anopheles* mosquitoes throughout the world, but only about 60 species

[6] Dr Amerasinghe sadly passed away in June 2005. He was instrumental in developing the urban malaria studies in Ghana and I wish to dedicate this paper as a memorial to his work in the field of tropical medicine.

are known to be vectors of malaria under natural conditions (Gilles and Warrell, 1993). Each species has its own preferred ecological niche, and a great variety of niches can be inhabited by anophelines, although the main anopheline vector in Africa, *A. gambiae s.l.* prefers relatively clean sunlit water. The life cycle of the mosquito is characterized by terrestrial (adult) and aquatic (egg, larva and pupa) stages. Only the terrestrial female adult mosquito is involved in malaria transmission. The human malaria parasite (*Plasmodium* spp.) develops partly in the female mosquito and partly in the vertebrate host. There are four human malaria species, of which *Plasmodium falciparum* is the most common in sub Saharan Africa and is responsible for almost all the deaths related to malaria (Gilles and Warrel, 1993).

In endemic regions, malaria is an important cause of human morbidity and mortality. Every year more than one million people die of malaria globally, predominantly children under five years of age. It is estimated that 300-500 million people world-wide are at risk of the disease, and of these, 90 percent live in Sub-Saharan Africa (Breman, 2001; Snow et al., 1999). Kleinschmidt et al. (2001), estimated that of West Africa's 300 million people, 168 million people live in an area with estimated malaria prevalence (percentage of people with malaria parasites in the peripheral blood circulation at a given point in time) above 30%, and 16 million of these live in an area with a predicted prevalence of more than 70%. In malaria endemic regions, people with parasitaemia in their blood are not always ill. Due to partial development of immunity, people in these regions tend to fall ill only with high parasite loads. Treatment of all cases of parasitaemia, however, is important in order to reduce the parasite reservoir in the population, which will in turn reduce malaria transmission risk.

Exposure Assessment

There are many factors, at different levels, affecting malaria transmission, and the most important are represented in Figure 1. These factors may impact vector longevity and/or effectiveness; mosquito and/or parasite development; and/or development of disease in humans. Several risk factors are similar for urban and rural areas, while some are specific to urban environments or certain types of agriculture.

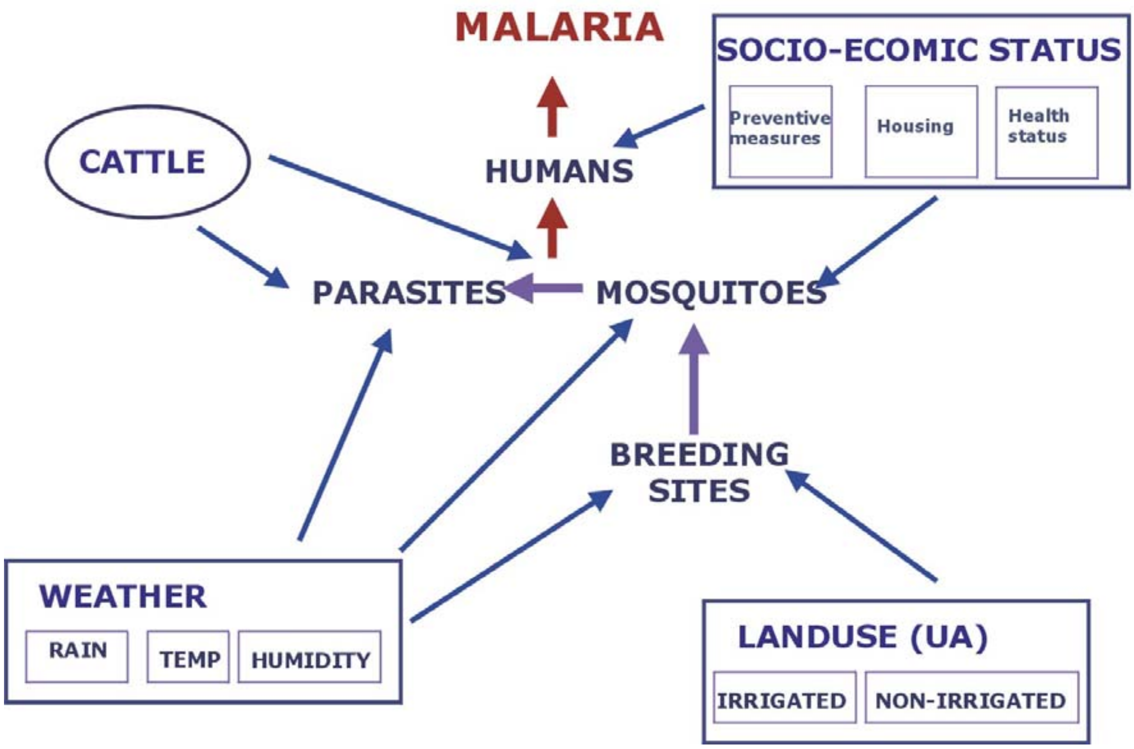

Figure 1. Diagram representing the risk factors affecting the transmission of malaria. (Reproduced from Klinkenberg et al., 2003)

Community risk factors

Malaria is, in general, regarded as a rural disease in Africa, and is often considered to be of low prevalence in urban areas. Some of the reasons for this are that in urban areas suitable *Anopheles* vector breeding sites are scarce, the host population is larger (resulting in lower biting rates), and the host population typically has better access to preventive methods and anti-malarial chemotherapy, resulting in a reduction in carrier rates (see overview in Warren et al., 1999, Robert et al., 2003). In the city of Accra, Ghana, parasitaemia prevalence was 1.6%, compared with 22% in rural communities in the same country (Gardiner et al., 1984). In the Gambia, parasitaemia prevalence in a peri-urban area was only 2%, while in rural areas this ranged between 30% and 90% (Lindsay et al., 1990). And in Lusaka, Zambia, 2% and 10% of children had parasitaemia in the dry and rainy season respectively, while in rural areas this was 10% and 27%, respectively (Watts et al., 1990). The low prevalence observed in urban areas may result in less immunity, leading to higher rates of acute disease in the urban areas in contrast to rural areas, where high transmission rates engender high levels of immunity and lower levels of acute disease. The situation may be worsened by the high levels of drug resistance attributed to self-medication and associated drug misuse in the urban setting (Warren et al., 1999).

Within rural populations, children and pregnant women are the most susceptible to malaria (Gilles and Warrel, 1993), and this will be comparable in urban areas. Similarly, socio-economic status will have an impact on the susceptibility of the community in the urban areas. Major factors affecting susceptibility are housing type and construction (Gunawardena et al., 1998; van der Hoek et al., 1998; Lindsay et al., 2003), and use of preventive measures, but the general health status of the community is also important. Urban agriculture can in this way also help to prevent malaria as it can positively impact the nutritional balance in diets. In general, people in the cities could be expected to be financially better off, but especially with rapid expansion there may be large groups of city dwellers below the poverty line. The World Bank has estimated that the number of urban poor will reach 1500 million by the year 2025 (UN-Habitat, 2001).

The use of preventive measures like mosquito coils, mosquito sprays and (insecticide treated) bednets, will affect transmission. Snow et al. (1998) showed in Kenya that the use of mosquito coils, repellents and aerosol insecticides lowers the risk of severe malaria development in children. Studies in Kumasi, Ghana showed that in urban and peri-urban areas 80-90% of the population used preventive measures (Afrane et al., 2004): the majority used screened windows and doors (15-50%) and sprays and coils (40-60%), while a small percentage used bednets (about 9%). Knowledge and perception of malaria also will have an impact on the disease. As the poor urban community can include people from different ethnic origin and cultural background, large differences may exist in knowledge of exposure route and treatment or perception of disease. For any control program to be successful, the perception and attitude of the community towards control must be incorporated. Women should be specifically targeted to be involved, because they often make decisions on child health, and because pregnant women themselves are at increased risk and their health status has a direct impact on the health of the newly born (Verhoeff, 2000). The mobility of the community also has to be taken into account, as travel between rural and urban areas by both village and city dwellers can transport malaria into the urban areas.

Environmental risk factors

A wide range of environmental factors influence malaria risk. Most of these affect the survival, and thus longevity, of the mosquito vector, which in turn has a direct impact on malaria transmission because the mosquitoes have to live long enough for the malaria parasite development to reach the infective stage. For *P. falciparum,* this takes between 8 and 25 days (Gilles and Warrell, 1993). Temperature will affect both parasite and mosquito development. The total mosquito development time from egg to adult can be as short as 8 days, but on average takes between 14 and 21 days (Gilles and Warrell, 1993). The lifespan of adult *Anopheles* varies somewhat between species, but is primarily dependent on external factors, among which temperature, humidity and the presence of natural enemies are the most important. The *average* duration of life of an adult female *Anopheles* under favourable climatic conditions is often about 10-14 days, but occasionally can be much longer (up to 4 weeks).

Apart from natural conditions like weather, over which we have little influence, there are several manageable risk factors, either natural or human-made, that have an impact on malaria transmission. These include the location of standing water, and the chemical use that can lead to mosquito resistance to insecticides. These are discussed in the following paragraphs.

In the urban environment the incidence of malaria is, in general, considered low, and the majority of mosquitoes present are *Culex* spp, which are not malaria vectors. However, some *Culex* species transmit filariasis in part of their geographic range and they are important nuisance mosquitoes for the human population. The low density of anopheline mosquitoes in the city environment can be attributed to the paucity of suitable breeding places due to increased density of houses and pollution of potential breeding sites - the *Anopheles* mosquitoes prefer relatively clean water, like rain puddles and pools, while *Culex* spp. prefer polluted water sources, like pit latrines and open drains. The introduction of irrigated urban agriculture using relatively clean water sources could create additional breeding sites that are suitable for the malaria vector mosquitoes. Several authors mention the breeding of anophelines in urban agricultural sites (Vercruysse et al., 1983; Warren et al., 1999; Trape et al., 1987 (part III); El Sayed et al., 2000) There are also suggestions that, for example, maize fields could create resting sites for mosquitoes, and that anophelines can breed in standing water in the axils of banana or maize plants, although anophelines are not known to prefer these types of breeding habitat. Recently a paper was published on a suggested link between maize cultivation and malaria in Ethiopia (Kebede 2005) but further research is still needed to verify these types of claim. If they are accurate, the impact of UA on malaria would not be restricted to irrigated UA alone.

An inventory of irrigated urban agriculture in six West African cities (IWMI, in press) showed that the main irrigation system used in open space irrigated urban vegetable production is irrigation with watering cans. Cans are filled in the local stream or from small wells or cisterns, which could form excellent breeding places for anophelines, depending on water quality. Wells can be either dug out wells or cement constructions. Figure 2 gives an overview of the main types of irrigation used in UA in West Africa, and shows the system components with higher potential risk for malaria vector breeding. As indicated, the risk is mainly at the level of water storage, as this is where open water bodies are provided which could be suitable for breeding, depending upon type of reservoir and water quality. Although water quality is known to influence breeding, there are few studies detailing in which ranges of water quality parameters certain types of mosquitoes breed, and more elaborate work is needed on this topic.
In addition to water quality and storage method, the specific location of UA sites may also affect breeding in some cases. For example, in Kumasi, Ghana, UA is mainly practiced in low-lying areas in the city which have easy access to water, and it could be that such areas in general produce more mosquitoes, regardless of UA (Afrane et al., 2004). Irrigation often leads to year-round cultivation and therefore the year-round presence of possible breeding sites. This could affect the seasonality of transmission, because mosquitoes would be able to breed continuously throughout the year.

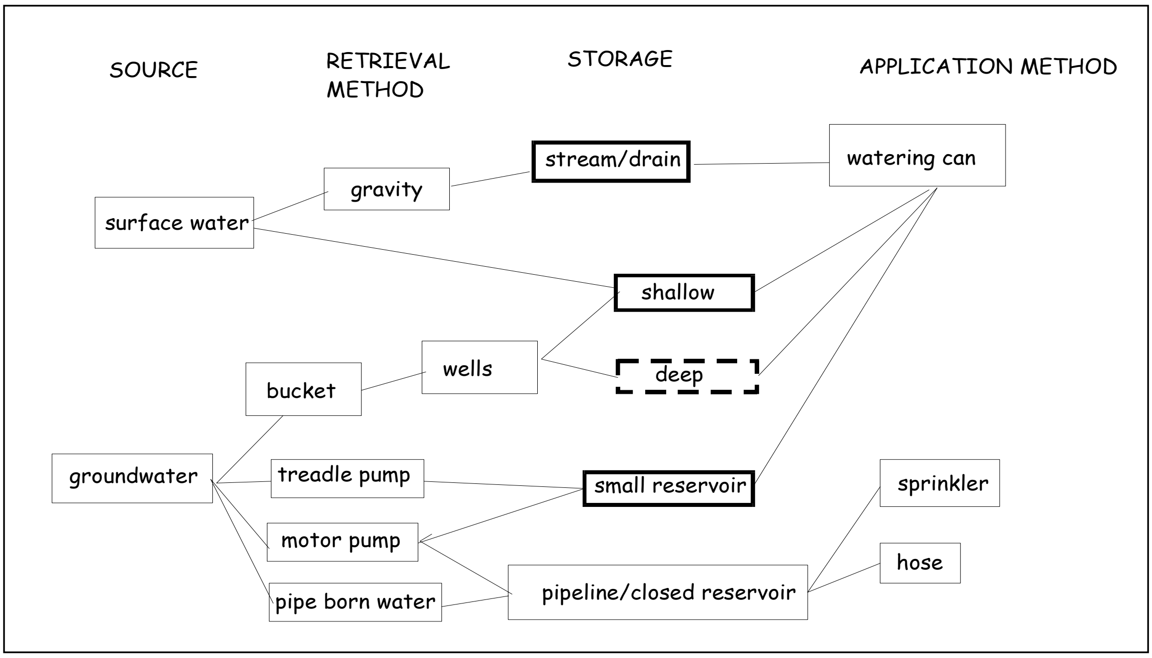

Figure 2. Irrigation methods in irrigated urban vegetable production in West Africa (reproduced from IWMI, in press). Boxes with thick outlines indicate higher possible malaria risk and a dotted outline indicates lower risk

The intensification of crop production in UA often implies high usage of pesticides. This, too, could have an impact on malaria risk, as pesticides and other chemicals washed in small quantities from the fields into the wells and other breeding sites could enhance the development of resistance to public health insecticides used against mosquito vectors. Various other farmer practices can also affect the possibilities for anopheline breeding. For example, growing fish in the wells could reduce potential anopheline breeding, but irrigation frequency and water level in the wells, among other factors, can also have an effect.

Institutional risk factors

Health care facilities in cities are generally better than those in rural areas, in terms of the number, distribution and accessibility of facilities to the population. However, the large urban population, and the often looser social structures in the highly mobile urban communities as compared to the rural population, may make it more difficult to reach urban communities and take community actions for malaria control, protection and awareness. As urban malaria mosquito breeding is more focal, environmental management has been suggested as a good option for control (Robert et al., 2003). However, more focal control also requires a better understanding of the local epidemiological and entomological characteristics to target the high-risk areas (Warren et al., 1999). Environmental management requires a high level of involvement of the community to be successful, and in the case of UA, the involvement of farmers is also needed. For the design of any control program, the early involvement of all stakeholders is important. Possible options for control are discussed in more detail below.

In addition to the malaria control guidelines of the Ministries of Health (MOH), the policies and actions of the Ministries of Food and Agriculture (MOFA) can have an impact on malaria risk related to UA. Agricultural pesticide policy, and implementation of regulatory control are obvious examples, as is the implementation of Integrated Pest Management (IPM) strategies that reduce agrochemical use. There are other, more indirect, impacts of policies on malaria risk. For instance, land tenure within cities is often very insecure, and farmers informally and unofficially cultivate the land. Insecurity of land tenure makes farmers reluctant to invest in irrigation structures on their fields, even if these could reduce the breeding risk of disease vectors.

To conclude this section on assessment of exposure to risk, the main risk factors involved in the impact of UA on malaria are summarized in Table 1.

Table 1. Categories of risk factors that impact the malaria risk related to UA.

Community risk factors	Environmental risk factors	Institutional risk factors
• Immunity status • Socio-economic status • Use of preventive measures • Risk perception • Mobility of population	• Creation of breeding places • UA • Temperature and humidity • Irrigated UA- seasonality • Water quality • Resting sites in crops • Agricultural practices • Drug resistance (parasite) • Insecticide resistance (vector)	• Availability of health facilities • Community structure • MOH & MOFA activities • Existing malaria control program • Agricultural policies (e.g. pesticide regulation, IPM)

Risk estimates

Malaria risk can be defined as the risk of a person developing the disease. This risk has two main parts: first, the risk of getting bitten by an infective mosquito, and second, the risk of developing malaria after being bitten. As discussed earlier, several factors have an effect on these two indicators. For example, socio-economic status will affect the risk of getting bitten. People are more likely to be bitten if they live in houses that are poorly constructed (van der Hoek et al., 1998; Lindsay et al., 2003), or do not have money for protective measures. Treatment seeking behaviour is also related to socio-economic status (Onwujekwe et al., 2005; Njau et al., 2006). A delay in seeking treatment can increase the risk of developing the disease after being bitten, and because of the costs or perceived costs of health care, people of low socio-economic status are less likely to seek treatment.

The most often used indicators of levels of transmission/severity are:

(i) The epidemiological parameters of malaria prevalence, the percentage of people infected or being ill at a given point in time; and malaria incidence, the number of new cases of disease or infection per unit of population in a given time period .

(ii) The entomological parameter known as the Entomological Inoculation Rate (EIR), which is a measure for the number of infective bites per unit of time (usually per night) that a person receives (Gilles and Warrel, 1993).

The EIR is computed as the product of the bites a person receives in a given time period, and the percentage of the biting mosquitoes that is infective:

$$EIR = ma * s$$

Where
ma = the number of bites a person receives per unit of time (biting rate)
s = the sporozoite rate, i.e. the percentage of infective mosquitoes in a population

There are several methods for obtaining the biting rate:
1) Pyrethrum Spray Sheet Collection (PSSC), which consists of collecting dead mosquitoes after the spraying of the bedroom with a pyrethroid insecticide. Examination of the mosquitoes will indicate if they are blood-fed in the previous night. Dividing the number of blood-fed mosquitoes by the number of people that slept in the room provides an approximation of the biting rate. This figure is an approximation because there are species of mosquitoes that feed indoors and go outdoors to rest (which will cause an underestimate of the biting rate) and others that feed outdoors and rest indoors (which will cause an overestimate of the biting rate). Entomological studies on the biting/resting proclivities of the vector population are important.

2) Human Bait Catch (HBC), which is the best method of assessing human vector contact, consists of trained volunteers sitting up during the night and directly collecting all mosquitoes that try to bite them. This gives the best figure of the real biting rate over a night.

3) In addition, there are several kinds of traps that can be used to estimate the biting rate, for example, light traps or bednet traps. For an extensive overview of mosquito traps and more details on the methods mentioned above we refer the reader to Service (1993).

In general, HBC and PSSC are the most widely used in entomological studies. For all methods, the collected vectors can be analysed in the laboratory to determine how many are infected with malaria sporozoites (using microscopic and/or molecular biological techniques) and this, together with the biting rate, will estimate the EIR.

The EIR gives the potential risk of transmission, i.e., the chance of getting bitten by an infective mosquito. This is not necessarily the same as actual risk of infection because, for various reasons mentioned above, not every invective bite will lead to parasitaemia, and not every person with parasitaemia will develop malaria. Malaria infection risk can be estimated assessed by assessing estimating the malaria prevalence and/or incidence in different areas. In malaria research both measures can be used, and depending on the study design, either prevalence or incidence can be obtained. Incidence data give an indication of the number of new cases occurring over time, while prevalence shows the occurrence of all cases accumulated over a certain period in time. When assessing presence of diseases it is important to control for confounding factors. Assessment in children gives the best indication for transmission risk, because immunity is relatively undeveloped yet; in adults, differential immune status can complicate the interpretation of malaria disease figures.

The combination of entomological and epidemiological surveys is the best way to assess an attributed risk of UA for malaria in cities. As many factors have an effect on malaria transmission, care should be taken when analyzing malaria data to take into account factors such as socio-economic status, use of preventive measures, and travel to rural areas, etc., as previously discussed. Given that malaria is the main public health problem in many parts of Africa, attributed risk of UA for malaria must be assessed, as well as the significance to cities of this possible risk, e.g. how much land area is used for UA, how much and what type of irrigation occurs, which type creates more risk and how far within or away from the city the impact stretches, and how many people are at additional risk.

To assess the risk for malaria attributable to UA, the following questions need to be answered:

1) Do *Anopheles* mosquitoes breed in irrigation installations in UA areas? If yes which irrigation types and practices support breeding?
2) Is there an increased mosquito density and biting rate for communities around UA sites?
3) Is there a higher malaria incidence in communities around UA sites compared to communities without UA sites (when controlled for confounding factors)?

Can previous studies help to assess the risk for malaria attributable to UA?

Although several studies mention the breeding of anophelines in urban agricultural sites (Vercruysse et al., 1983; Warren et al., 1999; Trape et al., 1987 (part III); El Sayed et al., 2000), there are few studies that have investigated the impact of urban agriculture on malaria *transmission* in cities. One study by Dossou-Yovo et al. (1994; 1998) evaluated the impact of rice cultivation on malaria transmission in the town of Bouaké, Ivory Coast. The research compared market garden areas with rice cultivation areas within the town, and found that although the biting rates were clearly higher in areas with rice cultivation, the sporozoite rates (percentage of mosquitoes being infective with the *Plasmodium* parasite) were lower in the areas with rice cultivation. The interaction of these two factors on the incidence of malaria morbidity and mortality was, however, unclear.

An interesting observation regarding urban agriculture practices and mosquito breeding was made in Niamey, Niger by Julvez et al. (1997). They noted that farmers along the heavily polluted river would dig wells to let the water filter in, using the sand as a filter to treat the water. This well water was then clean enough for mosquitoes to breed in, whereas they did not breed in the heavily polluted river during the dry season. Julvez et al. further noted that only first and second larval instars were found in other wells dug by farmers to irrigate their fields with watering cans. They suggested that the permanent disturbance of the water for the refilling of the watering cans might have prohibited larvae from developing into the pupa stage. Similar observations were made by Robert et al. (1998) in a survey of mosquito breeding in the market-garden wells in urban Dakar, Senegal. These wells have long been considered potential mosquito breeding places and larvivorous *Gambusia* fish were introduced for mosquito control during the 1930s. Robert et al. (1998) found that 12% of the mosquitoes collected in these wells over a 1-year period were anophelines, confirming breeding in 5 UA sites. A pilot study by IWMI and collaborators on the impact of UA on malaria in the city of Kumasi, Ghana, confirmed the breeding of *Anopheles* in urban agricultural sites with irrigation by watering cans from shallow wells (Afrane et al., 2004). Studies in Accra, Ghana, showed that over the time span of a year on average 6% of wells (from 0%-18%) used for irrigation were breeding anophelines (Klinkenberg et al., in prep.).

Thus, from existing studies, we can conclude that UA sites do have the potential to breed malaria vectors. The important issue is how this impacts biting rates. Is the contribution of the UA sites to mosquito breeding large enough to increase the mosquito densities in communities around them, and thereby increase the biting and transmission rates? Does presence of UA have an impact on the sporozoite infection rates of anophelines?

Robert et al. (1998) state that the presence of larvae in the wells does not coincide with the adult vector density peaks as reported in earlier studies for Dakar, and they suggest that the market garden wells might not be the most important mosquito breeding grounds. For the city of Kumasi in Ghana, however, preliminary studies have shown significantly higher anopheline densities and EIR in communities close to UA (Afrane et al., 2004). In Accra, higher biting densities for both *Anopheles* and *Culex* were found in communities around UA areas, than in communities without UA (Klinkenberg et al., in prep.). Further investigations need to determine whether the higher densities are due to UA as such, or simply to the location of UA in low-lying areas in the city, which collect standing water unrelated to UA.

It can be concluded from existing studies that the impact of UA on mosquito densities in surrounding communities is not completely clear, as some studies show increased densities in UA areas while others do not find a clear link. Further research is needed in order to investigate the contribution of UA breeding to anopheles densities in a wide range of communities and cities. This should be done for areas with different irrigation practices and water qualities to assess the impact under a wide range of conditions. It also needs to be determined whether increased vector densities translate to higher disease prevalence in the surrounding communities, and if so, to a higher at-risk population at the city level.

Dousso-Yovo (1994; 1998) found that the impact of rice cultivation on the incidence of malaria morbidity and mortality within the city of Bouaké, Ivory Coast was unclear. Epidemiological and socio-economic studies conducted in two cities in Ghana indicated that in Accra, but not in Kumasi, significantly more children had malaria parasitaemia in communities around irrigated UA sites than in areas without UA, and some, but not all, communities, showed an inverse relationship between malaria prevalence and distance from UA (Klinkenberg et al., 2005, 2006).

Current status – Where are we now, and what do we need to know and do?

- The few studies that have explored the impact of urban agriculture on malaria transmission to date suggest a slightly elevated potential risk. However, there is an urgent need for more elaborate studies to make a well-founded answer possible. In order to achieve this it is necessary to collect data from different locations, over time, in different geographical areas, and with different agriculture and irrigation practices and water qualities. Studies should also assess seasonal variation.. A combination of such studies would provide answers to the question of whether, and how much, UA impacts malaria risk, and how any increased risk can be mitigated.
- As many different actors are involved in agriculture and malaria, a trans-disciplinary approach for the study and control design will be essential. If UA does increase the risk for malaria, further questions arise as to the geographic extent of the risk, and the numbers of people at risk in a given city. Transect studies at different distances from UA could provide insight into how far such impact reaches. Communities at risk could be defined by plotting the found impact radius on maps with UA sites. In these communities, more detailed surveys should be undertaken to investigate other sources of mosquito breeding. Each city would need a program of studies to investigate its local epidemiological and entomological characteristics in order to design the best control program.

Options for control

Banning UA is no solution because, despite its potential health risks, urban agriculture, already implemented, has clear benefits in terms of providing livelihoods for farmers and vegetable traders, contributing to urban food security, and providing a more balanced diet for city populations (UNDP, 1996). Thus, we need to consider health risk minimization strategies that would help to maximize the benefits of UA.

In relation to malaria, a few options for control could be hypothesized:

- Environmental management could be applied to control vector breeding in UA sites, by reconstructing wells to make them less conducive to anopheline breeding and at the same time improving the irrigation efficiency for farmers. Due to the ecological preferences of anophelines, constructing cement wells with covers would prevent breeding.
- Another option would be to control breeding by using biological agents. For example, the widely used *Bacillus thuringiensis israelensis* (BTI) could be used in wells, but the exact implication of this on consumable vegetable production should be assessed.

At the community level, the most feasible option is vector control in the high-risk areas, especially bednet distribution in the communities within the UA impact radius.

In designing a control option, however, there are several issues that need to be taken into account:

- Apart from the UA sites, there will also be other breeding sites in urban areas and most of these will probably generate mainly nuisance mosquitoes. Engaging people in malaria control has sometimes proven difficult, as the majority of mosquitoes are nuisance biters and specifically controlling only the malaria mosquitoes will in most cases not reduce the nuisance biting and discomfort of the community.
- Malaria control in specific target areas has to take into account the fact that malaria is a widespread and major health problem, and although areas around UA sites may have a slightly higher risk, other areas also suffer from malaria. Therefore, equity issues need to be addressed, in terms of whom to give priority to in the planning of control programs. Studies in Ghana highlighted the vulnerability of the urban poor (Klinkenberg et al., 2006). Incorporating UA-related breeding into an overall control program would be best.
- Urban agriculture sometimes takes place in specific areas of cities which are not suitable for other purposes, or are only temporary. Land tenure is insecure and farmers may be reluctant to invest their time and energy in control activities.
- A long-lasting solution requires the involvement of different stakeholders, e.g. the general urban community, health and agricultural authorities, and the farmer community. It is very important to involve all stakeholders at an early stage, in order to design the control program in such a way that it is most beneficial and acceptable for all involved.
- As mentioned in several places in this paper, issues of equity and gender need to be taken into consideration when studying the malaria risk in UA. Broad community participation, as well as the communication between researchers, experts, and decision-makers, is essential in order to reach appropriate solutions for managing this risk. Thus, an Ecosystem Approach to Human Health (Ecohealth Approach) should be taken in the study of malaria risk in UA.

There is an urgent need to assess the risk of malaria from UA in different urban and peri-urban settings, and to study a variety of irrigation practices and different water quality scenarios. If the risk is significant, there is an urgent need to design interventions to minimize the risk while maximizing the benefits of UA. Any solution should take into account the different stakeholders involved, including the community, the farmers, and the health and agricultural authorities.

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Perceptions of health risks and benefits of urban and peri-urban livestock production in Kampala, Uganda.

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Abstract

Urban agriculture (UA), including livestock-keeping, is increasing in Kampala, as is the population. Livestock-keeping has been recognized as a significant source of food. There is, however, a lack of sufficient information for understanding and assessing the relative benefits and risks to health associated with urban livestock-keeping. This paper discusses many of the benefits and hazards, as raised by stakeholders in a variety of studies including a health impact assessment study. The paper concludes that, because of its clear benefits as a pro-poor coping strategy, UA, including livestock-keeping, must be officially recognized and managed in order to best increase the benefits and minimize the risks.

Introduction

Kampala city is experiencing rapid growth that has seen the population of approximately 700,000 people in 1991 double to 1.5 million in 2000 (Atukunda, 1999). The growth in the human population has been closely followed by an increase in UA activities, including livestock-keeping, in the city. This phenomenon has also been observed in other urban areas in African countries (Rakodi, 1997; Jamal and Weeks, 1993; Lee-Smith, 2003).

Livestock production as a pro-poor coping mechanism and survival strategy has been practiced in Kampala city for a long time. However, a significant increase in livestock keeping in Kampala was evidenced during the economic hardships of the 1970s despite the practice having been deemed illegal by the urban authorities in Uganda (Amis, 1992; Bibangabah, 1992).

Although different categories of people are involved in urban agriculture, including raising livestock, in Kampala, many are the poor, who lack resources and also have limited access to services (Maxwell and Zziwa, 1992, Ishagi et al., 2003). Livestock-keeping as a livelihood strategy for the poor enables them to realize some income through sale of animal products, live animals, and recycled waste products where possible. In addition, the practice can provide nutrition and food security to households.

However, the legal status of UA farming, including livestock-keeping, in Kampala is changing. In 2003, bills of ordinances to regulate and guide this practice had already been drafted. The ordinances were revised in a participatory manner in latter part of 2003, involving a cross-section of stakeholders – farmers and farmer groups, politicians, people involved in distribution/marketing of livestock products, technical personnel, and NGO representatives. The ordinances were passed by the city council in January 2004 and assented to by the Mayor in May 2004. As of April, 2006, the ordinances are soon due to be gazetted into law. This dramatic change by the local authorities is a clear acknowledgement of the benefits arising from urban agriculture and livestock-keeping that accrue not only to the people involved in this practice but also to both the general community and the city council. For example, Maxwell and Zziwa (1992) reported that an estimated 70% of eggs and poultry meat consumed in Kampala city was derived from urban and peri-urban chicken keepers in Kampala. While 36% of the households in Kampala were involved in some form of agricultural activities, approximately 3.4% of the households depended specifically on livestock production as a livelihood strategy (Maxwell and Zziwa, 1992; Uganda Population and Housing Census, 1991). For a city with approximately 190,297 households (Uganda Bureau of Statistics, 2003), this is substantial and considering that the practice is on the rise in Kampala

Generally speaking, data is lacking on differential exposure by susceptible population groups to various hazards associated with UA in Kampala and Uganda. Despite the clear benefits of keeping livestock in urban areas, there are also various health hazards associated with this practice, for farmers, neighbours and the consuming public. There is little information, however, quantifying the benefits and the health hazards associated with urban livestock production, either in Uganda or elsewhere in the region. The magnitude of the health hazards needs to be known and understood so that appropriate mitigation measures by the stakeholders, together with the local authorities, can be instituted.

Definition of Urban and Peri-Urban Agriculture (UA)

The definition of urban and peri-urban areas is quite varied, if not contentious. A number of criteria have been used to define these areas in different countries and environments, including population density and size, official geographic boundaries, and farming and non-farming activities (Mougeot, 1999). For this study, urban agriculture has been defined as the production of food on land and waters within urban boundaries and surrounding areas, through growing of crops, rearing of livestock (including poultry), or fish farming.

Because urban livestock-keeping, like any other agricultural activity, has been illegal in Kampala city for so long, there are no reliable estimates of the livestock populations in the city.

Although UA in Kampala city can make a significant contribution to household income and food security for the urban population, unfortunately, these benefits are undermined by potential health hazards. There are concerns about the potential adverse health effects and environmental degradation of raising livestock among the densely populated areas found in urban areas.

Identified hazards associated with urban livestock production in Uganda

A review of studies on UA (scoping studies, participatory urban appraisal, and others), including on-going studies on health impact assessment of livestock production in Kampala city, shows a number of potential human health hazards associated with keeping livestock, as perceived by livestock producers (farmers), consumers, and policy makers (Ishagi et al., 2003; Atukunda, 1999; Maxwell and Zziwa, 1992; Maxwell et al., 1998). Table 1 shows a summary of these studies.

Table 1. Perceptions of Health hazards and human health effects associated with keeping livestock identified by the stakeholders in Kampala

Problems associated with keeping livestock	Human Health effect
• Pollution (environmental problems): effluent from zero-grazing animals, poor manure disposal, dusts from poultry houses	• Dissemination of disease-causing organisms leading to diarrhoea and respiratory problems
• Living in close proximity with animals such as poultry and pigs for fear of thefts	• Infestation with internal parasites such as tapeworms (*Taenia solium*) and ectoparasites like mites and fleas (e.g. jiggers due to *Tunga penetrans*)
• Handling of sick animals, and consumption of contaminated animal products	• Zoonotic problems: veterinarians and animal handlers get disease from animal contact/handling e.g. brucellosis, tuberculosis, skin and diarrhoeal diseases • Diarrhoeal diseases in consumers of animal products • Drug resistance due to consumption of sub-therapeutic levels in animal products
• Stray animals	• Emotional stress (neighbour conflicts, noise) • Physical injury (children may be attacked; motor accidents may result in loss of life)

Apart from symptoms such as diarrhoea and respiratory problems, stakeholder knowledge of specific disease hazards that could arise from keeping livestock or consumption of livestock products is scarce. However, brucellosis and tuberculosis were specifically referred to as disease conditions associated with consumption of raw (unpasteurized/unboiled) or improperly boiled milk. Although there are some reports on the existence of these organisms among cattle and goats in the country (see, for example, Nakavuma et al., 1999; Kabagambe et al., 2001; Ndyamuba et al., 2001), the prevalence of these diseases in livestock and livestock products produced in Kampala city has not been determined. Although it is known that some people still consume fresh, but raw, cow's milk in Kampala, there are no studies to quantify such practices.

Diarrhoea arising from keeping and handling livestock, or consuming livestock products, can be a result of microbiological contamination, such as non-typhoidal *Salmonella* and *Escherichia coli* O157:H7 (Nasinyama et al., 2000; Nasinyama et al., 1998). There is anecdotal information to show that some dairy products such as ice-cream sold in Kampala are not safe from a microbiological viewpoint. The degree of contamination of animal food products derived from urban livestock in Kampala is being assessed, both quantitatively and qualitatively, in an on-going health impact assessment study (Mwiine, 2005).

During focus group discussions in the health impact assessment (Mwiine, 2005), urban livestock keepers mentioned that they are concerned about thefts, especially of live poultry and pigs. As a mitigation strategy, some farmers guard their animals by keeping the animals close to them, and sometimes by sharing living space with them, thus increasing the probability of exposure to zoonotic disease conditions of bacterial origin, such as *Salmonella* spp, internal parasites such as tapeworms (*Taenia solium*), and ectoparasites like mites and fleas. Another concern highlighted in the study is poor disposal of animal wastes, which poses a significant health hazard to farmers and their neighbours, and has been associated with augmented fly populations, leading to an increased probability of contamination of food within households, resulting, in turn, in diarrhoeal diseases.

Another important health hazard that has been identified is non-compliance with drug withdrawal periods by livestock farmers in Kampala city (Mwiine, 2005; Ishagi et al., 2003). Exposure to sub-therapeutic levels of antimicrobial agents including antibiotics is believed to predispose some micro-organisms in humans to multi-drug resistance, often resulting in dire consequences (Gardner, 1978; Holmberg et al., 1984; Lee et al., 1994; Nasinyama et al., 1998). Since the magnitude of exposure to residues of antimicrobial drugs in animal products is unknown in Kampala and Uganda in general, there is a need to determine the exposure levels to these drug residues as a result of consumption of animal products (milk, meat, and eggs) obtained from livestock raised in urban and peri-urban areas.

Stray animals are another problem associated with urban livestock-keeping. Stray animals often eat other people's crops, leading to neighbour conflicts and thus contributing to emotional stress. Furthermore, stray animals may inflict physical injuries on children, and are often involved in motor accidents that may result in loss of human life. Emotional stress to neighbours may also arise due to the foul smell emitted from unsanitary cattle, poultry and piggery units within a neighbourhood.

Benefits of Urban Livestock-Keeping in Kampala city

The benefits of urban livestock-keeping as identified through appraisal meetings and focus group discussions with the various stakeholders in the health impact assessment study in Kampala city are presented at three levels: the household, the community and the local government (Mwiine, 2005) (See Table 2).

Table 2. Ranked order of livestock-keeping benefits as reported by household, community and government respondents (or representatives)

Household level (farmers)	Community level (consumers)	Local Government Level (policy makers)
• food security • income generation (sale of animals, products) • household consumption (protein nutrition) • manure (for crops and flowers) • power generation (biogas) • employment for household members and the youth • cultural activities e.g. dowry, gifts	• protein nutrition • manure (sell or sharing with neighbours) • educational - neighbours learn from one another how to raise livestock) • social well-being of community is improved	• food security for the urban poor • animal & poultry keepers pay more taxes graduated tax thus increased revenue • social well-being of community is improved

Livestock farmers reported that they generated income mainly from sale of the animals themselves (in case of pig and broiler chicken operations), as well as the sale of livestock products, including eggs, milk and sometimes manure.

Urban livestock-keeping does contribute to food security and protein nutrition, for both farming and non-farming households in Kampala (Maxwell et al., 1998). This is particularly seen with cattle and layer chicken farming, where the supply of fresh, nutritious, and relatively cheaper milk and eggs is usually available in the communities all year round. For example, in 1992 it was reported that an estimated 70% of the consumer demand in Kampala city for poultry and poultry products was being met by the urban and peri-urban poultry production system (Maxwell and Zziwa, 1992, Mpinga, 1999).

Apart from simply acting as a food security strategy and providing protein nutrition to farming households and the community at large, livestock farming contributes to the community in other ways. Ironically, livestock farmers, irrespective of gender, are normally assessed higher taxes in the communities by the local authorities and, therefore, pay more graduated taxes than non-farming households despite the fact that urban livestock keeping is still technically illegal. Graduated tax contributes significantly to the Kampala city council revenue. It seems that where revenue is concerned, tax collectors will assess, levy, and collect, while turning a blind eye to issues of legality. On the other hand, law enforcers may clamp down on the practice, backed by the law, especially when an accident occurs as a result of UA activity or when a politician complains.

Urban livestock-farming in Kampala has provided an educational resource not only for farmers to learn from each other in the community, but also for schoolchildren. Indeed, agriculture has been incorporated in the national primary school curriculum in Uganda, and a number of schools in and around Kampala actively practice urban livestock farming, keeping cattle, pigs, rabbits and chickens. The city council seems to turn a blind eye to these practices.

Urban livestock production also offers a rural-urban linkage mechanism. Due to the limitation of land on which agriculture can be practiced in urban areas, people keeping livestock do purchase livestock feeds and feed supplements such as maize bran, cotton seed cake, molasses, soya and fish meal, among others. The raw materials for these feeds largely come from the rural areas. However, the magnitude and thus economic impact of this linkage has not yet been documented.

Challenges and Mitigation strategies

There is a wind of change blowing through the urban authority in Kampala city about the need to officially recognize and thereby streamline and regulate urban livestock farming specifically, and urban agriculture in general. As mentioned above, draft bills for ordinances have been reviewed in a participatory manner by stakeholders, and as of April 2006 are about to be gazetted into law.

Furthermore, there are a number of projects in the area of urban agriculture in Kampala city which have the objective of developing a clearer understanding of urban agriculture and livestock-keeping, with respect to the livelihoods, production, marketing and human health impacts. There is a need, however, for coordination of these projects to provide holistic information to the stakeholders and risk managers (policy makers), so they will be able to make informed decisions.

Waste management is one of the key challenges faced by livestock farmers in Kampala city, as well as in many other places. If not properly managed, animal waste can be a significant source of human health hazards, and is one of the major public health concerns cited by city authorities. Therefore, appropriate technologies in treatment and recycling of animal waste as manure, or feed utilizing best practices from other cities in the region are required. For example, poultry litter (droppings mixed with coffee husks) is being recycled as pig feed by some pig farmers in Kampala city (Muwanga, 2001). This practice occurs because chickens waste some feed, which gets incorporated in their litter and is then available to pigs. Some studies are being conducted to assess the safety as well as nutritional value of this type of waste as pig feed

In addition, activities geared at promoting, streamlining and regulating urban livestock production in Kampala city should have a gender focus. For example, ownership demographics in a recent scoping study on livestock-keeping among the poor in Kampala showed that of the 184 households studied, men dominated (60%) in ownership of cattle (both local and improved breeds), while women dominated in the ownership of chicken (75%). Furthermore, women's ownership of other species, such as pigs, local goats, and sheep, was shown to equal and sometimes exceed that of men (Ishagi et al., 2003).

Stakeholder consultations on how urban and peri-urban agriculture should be streamlined and regulated are crucial if people are to feel a sense of ownership of the policies and laws that develop pertaining to this important activity. The fear by farmers to provide information on their farming activities due to the existing legal implications is significant, and has often led to lack of cooperation by some farmers with research efforts. Therefore, education of farmers and other stakeholders on developments in urban agriculture - including closer interaction with extension workers - is likely to pave way for better provision to researchers and policy makers of information on farming activities. This information is invaluable for planning purposes, including the development of guidelines on where and what to farm in the city. Inter-sectoral collaboration will also be necessary in framing effective and holistic messages for the various stakeholders.

Conclusion

Despite concerns by the local authorities, and despite the identified risks associated with the practice of UA, including livestock-keeping in cities, its benefits as a pro-poor coping mechanism and survival strategy are increasingly being recognised in African cities. The keeping of livestock in cities is likely to continue, especially as rural areas transform themselves into peri-urban and eventually urban areas. In the case of Uganda, steps are already underway to streamline and regulate UA activities in Kampala city. However, there is a need for continued collaboration between researchers, policy makers, farmers, non-governmental organizations, and other stakeholders in the promotion of safe rearing of livestock in urban areas in Uganda.

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Assessment of health risks and benefits associated with UA: impact assessment, risk mitigation, and healthy public policy

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Abstract

This paper presents a review of risk assessment for the use of urban wastewater and solid waste in agriculture, and the health consequences posed by the practice, especially in sub-Saharan Africa. Findings from surveys conducted in Ghana have been incorporated to illustrate risk perceptions of the practice. Local authorities, produce consumers and sellers expressed concerns on health risks, especially from wastewater, but farmers seem to lack alternatives to reduce risks. In this paper, we have proposed a decision-making framework for identifying more appropriate measures for risk reduction and highlighted some measures that could be used to mitigate risks in urban agriculture in sub-Saharan Africa.

Introduction

Urban and peri-urban agriculture (UA) is an activity that involves production, processing, and marketing of food and other products on land and water in urban and peri-urban areas. UA involves the application of intensive production methods and (re)use of natural resources and urban wastes to yield a diversity of crops and livestock (UNDP, 1996). Peri-urban areas have been described by the UK Department for International Development (DFID) as places adjacent to the urban centre that are influenced by pressure on land use, conversion from rural to urban, ready access to large markets, services and physical inputs and increasing problems related to waste management and pollution from the urban centre (Adam, 2001).

There has been a drastic increase in UA in the last two decades, and this trend is likely to continue, mainly due to the increases in urban food demands brought about by urbanization. For instance, between 1990 and 2000, global population increased by 15%, with 25% in urban areas and less than 8% in rural areas (WHO/UNICEF, 2000). In Sub-Saharan Africa (SSA), urban population grew from 23% in 1980 to 34% in 1999 (World Bank, 2000). In 1996, it was estimated that 800 million people worldwide (150 million full-time) were engaged in urban agriculture. This practice contributed up to 15% of total world food supplies and this was expected to rise to 30% by 2005 (UNDP, 1996). UA is a source of livelihood to many and has been identified as a means of proving special support for women (WFS, 1996).

In most urban centres in developing countries, sanitation infrastructure is poor, and inadequate to cope with the urbanization rate. According to the UN 2002 Human Development Report, 2.4 billion people in the developing world lack access to basic sanitation. Three hundred million urban residents, mainly low-income dwellers, have no access to sanitation infrastructure (Giles and Brown, 1997). Approximately, two-thirds of the population in the developing world has no hygienic means of disposing of excreta, while even a greater number lack adequate means of disposing of total wastewater (Niemczynowicz, 1996). In Ghana, as in many other parts of SSA, only 4.5% of households are linked with a sewerage network, and this leads to mostly non-functional treatment plants (Keraita et al., 2002). Large quantities of untreated wastewater end up in nearby streams and other water bodies. UA farmers in search of irrigation water usually have no alternative to using this polluted water, thereby raising public health concerns (Hussain et al., 2002). This problem tends to overshadow the agronomic and socio-economic benefits of UA and is threatening its positive recognition in large parts of Africa.

In SSA, solid waste use in UA is common and is largely well perceived, hence the strong links between solid waste management and UA. In principle, recycling organic waste through composting could be a win-win situation for municipalities and farmers if economically viable for both sides (Drechsel and Kunze, 2001). The goal of urban waste reduction fits well with the promotion of UA, since urban and peri-urban farmers are in need of organic matter as soil conditioner or fertilizer. City and town authorities, on the other hand, wish to conserve disposal space and reduce the costs of landfills as well as of municipal solid waste (MSW) management. But as with wastewater, tensions can occur between farmers and public health officials especially in situations where waste contains excreta and composting is not meeting safety standards.

Substantial work has been done on health risks posed by wastewater and human excreta use (Feachem et al., 1983; Strauss, 1985). For instance, from a review of epidemiological evidence, Shuval et al. (1986) concluded that there is evidence of disease transmission in association with the use of raw or partially treated wastewater. This evidence pointed most strongly to the helminths as the primary problem, particularly in developing countries. According to (WHO, 1989), the use of excreta and wastewater in agriculture and aquaculture can result in an actual risk to public health only if all of the following occur: (i) either an infective dose of an excreted pathogen reaches a field or pond, or the pathogen multiplies in the field or pond to form an infective dose (ii) the infective dose reaches a human host (iii) the host becomes infected; and (iv) The infection causes disease or further transmission. If the infection does not cause disease or further transmission then only a potential risk to public health exists. Moreover, if this sequence of events is broken at any point, the potential risks cannot combine to constitute an actual risk.

This paper presents a risk assessment of the use of solid waste and wastewater in UA. Solid waste and wastewater are related by the possibility they pose of pathogenic and non-pathogenic contamination. The introduction has presented some of the benefits and hazards, and continues with hazard and exposure assessments. This is followed by a description of the health consequences, and stakeholders' perceptions of the risks and consequences. The paper concludes by highlighting some innovative approaches that could be used to mitigate risks in UA in sub-Saharan Africa.

1. Hazard assessment of wastewater and solid waste use

1.1 Sources and reuse practices in developing countries

The main sources of urban wastewater are domestic and industrial. Wastewater is mainly comprised of water, together with relatively small concentrations of suspended and dissolved organic and inorganic solids. Industrial wastewater is often associated with toxic elements such as heavy metals, but with limited industrial development in most developing countries, the greatest health concern when wastewater is used in agriculture is high levels of pathogenic organisms in untreated wastewater. Many litres of wastewater are produced daily, all of which should be treated and disposed off or reused safely. Most developing countries lack proper infrastructure for safe handling of wastewater and much of it ends up in streams, rivers and irrigation canals, being partly used in farming.

Municipal solid waste (MSW) use is another common phenomenon in UA. The state of Karnataka in India has a simple proverb: "Waste is food" (Furedy and Chowdhury, 1996). In SSA, as in many parts of the world, the age-old habit of returning household wastes to the food chain persists. Kitchen peelings and food leftovers are fed to animals, selected organics are fed into fishponds, and wastes are composted for home gardens. Where there is intensive farming in urban and peri-urban areas, with large amounts of MSW in the vicinity, farmers in all parts of the world find various ways of nutrient recycling from MSW. Table 1 lists common types of solid waste, wastewater and excreta reuse in peri-urban agriculture with comments on the practices. This brief summary of waste reuse practices indicates many potential health issues.

Table 1. Common practices of urban organic waste and wastewater reuse in developing countries

Type of waste	Contents	Practices	Comments & Examples of Health Issues
Kitchen and restaurant waste	Raw peelings and stems, rotten fresh fruits and vegetables and leftover cooked foods	Food waste fed to animals, deposited on nearby dumps for animals or sold Fed to animals, used in community composting, used for vermicompost (VC), and separated for sale.	Direct feeding of household livestock is probably rather low-risk. Low risk as farmers know contents but community compost heaps could be harmful to children when playing around the heaps and attract rodents and other vectors such as flies, cockroaches, birds, etc. Little is known about VC health risks but it may destroy vectors and pathogens
Mixed municipal solid waste	Small industrial and biomedical wastes, plastics, broken glass, human and animal excreta.	MSW applied to soil in 14 days in Asia while in W. Africa, MSW is directly applied on cereal fields, in dry season. Farmers also collect compost from central dumping sites. Other used in parks & garden, or estate developers.	As most pathogens do not survive long under intensive sunshine the practice is relatively safe for the consumer if crops are grown several weeks after application. But toxic substances such as heavy metals could cause soil contamination. Most centralized composting plants either have failed or are operating at low and non-viable capacity and products are hard to sell due to glass splinters, plastics and usually low nutrient content. Real estate and gardeners are often best clients.
Human excreta	Excreta from households and public latrines	Might be mixed with solid waste under controlled conditions or applied directly on cereal fields in the dry season e.g. in Northern Ghana	If cereals are grown weeks later, there should be no health impact to consumers. Risk for the farmer spreading the sludge.
Poultry and cattle waste	Poultry manure and cow dung	Poultry manure has high levels of nutrients and is used a lot in vegetable farming. Cow dung is used as manure, fuel etc.	Fresh poultry manure contains pathogens and has to be stored before use. It may also contain pesticide residues from bird treatment. Cow dung collectors lack access to washing facilities.
Public park waste	Twigs, grass, leaves, branches, etc.	Could be used as animal fodder or fuel by the poor.	Taking waste directly to compost plants deprives poor residents of fuel and fodder. May be contaminated with pesticides and vehicle pollution residues.
Agro-industrial wastes	Waste from cotton industry, breweries, abattoirs etc.	Could be a cheap alternative for soil amelioration.	Risks are especially high with abattoir waste.
Wastewater	Household and industrial sources	Used for dry-season and year-round irrigation.	Carrier of pathogens risking public health. Risk for farmers through direct contact.

Source: Adapted from Furedy and Chowdhury (1996)

1.2 Occurrence of pathogens in excreta and wastewater

Excreta and wastewater usually contain high concentrations of excreted pathogenic organisms. The principal categories found in wastewater and excreta are virus, bacteria, protozoa and helminths (Metcalf and Eddy, 1995; FAO, 1992). Infected or carrier humans of a particular disease may discharge these pathogenic organisms (Metcalf and Eddy, 1995). The numbers and types of pathogens found in wastewater and excreta vary both spatially and temporally depending on season, water use, economic status of the population, disease incidence in the population producing the wastewater or excreta, and quality of the water or food eaten. Animals may also discharge some pathogens. Table 2 shows the concentrations of major pathogens in faeces, faecal sludge and raw wastewater.

Table 2: Common concentrations of pathogenic organisms in excreta and wastewater.

Type of pathogen	Faeces *No./gram*[1]	Faecal sludge *No./liter*	Raw wastewater *No./liter*
Viruses			
Enteric viruses	$10^6 – 10^7$	10^3	10^5 - 10^6
Rotavirus	10^{11}	No data	10^2 - 10^5
Bacteria			
Faecal coliform	$10^7 – 10^9$	10^7	10^8 - 10^{10}
Salmonella spp.	$10^8 – 10^{10}$	10^3	1 - 10^5
Shigella spp.	$10^8 – 10^{10}$	10^2	10 - 10^4
Vibrio cholera	$10^8 – 10^{10}$	No data	10^2 - 10^5
Campylobacter	$10^8 – 10^{10}$	No data	10 - 10^4
Protozoa			
Entamoeba	10^7	$10^2 – 10^3$	10^2 - 10^5
Giardia	10^7	$10^2 – 10^3$	10^2 - 10^5
Cryptosporidium	10^7	$10^2 – 10^3$	10^2 - 10^5
Helminths			
Ascaris	10^4	10^2	1 - 10^3
Ancylostoma/Necator	10^4	10^2	1 - 10^3
Trichuris	10^4	10^2	10 - 10^2

[1]Excreted during acute phase of illness. Carriers may excrete less and non-infected individuals may excrete zero or few pathogens

Source: SaniCon (2002)

1.3 Factors affecting transmission of diseases from excreted pathogens

Most gastro-intestinal pathogens hardly reproduce outside of the human or animal digestive tract. They have differing levels of resistance against die-off (i.e. survival times), depending on the environment in which they are contained (see Table 3), and this affects causation and transmission of diseases. The helminths have the longest persistence in the environment. It is also clear that the survival time on crops is the least for all pathogens. These figures could help in coming up with some farm management measures for risk reduction. For instance, in Tamale, a city in northern Ghana, farmers apply raw faecal sludge on open fields during dry seasons, when temperatures are high, and leave it for several months, waiting for the rainy season. Only then do they incorporate it in the soil, and plant maize. Through this process, most pathogens die off, and the risk of disease transmission is reduced.

Table 3. Survival time of selected pathogens in different environments (in days unless otherwise stated)

Type of pathogen	*In faeces, nightsoil and sludge*	*In freshwater and sewage*	*In soils*	*On crops*
Viruses				
Enteroviruses	<100 but usually <20	<120 but usually <50	<100 but usually<20	<60 but usually <15
Bacteria				
Faecal coliform	<90 but usually <50	<60 but usually <30	<70 but usually <20	<30 but usually <15
Salmonella spp	<60 but usually <30	<60 but usually <30	<70 but usually <20	<30 but usually <15
Vibrio cholera	<30 but usually <5	<30 but usually <10	<20 but usually <10	<5 but usually <2
Protozoa				
Entamoeba histol.	<30 but usually <15	<30 but usually <15	<20 but usually <10	<10 but usually <2
Helminths				
Ascaris lumbric.	Many months	Many months	Many months	<60 but usually <30
Hookworm larvae			<90 but usually <30	<30 but usually <10
Taenia sagin. Eggs			Many months	<60 but usually <30
Trichuris trich. Eggs			Many months	<60 but usually <30

Source: Feachem et al. (1983)

Many studies have reported or summarized the microbial risks from excreta and wastewater use in agriculture (e.g. Feachem et al., 1983; Hussain et al., 2002). Strauss (1985) published a review on the survival of excreted pathogens on soils and crops – a factor of great relevance for the risk level of or non-risk of involved in using human waste use. Table 4 shows some factors that affect the survival of enteric bacteria, like E. coli, in the soil.

Table 4. Factors affecting survival time of enteric bacteria in soil

Soil factor	Effect on bacterial survival
Antagonism from soil microflora	Shorter survival time when antagonistic microflora are present; Longer survival time in sterile soil
Moisture content	Longer survival time in moist soils and during times of high rainfall
Moisture-holding capacity	Shorter survival time in sandy soils than in soils with greater water-holding capacity
Organic matter	Longer survival and possible re-growth when sufficient amounts of organic matter are present. (Re-growth is an increase, due to more favourable conditions, in the number of bacteria growing, in a population that had been decreasing.)
PH	Shorter survival time in acid soils (pH 3-5) than in alkaline soils
Sunlight	Shorter survival time at soil surface
Temperature	Longer survival at low temperatures (i.e. longer survival in winter than in summer)

Source: Shuval et al. (1986a) as adapted from Gerba et al. (1975)

2. Exposure assessment

The use of solid waste and wastewater in agriculture can cause occupational and environmental exposures. Firstly, the public health and safety problem for those working on the land or living on or near the land where the wastewater is being used hence occupational exposure. And secondly, wastewater-contaminated products may subsequently infect humans or animals through consumption or handling of the foodstuff or through secondary human contamination by consuming foodstuffs from animals that lived in polluted areas. This also involves the impacts caused on the environment hence environmental exposure.

2.1 Occupational exposure

Groups having occupational exposure to wastewater and solid waste are summarized below:

A. Waste workers

i. **Adults:** waste collectors and dump operators, compost miners, waste pickers of wood, cinders, coconut husks, seeds etc, waste separators and handlers in compost plants

ii. **Infants and children:** those accompanying waste workers, helping in the field, playing in wasteland, and guarding animals grazing on waste dumps

B. Farmers:

Those applying wastewater, farming on old dump sites and/or applying waste or immature compost

2.2 Environmental exposure

In addition to occupational exposure, solid waste and wastewater used in agriculture pose risks to the environment, to produce handlers, and even more to produce consumers. Exposed consumers include humans who eat food produced using wastewater or low quality compost, and who eat meat from livestock (especially poultry) that are fed with contaminated waste food, that forage plastics etc. from solid waste containers, that graze on garbage dumps, or that drink wastewater.

Use of waste from industries exposes the environment to chemical contamination. As organic solid waste is often stored and collected together with other types of waste, contamination of the organic fraction is easily possible by chemical constituents, heavy metals in particular. When wastewater or contaminated compost product is applied to land, these constituents can accumulate in soils. The contamination of soils by chemicals, the potential uptake by crops, and the possible chronic and long-term toxic effects in humans are discussed by Chang et al. (1995) and by Birley and Lock (1997). Plant uptake of heavy metals depends significantly on the metal as well as compost and soil conditions, such as acidity, organic matter content and redox potential. Similar metal amounts in different soils can be harmful in one and harmless in the other. Thus a number of other parameters must be known before any risk assessment related to heavy metals is possible.

Metals in municipal waste come from a variety of sources. Batteries, consumer electronics, ceramics, light bulbs, house dust and paint chips, used motor oils, plastics, and some inks and glass can all introduce metal contaminants into the solid waste stream. Composts are likely to contain these elements, although at low concentrations as most contaminants have been removed through sorting.

In small amounts, many trace elements (e.g. boron, zinc, copper, and nickel) are essential for plant growth. However, in higher amounts they may decrease plant growth. Other trace elements (e.g. arsenic, cadmium, lead, and mercury) are of greater concern primarily because of their potential to harm soil organisms or plants and their potential to enter the food chain and cause human illness. The impact of these metals on plants grown in compost-amended or wastewater-irrigated soils depends not only on the concentration of metals and soil/compost properties as mentioned above, but also on the kind of crop grown. Different types of plants can absorb and tolerate metals differently. In general, there is little evidence of crop contamination through compost. The application of MSW composts may, however, increase the metal content of uncontaminated soils. This may pose a risk to animals or children in the area who might ingest the composted soil directly.

2.3 Factors influencing levels of exposure

i ***Cultivation techniques:*** methods of application of waste/compost; composting time and methods, type of crops grown on soils receiving wastes; mono or multi cropping, and periods of crop growth ii ***Site characteristics and physical infrastructure:*** Location of aquifers, wells vulnerable to waste leachates and availability of sanitation facilities for workers

iii ***Animal characteristics and exposure:*** Types of animals fed organic wastes; their propensity to harbour parasites, etc., use of animals in ploughing and transportation, and prevalent wild and stray animals (e.g. rabid dogs at dumps).

iv ***Human characteristics, exposure, hygienic habits:*** Type of exposure: primary handlers of waste; composters; field or pond workers; crop handlers; consumers, immunity levels and hygiene practices of handlers, consumers, health of animal keepers, and cooking and food preparation habits of consumers

2.4 Regulating waste use in agriculture: The case of wastewater irrigation guidelines

To protect farmers' and consumers' health, the World Health Organization (WHO) published guidelines for the safe use of wastewater in agriculture as shown in Table 5 (WHO, 1989) The purpose of these guidelines is to guide design engineers and planners in the choice of wastewater treatment technologies and water management options. The acceptable levels of microbiological contamination included in the guidelines were derived from the results of the available epidemiological studies related to wastewater exposure, use and treatment. In addition, health protection measures (mainly risk management measures) were considered, especially crop selection, wastewater application measures (e.g. drip irrigation) and human exposure control particularly through protective clothing. Integration of these measures and adoption of a combination of several protection measures was encouraged (Blumenthal et al., 1989; WHO, 1989). Where economic constraints limit the level of wastewater treatment that can be provided, a disease control approach has been suggested, potentially using less strict microbiological guidelines and more management measures for health protection (Blumenthal et al., 2000; Peasey et al., 2000).

Table 5. Recommended microbiological quality guidelines for wastewater use in agriculture

Category	**Reuse condition**	***Exposed group***	***Intestinal nematodes[a] (arithmetic mean no. of eggs per litre[b])***	***Faecal coliforms (geometric mean no. per 100 ml[c])***	***Wastewater treatment expected to achieve the required microbiological quality***
A	Irrigation of crops likely to be eaten uncooked, sports fields, public parks[d]	Workers, consumers, public	≤1	≤1000[d]	A series of stabilization ponds designed to achieve the microbiological quality indicated, or equivalent treatment
B	Irrigation of cereal crops, industrial crops, fodder crops, pasture and trees[e]	Workers	≤1	No standard recommended	Retention in stabilization ponds for 8-10 days or equivalent helminth and faecal coliform removal
C	Localized irrigation of crops in category B if exposure of workers and the public does not occur	None	Not applicable	Not applicable	Pre-treatment as required by the irrigation technology, but not less than primary sedimentation

a In specific cases, local epidemiological, socio-cultural and environmental factors should be taken into account, and the guidelines modified
b Ascaris and Trichuris species and hookworms.
c During the irrigation period.
d A more stringent guideline (<200 faecal coliforms per 100 ml) is appropriate for public lawns, such as hotel lawns, with which the public may come into direct contact.
e In the case of fruit trees, irrigation should cease two weeks before fruit is picked, and no fruit should be picked off the ground. Sprinkler irrigation should not be used.

(Source: WHO, 1989)

3. Health consequences of wastewater and excreta use in agriculture

3.1. Infections associated with wastewater and excreta

Pathogenic organisms in wastewater and excreta can cause diseases. For instance, bacterial pathogenic organisms that may be excreted by humans may cause gastrointestinal tract diseases such as typhoid and paratyphoid fever, dysentery and cholera. Because these organisms are highly infectious, they are responsible for many deaths each year in areas with poor sanitation, especially in the tropics (Feachem et al., 1983; Mara, 1974). Table 6 shows some diseases caused by infectious agents present in raw wastewater.

Table 6. Pathogens and diseases associated with raw domestic wastewater

Pathogen by Taxon	Disease	Symptoms
Bacteria		
Escherichia coli	Gastroenteritis	Diarrhoea, nausea, dehydration
Salmonella typhi	Typhoid fever	Headache, fever, malaise, anorexia, cough
Salmonella sp	Salmonellosis	Diarrhoea, fever, abdominal stomach cramps
Shigella sp	Shigellosis	Bloody diarrhoea, vomiting, cramps, fever
Vibro cholerae	Cholera	Watery diarrhoea, severe dehydration, vomiting
Viruses		
Adenovirus	Respiratory disease	Respiratory symptoms, coughing
Poliovirus	Poliomyelitis	Often asymptomatic; fever, nausea, vomiting, paralysis
Rotavirus	Gastroenteritis	Diarrhoea, nausea, dehydration
Hepatitis A	Infectious hepatitis	Fever, malaise, jaundice, abdominal discomfort
Protozoans		
Cryptosporidium parvum	Cryptosporisiosis	Watery diarrhea, abdominal cramps, pain
Giardia intestinalis	Giardiasis	Diarrhoea, abdominal cramps, malaise, weight loss
Entamoeba histolytica	Amoebiasis (amoebic dysentery)	Bloody diarrhea, abdominal discomfort, fever, chills
Helminths		
Ascaris lumbricoides	Ascaris (Roundworm infestation)	Often asymptomatic; wheezing, coughing, fever
Enterobius vericularis	Enterobiasis (Pinworm)	Perianal pruritis, vulvovaginitis, urinary tract infection
Taenia saginata	Taeniasis (Beef tapeworm)	Abdominal discomfort and weight loss
Trichuris trichiura	Trichuriasis (Whipworm)	Abdominal cramping, nausea, vomiting, flatulence, diarrhea, tenesmus, and weight loss

Source: Adapted from Stanier et al., (1986); Feachem et al., *(*1983); Ottoson (2005).

3.2. Assessment of health consequences

Pathogenic health risk assessment involves evaluating the likelihood that an adverse health effect may occur when humans are exposed to one or more potential pathogens (Cooper and Olivieri 1998). An important element in infectious disease risk considerations is the concentration of the microbial agent required to elicit a response in those exposed.. There is a developing literature on the dose response relationships between human subjects and pathogenic micro-organisms. The risk assessment methodology, however, still remains in an early stage of development and more work is particularly needed in studying the dynamic properties of these models in the risk assessment application, including human immunity. Although risk assessment modelling using generic or site-specific input data can be valuable in providing general information pertaining to risk, the results should not be considered definitive. Risk assessment modelling should instead be considered one of many tools providing information to policy makers in the decision making process (Cooper and Olivieri, 1998).

Early approaches to measuring health risks represented by pathogenic microorganisms centred on detection. A "zero-risk" approach was used, which led to standards for wastewater use that approached those of drinking water, especially where vegetable crops were grown. After further reviews by Feachem et al. (1983) and Shuval et al. (1986), an epidemiological model was developed. Pathogens with long persistence in the environment, low minimal infective dose, little or no human immunity, minimal concurrent transmission and long latent period and/or soil development stage were taken to have high probability of infections. Table 7 presents the summary of how Shuval et al. (1986) rated the factors when considering the enteric pathogen groups. Table 6 contains both hazard and exposure assessments for the purpose of health consequences assessment.

Table 7. Epidemiological factors associated with pathogen infections through wastewater irrigation

Enteric pathogens	Persistence in environment	Minimum effective dose	Human Immunity	Concurrent routes of infection	Latency/ soil development
Viruses	Medium	Low	Long-term	Mainly home contact and food or water	No
Bacteria	Short/ medium	Medium/high	Short-/ medium-term	Mainly home contact and food or water	No
Protozoa	Short	Low/medium	None/little	Mainly home contact and food or water	No
Helminths	Long	Low	None/little	Mainly soil contact outside home and food	Yes

Source: Shuval et al. (1986)

The Shuval model shows that helminth diseases, if they are endemic, will be effectively transmitted by irrigation with raw wastewater. On the other hand, the enteric virus diseases should be the least effectively transmitted by irrigation with raw wastewater. The bacterial and protozoan diseases rank between these two extremes. Shuval et al. (1986) ranked the pathogens in the following descending order of risk. It is, however, noted that high risk pathogens cause less serious diseases.

1. **High**: Helminths (the intestinal nematodes - *Ascaris, Trichuris*, hookworm and *Taenia*)
2. **Lower:** Bacterial infections (i.e. cholera, typhoid and shigellosis) and protozoan infections (i.e. amoebiasis, giardiasis)
3. **Lowest:** Viral infections (viral gastroenteritis and infectious hepatitis)

3.3 Documented evidence of health consequences related to use of wastewater and excreta

In general, our understanding of specific **causal** factors in the health status of particular low-income populations living in unsatisfactory conditions is still very limited. In the case of composting, for example, we do not know whether there are specific patterns of disease and vulnerability that can be attributed to poor practices in small scale composting and garbage farming, except through incomplete composting (Furedy and Chowdhury, 1992). Evidence of health consequences related to the use of wastewater and excreta, on the other hand, is more common. Thus the following discussion will mainly focus on wastewater and excreta use.

(i) Evidence from farm and plant workers

This section is part of the evidence that supported the writing of the 1989 WHO guidelines and was documented by Blumenthal et al. (2000) in a study for revising the 1989 WHO guidelines.

Use of raw wastewater in irrigation causes significantly high levels of infections with intestinal nematodes in farm workers, in areas where such infections are endemic. In India, sewage farm workers had significant excess of Ascaris and hookworm infections compared to farmers irrigating with clean water (Krishnamoorthi et al., 1973). A cholera outbreak in Jerusalem, where it is not usually endemic, in 1970 was attributed to raw wastewater used in irrigation (Fattal et al., 1986). Evidence from Mexico shows significantly high prevalence of *Ascaris* infection on farm workers and their children, who come into contact through irrigation or playing in the fields. The excess infection is greater in children than adults, with prevalence rates more than 50% (Blumenthal et al., 1996; Peasey 2000). Children 1-4 years old also had significantly higher rates (almost 20% prevalence) of diarrhea disease (Cifuentes et al., 1993). Evidence showed very limited risk of infections among workers using partially treated wastewater for irrigation (Blumenthal et al., 1996).

(ii) Evidence from crop contamination

Wastewater containing pathogens can contaminate crops directly through contact during irrigation or indirectly as a result of soil contact, blowing dust, workers, and insects (Crook, 1998). Pathogens do not, however, readily penetrate fruits or vegetables unless the skin is broken. Contamination through roots is also minimal. Transmission of food-borne illness by enteric pathogens due to irrigation with reclaimed water has been established for more than 100 years (Yates and Garba, 1998) and this is the reason why irrigating crops, especially those eaten raw, with wastewater has been forbidden in some countries, such as Jordan (McCornick et al., 2004). However, most food-borne illness associated with enteric micro-organisms occurs during the mishandling of food, typically when a sick food handler doesn't practice proper sanitation like hand washing (Martijn and Huibers, 2001). Epidemics due to contamination of crops in the field are hard to trace as contamination is likely to be more random and the food may be dispersed over a large geographic area. Association of illness with non-food crops is limited to people coming into contact with the wet parts of the crops in the field or during processing.

Pathogens generally survive less on crops than in soils, as sunlight exerts a lethal effect on all micro-organisms involved in contamination. As much as 99% elimination of detectable viruses has been reported after 2 days' exposure to sunlight, supporting regulations that a suitable time interval should be maintained between irrigation and crop handling or grazing time (Feigin et al., 1991). Nevertheless, crops can become contaminated at any time and the reliability and completeness of pathogen removal by mechanisms of desiccation, exposure to sunlight, starvation, etc. is questionable. So, for food crops, the three best options for risk minimization are: (1) eliminating pathogens from reclaimed water before irrigation, (2) processing the crops before sale to the public, or (3) preventing direct contact between wastewater and edible portions of the crop (Crook, 1998). Post-harvest handling of crops, e.g. at markets and households, could even be more detrimental. This is influenced by culture and hygiene of the food and produce sellers as well as the consumers hence need for more holistic approach to risk reduction has to extend to post-harvest handling.

4. Risk perceptions in wastewater and solid waste use farming in Ghana

4.1 Farmers' perceptions of wastewater and its use in vegetable farming

Farmers practising UA in Ghana lack better options hence end up using wastewater-contaminated water sources for irrigation. These sources are more reliable, not paid for, and, less significantly, have more plant nutrients (Obuobie, 2003; Keraita, 2002; Abdul-Ghaniyu et al., 2002). In general, urban farmers in Ghana don't like being associated with the use of wastewater and excreta in agriculture, mainly due to threats from local authorities and a general public perception that "*anything waste is bad*". However, the users are often defensive and those who admit to using polluted water from urban drains are usually quick to add, "*... but there is nothing harmful with my water*". In a survey carried out in urban vegetable farming sites using wastewater-contaminated water sources in Accra, almost two-thirds of 83 urban farmers interviewed in Accra were pleased with using such water (Obuobie, 2003). On health risk perceptions, 14% of 73 urban and peri-urban vegetable farmers in Kumasi clearly indicated that they were not aware that untreated wastewater had disease causing organisms (Keraita, 2002). But hardly any of the farmers who were aware that wastewater is harmful in Kumasi could identify concrete primary health risks, although skin diseases were commonly mentioned. This could be also that they want to show that their farming practices pose no risks as could be deducted in the following expressions made by two farmers:

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

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

4.2. Farmers' perceptions of excreta use in agriculture

In Northern parts of Ghana, human excreta are often used in farming as a soil ameliorant. A study was conducted in Tamale and Bolgatanga to determine the driving factors, constraints and potentials for the use of human excreta in peri-urban agriculture (Cofie et al., 2005). Officials of the Municipal Sanitation Unit and a total of 90 farmers who use excreta were interviewed. Sixty-four percent of farmers interviewed used excreta as a cost-effective way to improve soil fertility and increase yields of maize and sorghum. Faecal sludge from septic tanks and public toilets is discharged on the farm land during the dry season and incorporated into the soil at the onset of the rainy season. Although this drying treatment is perceived to reduce the number of pathogens in sludge, 22% of farmers complained of itching feet and foot rot after working with the sludge, which is done without wearing protective foot covering. This constraint is coupled with the foul smell, transport problem and public mockery associated with the use of human waste for agriculture. In spite of these problems, there is competition for faecal sludge among farmers, due to benefits derived from its use.

4.3 Other stakeholders' perceptions on wastewater irrigation

i. **Produce sellers' perceptions**: Vegetable sellers in Accra, Kumasi and Tamale see urban vegetable farming as a source of employment for farmers and sellers and enables easy access to fresh vegetables on urban markets. However, nearly all of them condemn the use of drain water and polluted surface water for growing vegetables (wastewater irrigation), since it risks the health of their customers. They pointed out mainly to gastro intestinal infection as a possible health risk. Both women sellers (>95% of total sellers) and the few men who are involved share these views. Meanwhile, without wastewater, urban vegetable farming in Ghana like Accra and Tamale would be restricted mainly only to rainy seasons (4-6 months), causing a drastic gap in demand and supply of vegetables to urban markets. Sellers are then left with no alternative but continue buying and selling wastewater-irrigated vegetables.

ii. **Produce consumers' perceptions**: 1100 households were surveyed in 2003 in three major cities of Ghana for their perceptions on wastewater use in vegetable farming (unpublished survey). The household members most involved in buying and cooking vegetables, who turned out to be mostly women, were interviewed. Up to 96% of respondents in Kumasi indicated that they would not buy wastewater-irrigated vegetables because these could cause diseases. This reason was given by 88% of respondents in Accra and 70% in Tamale. The responses can be attributed mainly to the awareness levels and also the extent of use of wastewater in the three cities. For example, in Tamale and Accra, irrigation is very much limited to wastewater-contaminated sources and the two cities are much drier than to Kumasi. Nevertheless, in most cases, consumers buy and eat wastewater-irrigated vegetables without knowing. For the respondents who did buy wastewater-irrigated vegetables, in Tamale, 9% felt that they were just as good as those irrigated with other water sources, 6% said that washing would eliminate the risks, and 10% said they had no choice but to buy them, which was also a reason given by 8% of the buying respondents from Accra and 4% in Kumasi.

iii. **Local authorities' perceptions:** Officers in charge of urban agriculture and food contamination were interviewed in Accra, Kumasi, and Tamale. They were against the growing of crops with wastewater and did not encourage it. They expressed fear that the use of unsafe water might lead to health risks. In Accra there is a by-law against the use of drainage water for irrigation. Nonetheless, the practice continues, as such by-laws are difficult to enforce or may not get priority as there are many other health issues for the authorities to tackle.

4.4 Need for community participation

There seems to be a general consensus from the perception studies that wastewater use in UA has health risks. However, the various stakeholders have divergent interests and there is a clear lack of collaborative efforts to tackle the situation. This calls for the need for a holistic approach in risk reduction strategies. These must not only be technically appropriate but also be socio-economically and culturally viable. Basically, no strategy can succeed without consideration of the perceptions, attitudes, constraints, etc., of involved and affected groups. For instance, some strategies on post-harvest handling of crops may require behavioural changes in order to be successful. Community or stakeholder participation and proper communication then becomes vital for success of any risk reduction strategy. Issues like creating awareness in communities about the negative consequences of wastewater use, and training them in methods to minimize risks, is one of the entry points that can be of critical importance in breaking the accumulated impact of wastewater use.

5. Innovative approaches for risk mitigation in UA for sub-Saharan Africa

5.1 Problems with the existing risk reduction guidelines and related bylaws in SSA

Application of risk-reducing guidelines, like those provided by WHO (see section 3.4) and the resulting bylaws of local authorities, has been found to be difficult in many field situations, for example in India and West Africa, as discussed during an expert meeting in Hyderabad in 11-14 Nov. 2002 organized by IWMI and IDRC (www.cgiar.org/iwmi/india/hyderabad_declaration.htm). To take into account urban and peri-urban agriculture, adjustments to the WHO (1989) guidelines were suggested, especially in relation to the following three points:

First, in many countries, conventional wastewater treatment is not possible due to limited municipal/governmental resources, and small, old or non-extendable sewage systems. As the WHO microbiological guidelines assume certain levels of wastewater treatment, their enforcement in situations without any realistic option for treatment would prevent hundreds or thousands of farmers from irrigating along polluted streams and would put their livelihoods at risk. Restrictions would affect also food traders and the general market supply, especially in cases where other water sources are (seasonally) not available.

Second, in many cases it is difficult to apply the recommended additional health protection measures, especially in market-oriented urban agriculture[7]. Here, highly specialized farmers use every free space with water access to cultivate

[7] We refer here to market-oriented open-space vegetable growers, not backyards.

cash crops, especially those that are highly perishable. Although the plots are often small, irrigation allows year-round farming and a significant income generation as well as a contribution to the overall urban vegetable supply and diversified diets. These farmers are able to escape from the poverty trap (Danso et al. 2002a). However, small land sizes and insecure land tenure with the permanent risk of being expelled significantly constrain farmers' ability to invest in farm infrastructure, such as drip irrigation or the installation of on-farm sedimentation ponds. Moreover, farmers often live at large distances from their urban plots and prefer mobile equipment in order to reduce theft. Also crop restriction is an unrealistic measure in (peri)urban farming as only cash crop production corresponding to market demand gives the profit that the farmers' livelihoods are based on. Thus, any change (e.g. to switch from vegetables to tree crops) would in many cases be unrealistic from the land tenure perspective and would also ignore farmers' livelihood strategy (except where non-vegetable cash crops are suitable, e.g. olive trees in Middle East). Also recommendations to change irrigation systems or cease irrigation before harvest do not usually work out – for example, lettuce would be damaged already after a few days without watering. Finally, several field observations in many African countries (unpublished observations) have shown that many farmers who have farmed without protective clothing for "decades" do not perceive the need for it. Factors such as these significantly constrain the application of the WHO wastewater guidelines in urban farming. In peri-urban farms with more secure land tenure arrangements, however, the situation is different and more safety measures can be explored, such as simple on-farm wastewater treatment systems.

Finally, the microbiological part of the WHO guidelines has often been used or cited in isolation from other WHO recommended protective measures. One reason for this might be that the defined critical levels appear "handy" and easy to recommend, so authorities and institutions may choose this over thinking of other safety measures for health risk reduction that would be more locally appropriate and feasible.

With regard to these difficulties, it has been suggested that the WHO guidelines need adjustment for better application in wastewater-exposed urban and peri-urban agriculture in resource-poor countries (Drechsel et al., 2002). The overall goal should be to find a better balance between safeguarding consumers' (and farmers') health, and safeguarding farmers' livelihoods (Scott et al., 2004). A stepwise implementation approach for the guidelines as described in Von Sperling and Fattal (2001) was thought to be helpful. This could consider different levels of water treatment, including recommendations for regions or countries where (improved) treatment is not a realistic option. To achieve this, more emphasis should be placed on further protective measures, while considering the limitations of the current measures. This could include on-farm measures, including better land allocation, but also target post-harvest contamination of crops during transport and marketing, which takes place independent of irrigation water quality. The just published revision of the 1989 WHO guidelines (WHO, 2006) demonstrates a considerable move into this direction.

The addition of a livelihoods perspective can give the health guidelines more dynamism. For instance, more than 1500 farmers are involved in irrigated urban vegetable farming in Ghana's three main cities, and more than 80% of them use wastewater - especially in the dry season (Keraita et al., 2004). Several others are involved in transportation and marketing of the produce. Danso et al. (2002a), showed that these farmers reach annual income levels of US$ 400 –800. This is twice what their rain-fed counterparts get in the rural areas. These levels are achieved due to the intensive nature of farming made possible partly by the free and reliable supply of water, although in most cases this is wastewater or wastewater contaminated stream water. For many, this is their only livelihood.

5.2 Risk mitigation innovations

A flow diagram model of a new process for deciding on locally appropriate health protection measures has now been developed, which considers experiences in Ghana and elsewhere where wastewater is used directly or indirectly for urban and peri-urban agriculture, and where municipal wastewater treatment is not a realistic option in the short to medium term (see Fig. 1). The elements of the decision strategy are as follows; numbers in the text refer to the diagram:

Where a monitoring of wastewater treatment is institutionally and financially possible, the microbiological guidelines for wastewater irrigation should be applied. In this situation (1) the guidelines should assist design engineers setting the standard of the treatment system from the perspective of crop production[8].

- Where the establishment or maintenance of functional wastewater treatment facilities is not a realistic option, the concerned authorities have nevertheless different options to reduce health risk for farmers and consumers. First of all, they are asked to explore alternative water sources or cropping areas (2) with higher quality water (e.g. groundwater). In Cotonou, for example, the authorities allocated new land for urban farmers with the

[8] From this perspective, microbiological contamination should receive more attention than, for example, the degradable organic matter content (which can be a valuable source of nitrogen, among other things).

possibility of groundwater access while in Accra; the Water Research Institute is currently exploring groundwater use in wastewater-irrigated urban areas. Participation of relevant stakeholders is necessary for any success of innovations. In this case farmers should be involved from the start in exploring alternative approaches. Additional measures might be recommended if post-harvest contamination is likely (3).

- If alternative land and safe water sources are available and accepted by the farmers, it might be possible to apply the microbiological guidelines (4). If water quality, however, can not be guarantied, agricultural engineers should investigate possibilities of (5a) and (5b)

  a) Alternative irrigation technologies and irrigation methods reducing
  (i) Farmer's exposure (e.g. during water fetching and application),
  (ii) Crop contact (e.g. surface instead of overhead irrigation), and
  (iii) Microbiological water contamination levels (e.g. through improved and better-located shallow wells).

  b) Crop selection and patterns taking market demand, cultural preferences and gender balance in cultivation/marketing into account.

  c) On-farm water treatment options, such as simple sedimentation tanks, taking into account land tenure arrangements, labour constraints and farmers' interest and ability for on-site investments.

  d) Awareness campaigns to educate farmers on their own health risks and those of consumers, as well as offer guidance on health protection measures.

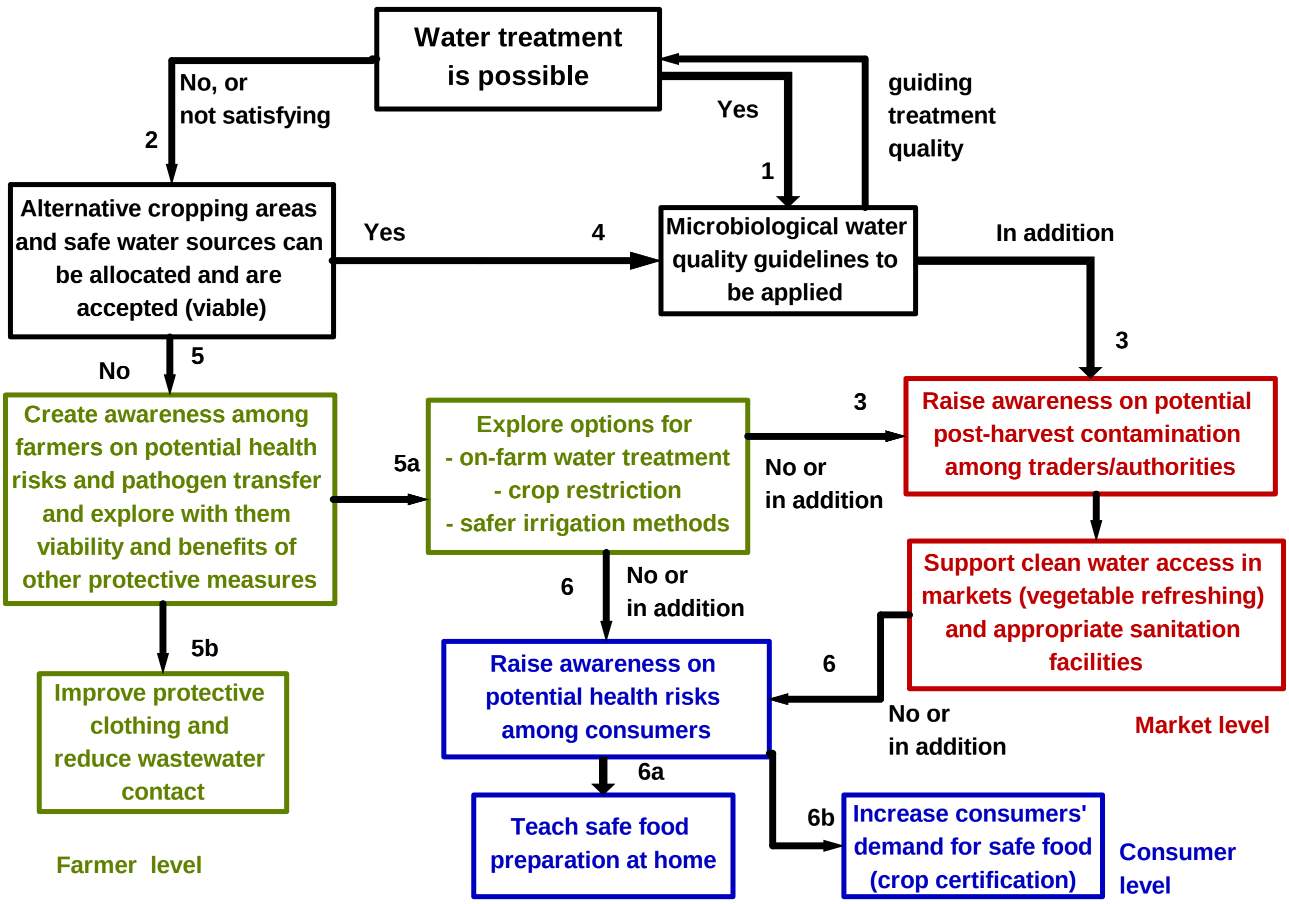

Figure 1. Entry points of risk reduction related to wastewater use (Drechsel et al., 2002; IWMI, 2006)

- It can also be crucial to focus on post-harvest contamination at markets (3), i.e. on the availability of clean water for vegetable handling, especially crop washing and "refreshing" as well as general hygienic conditions for traders (e.g. availability of sufficient sanitation facilities). This has to be combined with related education and awareness campaigns. Another option could be mass disinfections of market produce (Birley and Lock, 1999). However, authorities should also consider well-established but often officially ignored informal vegetable markets e.g. in upper class suburbs, and insist on the availability of clean water. Related costs are likely to be insignificant in comparison with effective wastewater treatment.

- Risks to consumers (6) should be addressed by sensitising households on health implications related to polluted irrigation water and unhygienic produce handling. Recommendations will have to consider local diets and food preparation behaviour and options. Improved vegetable washing and (if possible) cooking can significantly reduce possible health risks through wastewater irrigation or post-harvest contamination (6a). A related (long-term) target is to raise consumers' demand for, and willingness to pay for, safe food (6b). This could catalyse awareness shifts also among traders, farmers, and authorities. Crop certification could become an option (Westcot, 1997). However, this transition has still a long way to go in many countries, considering the dominance of more obvious health risks such as HIV, malaria, and lack of drinking water, as well as the lack of general sanitation facilities (Danso et al., 2002b). The strategies related to **markets** and especially **consumers** should also receive attention in situations of functional treatment and applied wastewater irrigation guidelines. The reason is that post-harvest contamination through unhygienic crop handling may take place independently of enforced or non-enforced irrigation guidelines.

5.3 Examples of risk reduction strategies

(i) For wastewater irrigation

A recent overview about risk reduction measures was provided by IWMI (2006). Control measures aimed at protecting agricultural field workers and crop handlers include the provision (and insistence on the wearing) of protective clothing, the maintenance of high levels of hygiene and immunization against (or chemotherapeutic control of) selected infections; see WHO (1989) for examples. Risks to consumers can be reduced through cooking the agricultural product before consumption and by high standards of food hygiene, including water availability, which should be emphasized in the health education associated with wastewater use schemes. Local residents should be kept fully informed on the use of wastewater in agriculture so that they, and their children, can avoid these areas (FAO, 1992). The greatest risk of infection or illness is through effluent ingestion. Such a situation may occur through drinking from the supply systems by accident or for lack of alternatives. Therefore, all pipes and appurtenances used for irrigation with reclaimed effluent should be colour-coded, all valves and outlets should be tagged with appropriate warnings (Feign et al., 1991), and, wherever possible, outlet fittings should be designed/selected so as to prevent misuse (FAO, 1992). As for sprinkler irrigation, the general practice is to limit exposure to aerosols produced from reclaimed water that is not highly disinfected through design or operational controls.

- Although there is no evidence to suggest that those living near wastewater-irrigated fields are at significant risk, sprinklers should not be used within 100m of houses or roads (FAO, 1992)

- It is recommended that appropriate buffer zones, generally 100-500 m (Young, 1980), be established between spray-irrigated fields and residential areas or other sites involved in intensive public activity (Feign et al., 1991).

(ii) For composting

As most risks (also for workers) are related to the composition of the waste material, the quality of separation is a crucial indicator for risk reduction. Separation can take place at the source of the waste and/or at the composting site. An efficient system is the 'green or brown container' used e.g. in parts of Europe, which only receives organic waste, such as garden and kitchen refuse. The second parameter for risk reduction is the composting process. If acceptable compost temperatures can be obtained in all parts of the pile (e.g. through turning), risks related to pathogens will be minimized. But even direct application of waste containing fresh excreta does not automatically induce risks. The application method, time till cropping, and type of crop are important factors of risk reduction. Sludge application should in addition only take place on sites where run-off or groundwater pollution are unlikely.
The third measure of risk reduction is the continuous monitoring of compost quality and the provision of sanitation facilities for compost workers.

6. Conclusion

Although this paper focuses on health risks of wastewater and solid waste use in urban agriculture, the aim is not to condemn the use of either but to provide support for risk assessment, with options for risk mitigation, and therefore promotion of UA. It is very common for health considerations to be used as a reason for restricting urban agriculture. But, while public health officials undoubtedly recognize this problem, the actual regulations designed to control or reduce these in cities of developing countries are haphazard and often outdated. In addition, these regulations are rarely enforced, except when there is a health emergency, as other health risks (e.g. malaria, HIV) will have higher priority. The evidence about actual health risks associated with UA is limited and in general not overwhelming. This is especially the case in developing countries where people may have worked and lived in unsanitary conditions from infancy.

The use of wastewater and solid waste in UA has many benefits, and health risks posed can be minimized if adequate control measures are consistently practiced, and workers and consumers adopt basic precautions and hygienic practices. Accompanied by behavioural changes, technically simple and cheap control measures, like improved irrigation water management at farms, low-cost on-farm treatment of wastewater, sorting of waste at source, provision of clean water in markets, vegetable washing in households, etc., could be used, and considerable risk abatement achieved. Although a range of studies exists on the potential health risks, in developing countries assessment and mitigation of risks related to wastewater and solid waste composting are rare, as are recommendations with broad adoption potential in the context of UA. The World Health Organization has recognized this challenge in its 2006 revision of the guidelines. The International Water Management Institute and its partners will continue to assist in this process, with research on practical and low-cost options for risk reduction.

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Risk perception, communication and mitigation in urban agriculture: community participation and gender perspectives

D. Lee-Smith

Abstract

This paper explores some of the ways in which men's and women's different experiences give them different perceptions of risk, in the context of urban agriculture (UA) in sub-Saharan Africa (SSA). The effects of gender roles and poverty on people's risk perception and risk mitigation are discussed. Risk perception is discussed in relation to human wastes, wastewater re-use, solid waste in general, and livestock-rearing. The paper notes that significant gender differences exist in perception of urban environment burdens, and the important role of women in risk mitigation is highlighted. The paper concludes that many people are aware of health risks associated with UA, but constrained by poverty from mitigating these. In addition to the provision of basic services to the poor, information-sharing and empowerment are suggested as means for developing risk-management strategies.

Introduction

This paper addresses the perception of health risks among poor communities practising urban agriculture, and focuses especially on the differences between men and women. It also addresses some issues related to the communication of health risks to communities, and the way in which communities may themselves adopt mitigation strategies. This is specifically addressed as a gender issue. Sometimes women are seen as more vulnerable than men, and the issue of vulnerability of different groups to different levels and types of risk is briefly touched on. The paper demonstrates, however, that the capacity of communities in general and women in particular to respond to risks as active agents should not be overlooked.

Urban agriculture (UA) is taken to include peri-urban agriculture, and describes the crop and livestock production systems in and around urban areas, which are tightly interlinked with other urban activities in terms of inputs and outputs. This definition follows Mougeot and others in seeing important ecological as well as economic elements in the way urban agriculture systems work in the urban system as a whole (Mougeot, 1994; Smit et al., 1996). In this context, the Ecohealth approach is well suited to the study and understanding of UA in general. With its emphasis on community participation and on equity, especially gender equity, the Ecohealth approach is particularly appropriate to this paper.

Many urban by-products become agricultural inputs, including composted domestic and market wastes that are used on crops, and market or even industrial wastes such as brewery by-products that are used as animal feeds. On the other hand, the by-products of UA themselves become inputs elsewhere, sometimes in the form of crop-livestock system intensification, such as manure for use on crops, and crop stover for fodder. By-products of UA can also become problems, especially in terms of human health - the subject of this paper and the workshop it arose from.

These are not always perceived as separate risks, either by urban farmers or by consumers. The following main health risks from UA have been identified:

- the use of liquid or solid wastes contaminated by pathogens;
- human diseases (e.g. malaria) transferred by vectors attracted by UA;
- toxic levels of agrochemicals in wastewater used for UA irrigation (where there is over-use of pesticides by poor urban farmers, for example);
- contamination by metals in soils, air or water;
- transmission of diseases from animals to humans (zoonosis);
- unsanitary handling of food; and
- occupational health risks (Lock and De Zeeuw, 2003).

This paper draws heavily on the participatory urban appraisal carried out in Kampala as part of a joint project entitled "Health Impacts of Urban Agriculture in Kampala, Uganda", which is addressed in several of the papers in this volume. Issues of community participation and gender are addressed in the paper in relation to:

- contamination of water used for UA irrigation with pathogens or toxic substances;
- the handling of solid wastes as part of UA systems;
- disease transfer by vectors attracted by UA, (malaria); and
- livestock-keeping practices.

Because studies on perception and management of health risks associated with urban agriculture are scarce, this paper also makes use of findings on perception of relevant health risks from studies of similar communities to those found to be practising urban agriculture in low-income urban areas. Risks are usually perceived and assessed in relation to benefits. A basic assumption in this paper is that people make trade-offs of risks and benefits in pursuing their livelihood strategies. Thus the importance of variability in the perception of risk is examined. The capacity of communities to respond to risk and to adopt mitigation strategies is also addressed, particularly with regard to the empowerment of women. In this respect, the literature on gender and disasters provides some interesting insights: women's networks have been shown to be highly responsive in mitigating the effects of natural disasters through organized response at the community level.

Why risk perceptions vary

Risk assessment is always subjective. Individuals will always weigh the benefits and risks of any action differently, depending on their *values*, *knowledge*, and *circumstances*. A mother with a dehydrated child may give it dirty water rather than nothing at all, knowing she is taking another kind of risk. Low-income farmers may spray their crops with toxic levels of agrochemical to assure their income, whereas higher-income people who might end up eating the food might not want the farmers to use these amounts of agrochemicals. On the other hand, some people may take risks because they don't know something is hazardous. The poor farmer may think that the chemicals are not harmful, for example. The mother may think the water is safe.

The perception of risk depends on what a person knows, as well as on what he or she stands to gain or lose. What people stand to gain or lose depends on what they value. And what they value depends upon who they are. Thus, starving or penniless people may live and farm in hazardous areas, taking risks that better-off people will not. Women and men may perceive risks in different ways not so much because they have different levels of knowledge – though this could also be true – but because of their social roles and responsibilities.

In sub-Saharan Africa, women more than men are generally responsible for looking after the home, to the extent of being responsible for providing it with food, usually through peasant subsistence farming. This is why women predominate among farmers in urban areas when the food is produced for home consumption (Lee-Smith, 1994; Lee-Smith and Hinchey Trujillo, 2006). A poor woman living in a city may want so much to provide food for her family that she may take a big risk by farming on someone else's land or next to a waste dump. Then she will probably take the food home to feed her husband and children. Her husband, on the other hand, may believe that everything depends on him earning a living, to provide for his family and gain status in his community. If he is desperate he may take the risk of stealing. People take different risks.

Since knowledge is a major factor in risk perception, it is important that the woman *know* that she may risk having her crops slashed and that she may be exposing her family to agrochemical hazards. This knowledge could influence her decision to farm where she does. Likewise one may warn the husband that he risks imprisonment, and that may give him pause, but in the end both of them will still want to achieve their objectives. They will balance the risks against their objectives, and choose less risky alternatives that allow them to meet their objectives.

Communicating to people about hazards is crucial to minimizing the health risks of urban agriculture, but it is not the only thing that will mitigate them. A mitigation strategy has to take account of people's perceptions, which consist of their values as well as their knowledge. Circumstances like poverty, lack of opportunity, and gender differences will also affect how people will perceive a risk and try to mitigate it.

Women's and men's roles in urban food production

Urban farming is a poverty alleviation strategy documented since the 1980s (Lee-Smith et al., 1987). East African research shows that children of urban farming families are better nourished than those from non-farming families (Maxwell et al., 1999; Mwangi, 1995). Both men and women engage in urban farming, although studies in East Africa indicate a slightly higher proportion of women than men, with a distinct difference in their roles. Women engage more than men in unpaid family labour, taking responsibility for the production of the household's food in the absence of income security. In East Africa, men engage more in both paid labour in UA and in cash sales of UA products. This has implications for their perceptions of the risks of hunger and their mitigation strategies (Egziabher et al., 1994; Mascarenhas, 1999). More men than women are engaged in urban farming in West Africa, where the proportion of urban food produced for sale is also higher (Anosike and Fasona, 2004; Armar-Klemesu and Maxwell, 2000; Kessler et al., 2004; Moustier and Mbaye, 2000; Obuobie et al., 2004). These data do not, however, mean that women do not engage in commercial production at all.

The diversity of gender roles in relation to farming is very large. In some places certain crops are assigned to women and others to men. For example, in Kampala it was observed that sweet potatoes are generally planted by women, whereas sugar cane is more often a man's crop. The former is more often consumed at home, whereas the latter is more often sold. Such variations in gender roles in urban agricultural practices may be very different in different cities and countries, and considerably more research is needed to analyse their implications for gender equity and sound food security policies.

Perceptions of health risks from human wastes

In both East and West Africa, women more than men are responsible for the handling of all domestic wastes, as well as of water and food supply for the home, especially in the absence of services and infrastructure. A study from Port Harcourt, Nigeria observes:

"Women are solely responsible for the collecting of water. Even when the husband is jobless in married families, neither partner sees any reason why the man should assist in collecting water…The same applies to the management of wastes. The dumping into the swamp of solid wastes, both human wastes and organic refuse, has the most serious consequences for human health and the health of the environment. Again the data show that women and children are responsible for this work, with no effort by men to participate or take any interest in the problem….People in Elechi Beach Waterside try to supplement their incomes by growing food in rural areas while living in town. Women are also responsible for food supply and preparation." (Oruwari, 1999.)

Findings from Lagos, Dar-es-Salaam and Kampala are similar (Etta, 1999; Mascarenhas, 1999; Kwagala, 1999).

In an analysis of perceptions of the impacts of urban environment burdens, including lack of services, in Dar-es-Salaam, Mascarenhas (1999) notes significant gender differences. Women perceived impacts more acutely than did men, which Mascarenhas attributes to the fact that fewer men were involved in waste disposal or in cleaning up the neighbourhood. But it is interesting that both men and women said that health problems were the most important impacts of a poor urban environment, and that men and women ranked all impacts in the same order (See Table 1, below). Mascarenhas also notes that women's heightened perceptions of increased ill-health in urban areas came more from a concern with others' health than with their own. And although this concern was mainly focused on their children, women also act as caretakers of the sick in general.

Table 1. Gender differences in perception of the impact of poor urban environment (From Mascarenhas, 1999; field data 1995)

Impact	Women			Men		
	No.	%	Rank	No.	%	Rank
Increases illness	95	(79.2)	1	57	(47.2)	1
Increases work	60	(50.0)	2	28	(23.3)	2
Increases time for cleaning	44	(36.7)	3	15	(12.5)	3
Spoils business	19	(15.8)	4	8	(6.7)	4
Increases distance to walk	18	(15.0)	5	6	(5.0)	5
Less gardening space	6	(5.0)	6	2	(1.7)	6
Total	N = 120			N = 120		

In analysing perceptions of environment, health and disease in two neighbourhoods in Kampala (Katoogo and Kawaala), Kwagala (1999) notes that while well-off people can afford to invest in services, poorer people tend to follow the rural perception of a house as "a place where you can lay your head". Her data show the following priorities (from highest to lowest) in the order of constructing major items in the establishment of an urban house:

House/sleeping place – Latrine – Bathing Structure – Drainage

Thus, poorer people at first make do with only a sleeping place, leaving until later the digging of an outside latrine and structure for bathing in (this is to give privacy only, as water supply is carried from elsewhere). Digging a drain to get rid of wastewater from the household is the last priority. Kwagala notes that "women have to carry the burden of coping with the hazards of the urban environment. They have to clean up, deal with wastewater, and cope with human waste disposal". Probably because of this, women were found to be more aware and more informed about waste disposal practices and problems than men. While this study explores numerous traditions and taboos associated with human waste disposal – including the widespread Bantu custom that in-laws may not use the same latrine as their hosts – the overall conclusion is that most men and women are aware of the connection between disease and pathogens that may occur in wastewater and human waste. Thus the study implies that people know that human excreta are harmful and that dirty water can be hazardous. What constrains better sanitation are rather other factors, such as the high water table, the high cost of latrine construction (especially the fact that latrines generate no income for landlords), lack of space, and lack of planning (Kwagala, 1999).

A Participatory Urban Appraisal carried out by a multi-disciplinary and multi-institutional team of researchers on urban and peri-urban agriculture in Kampala from 2002-2003 produced similar findings (Musoke, 2003). It was found that people were aware of health risks, especially from the poor sanitation conditions in wetlands, with shallow or no latrines, and overcrowded areas where people "wrap and throw" human waste. Some poor households were reportedly getting their water supply from other households' drains, and were apparently aware that this could make them and their children sick, but had no alternatives. This study concluded that people were aware of health risks from wastes but constrained by poverty (Musoke, 2003).

Perceptions of health risks from wastewater re-use

Throughout Africa, urban farmers use wastewater partly out of necessity, but also partly because they are aware that wastewater contains nutrients useful to plant growth. In Nairobi, Kenya, urban farmers have resorted to puncturing the main sewer lines in order to utilize the nutrients for better crop production (Lamba, 1994; Hide et al., 2000, 2001; Kilelu, 2004). The urban farmers who do this are mainly producing for the market (Hide and Kimani, 2001). This therefore represents a public health risk to consumers as well as a risk to the farmers and their families.

The main risk for consumers of wastewater-irrigated produce arises when vegetables or salad crops grown with untreated water are consumed raw, without proper washing or treatment. Wastewater used for irrigation purposes presents a risk of cholera, typhoid, and other bacterial infections, as well as diarrhea, amoebic dysentery, and infections from intestinal nematodes (Edwards, 2001; Blumenthal, 2001). The supply of clean water in markets, and the awareness of health risks among traders and handlers of vegetables can be more critical risk factors than wastewater irrigation, according to recent findings in Ghana (Amoah et al., 2006). As described in the Anglophone Africa Training Course on Urban Agriculture held in Nairobi in March 2004, in the module on Wastewater Use in Urban Agriculture, cooked food represents almost no risk of bacterial infection, with proper hygienic food handling, and simple household treatments can be devised to reduce the risk of intestinal nematode infection. Agricultural workers in wastewater-irrigated fields, however, are directly exposed to infection and require protective clothing as well as greater risk awareness (Gueye and Sy, 2001). Further risks are associated with contamination from heavy metals and chlorinated hydrocarbons, due to uncontrolled industrial discharges into water courses or to over-use of agrochemicals (Edwards, 2001; Blumenthal, 2001; Gueye and Sy, 2001).

The Participatory Urban Appraisal of UA in Kampala (Musoke, 2003) found that urban farmers had a quite sophisticated understanding of the risks associated with contaminated wastewater, in that they distinguished between pathogenic and toxic contaminants. In focus group discussions, farmers mentioned that contamination of ground water by latrines could make their children sick and also mentioned that run-off from industries was also a problem.

Residents of a less densely populated peri-urban area thought, presumably correctly, that there was little health risk as there were few latrines and almost no industrial plants discharging into the wetlands near them, which they use for farming. People in a recently built and densely populated urban slum (Banda), on the other hand, pointed out contamination from shallow pit latrines subject to flooding as a pathogenic risk, and distinguished this from toxic industrial discharge into the same waterway (Musoke, 2003). They also noted the risk of malaria from mosquitoes breeding in puddles of water in sand mining and brick-making areas, and car washes. The authors did not confirm whether these mosquitoes were actually malaria vectors.

In Nairobi, discussions with urban farmers using untreated sewage revealed the following interesting gender difference:

Older male farmer dressed in gum boots: "There is no risk, we are OK, we don't need protective clothing."
Young woman farmer, barefoot: "That is not true. We get sick all the time. The children get upset stomachs and so do I. My skin is affected badly" (Author's field visit, April, 2003).

For various reasons, including not just their particular conditions, but perhaps also the difference in power between the two persons, or their perceptions of how the visitors might help or harass them, this man and this woman conveyed very different risk perceptions.

There is also a distinct difference in risk perceptions among producers and consumers of wastewater irrigated crops. I have observed men and women farmers in Lima, Peru, and Kumasi, Ghana, washing what were probably uncontaminated vegetables in water taken from an open ditch serving as a drain. When asked, the farmers in both cases explained that this was to impress the consumers that the vegetables were fresh and clean. This is similar to what is reported in recent findings from Ghana (Amoah et al., 2006).

Perceptions of solid wastes and strategies for their management

Regarding solid waste in general, my own findings and those of Urban Harvest suggest that perceptions may change over time and are responsive to information and awareness raising.

A study of three communities in Kenya in the early 1990s found that women managing solid wastes generally did not distinguish between organic (i.e. biodegradable) and inorganic (i.e. non-biodegradable) wastes (Lee-Smith, 1994). The strategies of rural peasant women, who either buried all wastes for later use as a soil treatment or threw them directly onto the garden, were followed to a lesser extent by women living in workers' housing on plantations, and in an urban slum. Both the urban and the plantation women most often said they dumped all waste at collection points or burned it. Waste dumps were also used by livestock as a source of fodder so dumping represented a livestock-raising strategy, which might have been appropriate in the countryside, where wastes are generally organic, but was less appropriate in the urban settings, where more of the waste was inorganic.

In Kenya in the early 1990s there were many women who expressed concern about the health problems posed by the waste strewn everywhere or left uncollected at the dumping sites. They particularly mentioned that they believed this was a threat to their children's health. However, some urban and plantation respondents thought that it was OK to throw refuse anywhere, as it gets eaten by livestock, fertilizes the ground, or gets swept away by the rains. In this respect several women observed that roads and rivers are the right place to throw refuse as "it goes with the water". In no case was there any evidence of an appreciation of wastes falling into separate categories, with some wastes decaying and being useful as fodder or nutrients, and some not (Lee-Smith, 1994).

In Kampala, Uganda, after 2000, however, perceptions and practices were more adapted to urban realities. Everyone seemed aware that there is a difference between organic and inorganic (non-biodegradable) waste. Urban farmers in all the areas surveyed in 2002 separated a number of different forms of waste. Everyone separated domestic waste, using the organic portion as animal feed or soil treatment, and disposing of the rest as best they could. Clearly useful items are recycled, as with tin cans sold to itinerant traders, but the remainder, apparently largely consisting of polythene, is often burned, or dumped wherever possible, in refuse containers provided by local councils, on empty land, or in latrines. Field observation revealed that battery cells are carefully kept and thrown into latrines as they counteract smells (personal observation, 2002). In peri-urban areas animal waste was used as soil treatment, whereas in urban areas it was often dumped. This was due to lack of space for crop growing and/or access to a market for manure, and clearly not due to a lack of awareness of its potential use (Musoke, 2003).

Perceptions of health risks from livestock-keeping

People appear less conscious of the risks posed by animal wastes than of those posed by human wastes. Although it was found that urban farmers and their families avoided contact with human waste, believing it to cause disease, they did not avoid livestock waste for the same reason (David, 2004). In Nairobi, Kisumu, and Kampala, animal waste is generally used as manure for growing crops, although where the area is densely populated and there is less room for crop farming, animal waste is dumped along with other wastes in a haphazard manner (Ishani et al., 2002a, 2002b; Musoke, 2003).

Studies in Nairobi and Kisumu, Kenya (Ishani et al., 2002a, 2002b), found that urban farmers thought there were no significant health risks associated with keeping livestock, although the smell of animal wastes was frequently mentioned as a problem. This is consistent with the findings of the Participatory Urban Appraisal in Kampala (Musoke, 2003), where livestock and their wastes are generally not listed as perceived hazards, but complaints are made about the bad smell, especially from pigs. In only a very few cases were the hazards of lice and jiggers from livestock mentioned as a problem, indicating some awareness of a possible health risk. These cases were in the peri-urban area of Kampala, which has rural characteristics and some larger scale commercial livestock production, and in the city centre farming area, which has a high population density.

A gender study in Kisumu by Ishani et al. came up with some interesting findings on practices and perceptions of health risks. Regarding the health of the livestock, it was found that women were actually more involved although "officially" (according to questionnaire responses) men were said to be responsible. This difference comes about because of women's responsibility for household chores. Men are the traditional owners of cattle and large livestock in rural settings, and respect was accorded to this power relationship based on conventionally accepted gender roles. Since women are considered responsible for household chores according to these same conventions, however, they are the ones who actually do the work of tending the livestock and were therefore more aware of and worried about the risk of animals, especially poultry, getting sick, because of the potential loss of income this would represent. Children were often involved in animal waste disposal, in both male- and female-headed households that kept livestock. However, women were said to be the ones who cleaned out livestock sheds, and to suffer from diseases as a result (Ishani et al., 2002b).

It should be noted from the East African scoping studies of urban livestock keepers that, conventionally, women are regarded as the owners and keepers of small livestock, especially poultry, while men are regarded as the owners of large livestock, especially cattle. There may be taboos (namely restrictions based on customary belief systems) against women's ownership of large livestock, although, despite the observations above, there appears to be a shift away from this kind of taboo, due to changes in the conditions of urban life and to the spread of HIV-AIDS, particularly in Kisumu. In the study conducted in Kisumu, some female-headed households were found to be the "owners" of large livestock, meaning they could sell them if they needed to, and women looked after large livestock in all types of household, even through they were considered to "belong" to the men (Ishani et al., 2002b).

These are subtle shifts and involve changes in interpersonal behaviours within different households. For example, Zarina Ishani (personal communication) has described to me how one urban AIDS widow simply ignored her adult son, who according to convention would be the rightful "owner" of the cattle she was looking after, because he was a drunkard. She would sell them herself and manage the proceeds, and her neighbours and relatives approved this behaviour, which was unconventional, because they understood her situation.

Ishani et al. (2002b) found that a few urban livestock keepers shared their living space with the livestock at night for security reasons, and that livestock in one area drank from an open sewer, while pigs grazed in sewage and were slaughtered without removal of the skin. All these issues constitute severe health risks for humans, because of the possibility of disease transmission through direct contact with animals, or in the food chain. According to ongoing work of veterinary medical doctors working on awareness creation for poor urban farmers in Nairobi, there are a number of zoonotic diseases that can be transmitted through various pathways in such conditions (Forum Report). However, it was apparent that the urban livestock keepers in Kisumu were generally unaware of these risks. Thus, typhoid and malaria were the most frequently mentioned family health problems, while skin diseases were observed especially in children. It is possible that the symptoms observed may in fact have been attributable to zoonotic diseases. Future studies of health conditions and zoonotic disease transmission pathways in the City of Kampala may throw more light on this aspect of disease risk from livestock keeping.

Although awareness of pathogenic risks from animal wastes appears to be low, awareness of other disease risks from livestock practices may be as good in some traditional systems as in western societies (or better). For example, FAO notes that in India there is a taboo on the feeding of herbivores with animal protein, and there was wide public concern for animal welfare during the Bovine Spongiform Encephalopathy (BSE) crisis in Europe in the 1980s and 1990s (Schiere and Ven Der Hoek, 2001). Other practices in traditional livestock keeping societies, such as protection of animals' hooves from hard road surfaces, are also noted. These and other practices, which are different from industrial animal production systems, should be preserved in developing country livestock systems where they promote human and animal health (Schiere and Ven Der Hoek, 2001).

Women's role in managing disaster mitigation strategies

Risk assessment and studies of the perception of risk abound in the area of natural disasters (See, for example, Risk Analysis: An International Journal, published by the Society for Risk Analysis, 2005; and the National Risk Assessments Project of Geoscience, Australia, 2006). This is therefore a fruitful area in which to examine gender differences, both in terms of vulnerability and in terms of mitigation. There is a large literature on risk perception of natural disasters and the analysis of vulnerability of different groups to such natural disasters. Gender perspectives in the study of natural disasters originally focussed on women as a vulnerable group, due to the fact that gender inequalities in human rights, political and economic status, ownership of assets, level of education and health, and exposure to violence make women more vulnerable before, during and after disasters (UN DAW, 2001) . However, more recent work also shows that women have a larger role in disaster mitigation and post-disaster reconstruction than previously understood and that this is expanding through action by women's networks (UN DAW, 2001) . This awareness in the literature has come about due to recognition of two aspects of women's roles: as caregivers, and as active agents and not just as victims (UN DAW, 2001).

Studies of what happens in the aftermath of disasters where housing, infrastructure and means of livelihood are destroyed show that 95 percent of rescues are carried out by local people before emergency responders from outside arrive on the scene. Women are active in communities and households but can often be marginalized by relief agencies. Women in areas as far apart as Bosnia, Guatemala, India and Turkey build shelters and houses, dig wells and ditches, and otherwise take a leading role. Although some non-governmental organizations and international relief agencies do not recognize local women's efforts, others are beginning to provide them with the support, skills, information and contacts they need to play an active role in disaster mitigation and response. One example is the Foundation for the Support of Women's Work in Turkey, where women played a strong role in the aftermath of the major earthquake in 1999. Risk mitigation strategies in general thus offer the opportunity to empower women through recognition of their efforts to transform their care-giving roles into new initiatives (UN DAW, 2001; PAHO, 2001).

There is a parallel here with the opportunities presented by women's care-giving role in mitigating health risks, including those associated with urban agriculture. For example, in response to the cholera epidemic in Latin American towns in the last century the "glass of milk movement" started by women to make sure their children were fed, immediately took on the tasks of improving sanitation and hygiene as well. Women's groups responded faster and more effectively than governments and relief agencies, to combat the spread of cholera and ensure that children were properly nourished as well as protected against the disease. The work encompassed sanitation improvements as well as feeding centres providing milk in the slums, and spread across national boundaries through women's networks (Mazingira, 1992; Machada, 1994).

Conclusion and recommendations for mitigation strategies

Available (but limited) data from Africa, mostly from East Africa, suggest that both men and women are aware of many of the health risks associated with urban agriculture, although they are often not able to do much to mitigate these risks due to poverty and the lack of alternative means of livelihood or survival. There appear to be many subtle differences between the perceptions and strategies adopted by men and women, due to the different roles assigned to them because of their gender.

Although the data are extremely limited, it appears from the cases studied that women, more than men, are aware of the details of waste management in homes and communities, as well as of food and water supply to the home, because they are more often occupied in household and domestic chores. It is possible that women may have more awareness of health risks from UA because of this, although there is no evidence from data to support such an assumption at present. Nevertheless, it is recommended that communication strategies for health risk mitigation target women specifically, or at the very least ensure that they are included, especially in relation to the handling of wastes, in the expectation that this is the main route which could influence the knowledge being acted upon.

My observations from field studies show that some urban populations seem to be well aware of the following risks associated with urban agriculture:

- Pathogens in wastewater, associated with poor sanitation
- Chemicals, such as petrol, discharged into wastewater by nearby industries and enterprises using chemicals, including motor vehicle workshops
- Trapped puddles of water providing breeding grounds for malarial mosquitoes

It seems possible that perceptions about waste management strategies may be shifting with urbanization. Whereas some rural and urban Kenyan women in the early 1990s failed to distinguish between organic and inorganic waste, an urban population in Uganda ten years later distinguished these very well and adopted corresponding strategies. It is possible that the urban population interviewed had been exposed to public information campaigns or extension services that created awareness. This is a very important area for further study. Changes in waste management practices are essential for risk mitigation in UA, so an understanding of what has changed people's attitudes is essential. If public sector or NGO information and extension campaigns are effective in creating changes in perceptions, these should be continued and expanded.

However, as people cannot always act on this knowledge, due to poverty, information campaigns are not the most effective ways of mitigating these kinds of risks. Affordable and alternative systems of sanitation, public sector involvement in the upgrading of informal settlements (including provision of a cheap and clean water supply), and support for self-help organizations in the community to improve drainage and hygiene would be much more effective. Similarly, the public sector needs to establish or enforce environmental controls on toxic discharges into wastewater drains and river systems.

Although it has been shown clearly that some people are aware of risks but forced by poverty to overlook them, the data seem to indicate that some urban populations are unaware of the health risks associated with livestock-keeping. It is possible that people may not be as aware of the risks of disease transmission from animal wastes as they are of the risks from human wastes. There may be a similar lack of awareness of the risks of close contact between humans and animals. The data suggest that quite a lot could be achieved through public information dissemination on the risks of disease transmission through livestock keeping.

Although urban dwellers may be aware of health risks, they may be unable or unwilling to avoid them. As discussed above, values, as well as knowledge, can play a role. Poor people may be so constrained by the need to survive that they make a trade-off and take risks with their health, as in the case of people getting water from someone else's drain. This does not mean that the same people would not adopt a strategy to avoid the risk if they were given some encouragement, and technical or financial support. Here the concept of empowerment becomes quite useful. Literature from a related field of risk assessment, that of natural disasters, suggests that poor people, and women especially, will adopt mitigation strategies and manage risk effectively when opportunities are given to do so.

The data presented, though limited, suggest that, in addition to technical and financial support to provide basic water and sanitation services, an approach must be taken that combines information dissemination with empowerment of low-income groups, especially women. Such groups need to be empowered to work out risk management strategies, and need to be provided with appropriate support mechanisms. Knowledge and infrastructure are key for the mitigation of health risks in the context of urban agriculture.

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Dr. Diana Lee-Smith was the Research and Development Coordinator for Urban Harvest, Sub-Saharan Africa, 2002 - 2005. Urban Harvest (formerly SIUPA, the System-Wide Initiative on Urban and Peri-Urban Agriculture, of the Consultative Group on International Agricultural Research, CGIAR) is hosted by the International Potato Centre (CIP). Originally from UK but resident in Kenya for over 30 years, Dr. Lee-Smith holds a Doctoral degree in Architecture and Development Studies from Lund University in Sweden. As a founding member of the Mazingira Institute, an independent research body in Kenya, she was involved in the first national survey of urban agriculture in 1985, and has published widely on the subject. Her writings on urban agriculture have appeared in both academic and popular journals and magazines, including Third World Planning Review and Ecodecision. She has also produced conference papers and publications on urban agriculture, such as "Urban Food Production: A Survival Strategy of Urban Households," and has promoted the area in her activities in other areas of urban work, especially while working at the United Nations Centre for Human Settlements (UN-Habitat) from 1998 to 2001.

PART II – WORKSHOP PROCEEDINGS

Day 1

Opening session

ANA BOISCHIO, IDRC

The session was chaired by Ana Boischio, Programme Officer at the International Development Research Centre (IDRC), Ottawa, Canada. She introduced the panellists of the opening session and thanked the regional office of CIP, the International Potato Centre, whose Urban Harvest programme based in Nairobi worked on the organization of the workshop. Urban Harvest, formerly known as SIUPA, is a system-wide initiative of the Consultative Group on International Agricultural Research (CGIAR). SIUPA is supported by IDRC. She particularly thanked Diana Lee-Smith, the Urban Harvest Regional Coordinator, and her assistant, Peter Kingori.

Welcome

CONNIE FREEMAN, Regional Director, Eastern and Southern Africa Regional Office, International Development Research Centre (IDRC), Nairobi, Kenya

Ms Connie Freeman welcomed all delegates to the workshop. She informed participants that IDRC has been working for over 30 years in Asia, Africa and Latin America. Since consolidation of the Southern Africa programme, the regional IDRC office in Nairobi oversees activities in 24 countries in Eastern and Southern Africa. IDRC has a broad range of programmes in Environmental and Natural Resource Management, Social and Economic Equity, and Information and Communication Technologies For Development. IDRC's mandate includes support to facilitate research to be done by Africans, grounded in the local environment and based upon what local people think is right. IDRC mainly supports research activities in the Southern countries, where the work is actually taking place.

She said she was delighted to open this session on urban and peri-urban agriculture (UPA) and stressed that UPA is "here to stay". As agriculture cannot be taken out of cities, it is something we need to deal with and make work in a healthy and sustainable way. This, she said, is what this workshop is about: to look at the health risks and benefits of UPA. Participants will share knowledge, of which there is plenty, and will work to identify gaps in that knowledge and set up research in priority areas. She warned that solutions to development are not straightforward.

She stressed that development is a multidisciplinary process that is often hard to get a handle on. IDRC programmes are already multidisciplinary in nature, such as 'Eco-health', 'Cities feeding people' and now 'Urban and peri-urban agriculture'. Workshop activities have been planned to look at health aspects of UPA, find solutions that will both broaden and narrow the topic, and find the intersection point. Another goal of IDRC's programmes is to 'close the loop'. Like many research organizations, IDRC for many years carried out research, organized conferences and published books, but it now wants to close the loop between research and policy. Has research been relevant to policy-makers, development practitioners and people it is meant to help? We should make research something that we can use. A close look at the participant list shows that we are looking at the goal.

She told participants that with her background in development economics, she would be joining them in their deliberations to make policy, or its implementation, pivotal to project implementation from start to finish. She emphasized that policy or its practice should be integrated into research from the conception phase. The goal should be to establish a research agenda and methodology based on research analysis.

She wished participants the best during their deliberations.

Opening speech

JOE AKETCH, His Worship the Mayor of Nairobi, Kenya
Speech delivered by Deputy Mayor Lawrence Ngacha

Deputy Mayor Lawrence Ngacha welcomed participants to Nairobi and to the meeting. He apologized that His Worship the Mayor was not able to attend this important meeting. Councillor Ngacha informed participants that there had recently been a peaceful change in government and attitudes.

He thanked everyone for the opportunity to open this workshop. He particularly appreciated the presence of participants from Ghana, Senegal, Uganda and Zimbabwe, mentioning that the topic of urban and peri-urban agriculture was pertinent to any urban dweller anywhere in Africa. Africa is grappling with modernization, as African townships are not more than 100 years old. Other cities in the world have long traditions, some even more than a thousand years old. So this evolution is a new experience. Many city dwellers have migrated into town with their rural experience. Most keep gardens at the backyard of their houses to grow vegetables and other foods. Some even keep chickens, and yet others have started zero-grazing units. Some carry out these activities for commercial purposes, for others it is a hobby. But whatever the need to keep a market garden, if you allow too many commercial activities to take place the privilege will be abused, and the city dweller may end up with problems with health authorities.

Cities have limits to what they can provide. The countryside is still productive, and we in local authority feel that if marketing and distribution channels were improved there would be plenty of food around. If the infrastructure in the informal settlements could be improved, residents would also be in a position to meet their food needs through organized trade. It is important to look at areas of conflict between those wishing to engage in urban agriculture and those with the responsibility for maintaining good health. Some people keep pets such as dogs and cats, and these may be a nuisance to others living in the vicinity. Local authorities, cities and facilities are created because there is a common denominator. If one group suffers from the activities of another because they are sharing the homestead, those activities have become a nuisance. In other parts of the world, urban areas have designated areas for farming so that one can live in the town yet carry out farming activities in a different area.

He asked participants not to be biased when looking at ways of advising on the kind of by-laws that should be put in place and how these can be harmonized. In Kenya, Sessional Paper No 196 on industrial transformation, which extends to 2020, does not allow for urban agriculture. The position taken here is that the sanitation status in the country has not achieved the required standards. The common concern is that those engaged in this kind of agriculture deliberately block sewers to gain access to water for irrigation. The quality of food produced this way cannot therefore be guaranteed as it is not produced under acceptable hygiene standards.

Yet all is not lost for urban agriculture. Several openings come in the area of organized agriculture that involves garbage collection and recycling. These activities can help in composting; they can boost farming in other areas and help create jobs.

Councillor Ngacha hoped that participants would come up with ideas that would add value to the already existing practices, for the benefit of all urban dwellers. He wished them a pleasant stay in Kenya and fruitful discussions.

1. Keynote Presentation - Urban Management Program and UA

DINESH MEHTA, Head, Urban Management Programme, Habitat, Nairobi, Kenya

Background

The Urban Management Programme is a joint programme of UN-Habitat, UNDP and the World Bank. It provides support to cities worldwide. The programme has been going on for 8 years in 6 programme offices and in 25 regional and national institutions, working in 138 cities in 58 countries and compiling information on urban agricultural practices. Over the years, the programme has been working on innovative urban issues and new urban challenges. The programme is interested in UPA, as it is common to many cities.

It is predicted that within a few decades, close to 50% of the people in Africa will be living in urban areas. The programme aims to build the capacity of city officials and other stakeholders involved in managing cities. Its orientation is pro-poor in matters of governance. How do we make cities more pro-poor and improve governance?

Interest in UPA

Africa has witnessed one of fastest rates of urban growth. In other areas development comes with urbanization. But in Africa rapid urban growth has not resulted in economic growth. Indeed, in some African countries growth in the economy has been negative. This new phenomenon is referred to as the urbanization of poverty.

Refugees and internally displaced people have migrated or moved due to conflicts, or are moving for economic opportunity that they perceive cannot be found in the countryside. Food security therefore becomes an important aspect for the urban population. For the last 15 years, not enough attention has been paid to UPA, as it simply was not considered an urban function city managers should grapple with.

Increasingly this challenge of urbanized poverty has become an issue in our programme. Early efforts concentrated on economic aspects of the informal sector - but people in urban areas were going hungry.

Developing countries such as India also carry out urban agriculture. All vegetables sold in Mumbai are cultivated on marginal lands along the railway line. The municipal drain passes through Calcutta, and large-scale fishing is carried out in raw sewage and treatment ponds. The rivers around these areas are dry for up to eight months in a year. A major concern is, is it safe to use untreated municipal waste to grow vegetables and other plants or to carry out a fishing industry?

Areas of operation

With support from IDRC, the Urban Management Programme began pilot projects in Latin America—in the municipality of Quito in Ecuador—where cities were receptive to urban agriculture. In Quito, the programme has not tackled issues related to health risks associated with urban agriculture; rather, it has concentrated on convincing municipal authorities to put urban agriculture on their agenda. Similar work has begun in West Africa through partners in Cote d'Ivoire, Mali and Senegal. But we are still in the early days of convincing local authorities of the merits of urban agriculture.

Innovative work

The new government in Brazil is preparing a hunger map. The conventional way of measuring poverty is by using income levels. Different countries define poverty levels differently. But in Brazil the programme is defining poverty by counting how many people go hungry in a day, how many eat only one meal in a day, how many get two meals in a day, where these people live, what are the local solutions to dealing with hunger. The new government in Brazil has been so impressed with this work that there is now a national hunger project for the whole of Brazil, and it is becoming a model for cities.

With support from IDRC we moved to providing micro finance and credit facilities for those involved in urban agriculture. Success in five or six countries in Latin America has been notable and we are now looking for means of funding the programme in other selected cities.

Health risks will certainly need to be dealt with in the programme and we are interested to see how these will be overcome. We are carrying out innovative work in using land and providing shelter, and we are now moving into new areas like how cities in Africa can deal with HIV/AIDS.

The programme has started email discussion groups on urban agriculture, bringing in partners in 130 cities. We plan to gather and use the information we glean about urban agriculture and urban livestock from the varied experiences of our partners.

2. Healthy cities, UPA and environmental risk assessment

AHMED NEJJAR, Regional Adviser, Health and Environmental Unit, WHO-AFRO, Brazzaville, Congo

It is difficult to differentiate between rural agriculture on the one hand and urban and peri-urban agriculture on the other, as practices are not necessarily different. UPA, however, is playing an important role in most African countries, which early recognized its benefits - such as increased access to food and nutrition for low-income groups. In some cities UPA can provide the major share of household food consumption. For UPA to be efficient and to play its role in food security, it needs to be integrated into urban and ecological systems, and this is not always the case in African cities. Urban agriculture complements rural sources of food supply to cities. The differences in UPA practices are in the types of areas where it is practised, the product destination, and the scale of production systems.

Health and environmental risks of UPA

Health risks can result from using contaminated inputs, such as untreated wastewater, during food production. Environmental risks can result from environmental contamination, through, for example, the use of pesticides that pollute the environment, farming practices that use toxic chemicals, or livestock waste. Management of waste is a major problem in even some of the most organized cities. Much can be done to alleviate the problems associated with waste disposal, however, particularly by using low-cost biological processes.

Environmental indicators of health include

- percentage of urban residents connected to both water and sewerage systems
- per capita water use per day
- percentage of wastewater that is treated
- per capita solid waste generation
- percentage of households with garbage collection

Major health risks associated with UPA

Like rural agriculture, UPA entails risks to health of the local population if it is not managed and carried out properly. The major health risks include

- diseases associated with reusing urban wastes and wastewater
- vector-borne diseases
- diseases associated with the use of agrochemicals
- diseases associated with contamination of soil and water by heavy metals
- zoonotic diseases
- post-harvest contamination resulting from food handling and marketing

Malaria risks

Malaria has received a lot of attention in connection with UPA. Through poor environmental management, UPA has the potential to increase malaria rates. UPA can create breeding sites such as in ditches, poorly drained water surfaces caused by poor irrigation or interference with natural drainage, and uncovered water tanks. Surveys in Africa show a gradient in malarial mosquito density, from a low density in the urban centre to a high density in the urban periphery. In urban Africa, small agricultural centres are a major source of mosquito breeding and are responsible for the increasing spread of malaria. The type of crops grown also has an important effect on the malaria vector.

The World Health Organization has several programmes that seek to

- provide technical assistance at country, regional, and global levels
- enable African countries to participate in existing mechanisms for exchanging information and in networks
- assist in identifying and providing funding sources
- provide training in priority areas (chemical safety, water quality, wastewater treatment and reuse, solid waste management, food safety, etc.)

Division of Healthy Environments and Sustainable Development

There are several units and programmes under the Division of Healthy Environments and Sustainable Development (DES). These include the Environment Risk Assessment Programme, the Environment and Promotion of Health Programme, the Food Safety Unit, and the Water, Sanitation and Health Programme.

Health can be improved substantially by improving the physical, social and economic environment. The goals of DES are to

- provide countries with technical guidance on environmental health impact assessment
- strengthen environmental health measures and mitigate harmful effects
- use community-based approaches to health

The **Environmental Risk Assessment** Programme aims to

- protect human health through the control, mitigation and elimination of environmental health hazards
- assist countries to improve public health by controlling environmental risks and hazards (chemical safety, environmental health, impact assessment, water, wastes)
- work in priority areas identified for mitigation, including pesticide poisoning, food and environmental contamination, obsolete pesticides, safe use of chemicals in vector control, poison legislation, and inadequate labelling

The **Environment and Promotion of Health** Programme aims to

- assist counties implement environmental health policies; a central focus is on tools and initiatives, in particular the 'healthy settings' approach
- concentrate on activities linked to healthy cities, schools, villages, markets, etc.

The **Food Safety** Programme aims to assist member countries to ensure consumer protection and significantly reduce the incidence of food-borne illnesses.

The **Water, Sanitation and Health** Programme supports countries in providing access to safe water and adequate sanitation for all, to improve the health and well-being of the people.

3. Health risk and benefit assessment in urban and peri-urban agriculture

DONALD COLE, Associate Professor, Department of Public Health Sciences, University of Toronto, Canada

Health impact assessment

Health impact assessment (HIA) is part of environmental impact assessment. It includes both risk and benefit assessment, and risk management. It covers all areas that affect health—physical, biological, psychosocial, chemical, and socio-economic. Health impact assessment is a prospective assessment of the change in health risk (either positive or negative) reasonably attributable to a project programme or policy. It consists of identifying potential health hazards, assessing potential health effects, and implementing health safeguards.

Health impact assessment covers all potential pathways of exposure that lead to health hazards—biological (such as multiplication of salmonella), psychosocial (such as overload owing to long working hours), physical (such as internal and external injuries) and chemical (such as contact with pesticides and lead in roadside vegetables). Hazards and risks are socially constructed, because different groups have different perceptions of health. These hazards affect health in various ways:

- musculoskeletal, such as back and shoulder pain
- gastrointestinal, such as diarrhoea due to salmonella
- nervous problems, such as lead poisoning among children
- reproductive, such as congenital malformations due to pesticides
- multiple, such as nutritional status
- communicable and non-communicable illnesses, such as cancer

Susceptibility to health impacts varies according to the population: the poor are more vulnerable than the rich, men than women, children than adults, and the ill than the healthy.

Hazards can either be direct or multiplied through different cycles in various media. Media that can pass on hazards include water, sediment, dust and soil, air and terrestrial vegetation. Contaminants are passed on through foods, including breast milk.

Aims of quantitative health risks assessment (HRA)

In conducting a health risks assessment (HRA), the aim is to quantify the likely health impacts of hazardous substances, processes, actions or events. Thus one can arrive at a probability distribution of the occurrence of these likely health effects in particular populations. The assessment should indicate the uncertainties associated with such estimates, including magnitude, timing, and variation in population distribution.

The steps included in HRA are first, to identify hazards—physical, chemical, biological. Step two is to assess the intensity, frequency and duration of exposure through various media; the routes of exposure, (e.g. inhalation, ingestion, skin contact); and the number, nature and characteristics of potentially exposed people. Third, toxicity is assessed through toxicological studies in the laboratory, observational studies, and epidemiological studies of people exposed either working or living in an environment. Finally, risks are characterized deterministically with computer-assisted modelling or by using probabilistic approaches with special software.

HRA involves elaborate work on exposure assessment, toxicity information and risk characterization. It identifies hazard types as either physical, historically the focus of HRA (e.g. likelihood of injuries), chemical (e.g. cancer assessment) or, increasingly, biological (e.g. salmonella in poultry). Risk mitigation or management requires inclusive processing consistent with environmental justice perspectives, differential willingness to take or assume risks, and joint health risk assessment and management processes involving scientists, managers and the public.

Risk and benefit evaluation

Differential evaluation may underlie differences among groups, for example, food on the table vs. long-term risk of disease. Valuation can also be quantified to a common measure, for example, quality- or disability-adjusted life years. To estimate the economic burden of illness caused by hazards, consider both direct and indirect losses. Direct losses are, for example, from reduced work capacity among those infected with parasites or zoonotic infections. Indirect losses come from sick days or lost farm workdays, either for the farmers themselves or for looking after ill children. Wages to contracted workers must be paid out to replace workdays lost from sickness. Economists estimate the productivity effects of risk reduction in terms of improvement in work capacity among workers, for example, after treatment of parasitic infections and concomitant anaemia.

How to assess health risk

To assess UPA health risk of a town or city, first describe the range of agricultural practices. Gather data on the distribution of hazardous conditions and health-promoting practices. Show the relationship between conditions and the health problems. Use this information to carry out health risk and health impact assessments relevant to UPA. Estimate the value of good health—that is, what can be achieved when people are in good health. Incorporate all the above steps and factors into assessing UPA for a given town or city.

Websites with important sources of information on potential risks in UPA and for software on probabilistic approaches

- www.afro.who.int/des/pdf/healthhazard.pdf
- @Risk (www.palisade.com)
- Crystal Ball (www.crystalball.com)
- www.epa.gov/iris
- www.who.int/whr
- http://www.idrc.ca/cfp/ev-6543-201-1-DO_TOPIC.html

4. Health risks and benefits of urban and peri-urban agriculture and livestock in Kenya

ALFRED LANG'AT, Chief Public Health Officer, Ministry of Health, Nairobi, Kenya

As a policy-maker, Mr Lang'at is interested in using outcomes of this workshop. In Kenya, 80% of the population lives in rural areas. At least half of the remaining 20% lives in Nairobi during the day. In the central part of Kenya the rural population consists mainly of agriculturists; to the south, pastoralists; and to the east and southeast, those engaged in mixed farming. In the city is found a mixture of all these peoples. The ministry looks at UPA from two perspectives; its benefits and its hazards.

Benefits

UPA is a means of enhancing food security for low-income people, particularly those living in informal settlements. The low-density areas have reasonable acreage, used intensively to keep animals, which supply milk to town dwellers.

Hazards

Unfortunately, this milk is not processed but supplied raw, and unpasteurized milk products can spread diseases like brucellosis. Straying animals are not simply annoying—and politicians have always advocated killing them. Most of these strays consume industrial effluent and can cause outbreaks of swine diseases. A study done recently indicated traces of lead in pork from pigs reared in urban areas. Crops, particularly vegetables grown along highways near Nairobi and other towns, also had high levels of lead residues.

Other UPA hazards include outbreaks of infectious diseases such as typhoid and cholera. Research shows that some of these bacteria can stay within the atmosphere for up to two weeks.

Flower farms in peri-urban areas are labour intensive, and they use agrochemicals and fertilizers that pollute groundwater and boreholes. It is quite common in the city for people to block sewage lines to get water for irrigation. In other areas farmers illegally divert water for domestic use to their farms, causing water shortages.

Solutions

We need to educate people on these health issues. We need to urge farmers to engage in healthy agricultural practices whether they own the land or not. We need to exercise some control of UPA by using statutes already in place such as the Public Health Act and the Local Authorities Act.

5. Assessment of risks and benefits of UPA: nutritional and dietary perspectives

FIONA YEUDALL, Assistant Professor, School of Nutrition, Ryerson University, Toronto, Canada

Relationship of nutrition to health

Approximately 20% of the global disease burden is attributable to the joint effects of micronutrient malnutrition and lack of protein energy. Childhood and maternal under-nutrition are the result of a number of factors: underweight; lack of breastfeeding; deficiency of minerals such as iodine (causing cretinism and goitre), iron (causing anaemia and impaired vision), vitamin A (causing anaemia and impaired mental functioning) and zinc (causing impaired growth and immune system).

Benefits of urban and peri-urban agriculture

Urban and peri-urban agriculture increases availability of food and access to it, although we lack empirical evidence of this. Urban and rural diets are different in composition. Higher urban income helps make diets more diverse in urban areas. It is generally believed that malnutrition and micronutrient deficiencies are less prevalent among children in urban areas because of increased family income and access to food in the household. However, little is known about how these factors interact in urban areas and how they affect the nutritional status of the vulnerable groups.

Emerging issues

Nutrition and pollution are interrelated; for instance, lead interferes with metabolism of iron. Many questions are as yet unanswered, such as these: Do environmental contamination and chronic inflammation influence growth potential? What is the impact of antioxidant intake? Recent work in Brazil examined fruit consumption as a means to reduce methyl mercury absorption, and there is increasing interest in examining the mitigating effect of increasing antioxidant intake to counteract the deleterious effect of pollution. It is well known that smokers have increased requirements for antioxidants. We need to see how this extends to people living in contaminated environments.

Risk assessment framework

Risk assessment is a systematic approach to estimating and comparing the burden of disease and injury resulting from different risks and includes hazard identification, exposure assessment and risk characterization. Data on food consumption is required in order to assess exposure and characterize risk. Risk assessment should include a range of protective as well as hazardous risk factors. A disability-adjusted life year (1 DALY = loss of 1 health year of life) could be used to quantify the benefits of improving quality of diet and UPA.

Nutritional assessment

Nutritional assessment is used to determine the health status of persons or population groups as influenced by intake and use of nutrients. It should include (1) dietary evaluation, (2) anthropometrics measurements, and (3) functional and (4) biochemical measurements. The methods selected depend on objectives, resources and the desire of the community to participate. Some measuring tools require software for analysis. In dietary assessment, food consumption assessment can produce both qualitative and quantitative data and is expressed in nutrients and foods.

1. Dietary Evaluation

At the national level, food consumption is measured using food balance sheets; at household level use is made of a food account or inventory, a family food scale, and household food recording methods used. This method has limitations, as it does not account for waste or intra-household distribution.

For individual food consumption, food is measured by using qualitative methods such as retrospective information on food patterns over long, less-defined periods, or by assessing nutrient intake. It includes the use of food frequency questionnaires and measures of dietary diversity. Quantitative methods include measuring the quantity consumed over a specific period, using estimated and weighed recalls and records, and estimating nutrient and adequacy intake.

2. Nutritional anthropometry

Nutritional anthropometrics is a measurement of the physical dimensions and gross composition of the human body. Where chronic imbalances exist, the pattern of growth and the relative proportion of body tissues such as fat, muscle and total body water are modified. Anthropometric measuring indices include growth (height, weight) and body composition measures.

3. Functional measurements

Another tool used is functional indices, which reflect the metabolic activities nutrients support, or the homeostatic responses of organisms to regulate the body's supply of nutrients. A functional index provides a measure of the biological importance of given nutrients and assesses functional consequences of deficiency, for example, degree of adaptation to the dark can be used as a proxy measure for vitamin A deficiency. Functional indices are important when examining relationships such as between nutrition and infection, growth and immune function.

4. Biochemical measurements

Biochemical measures make use of biomarkers. These are biochemical indices that respond predictably to a given dietary component. Several have been developed for field use, using capillary blood, human milk and to a lesser extent hair and urine.

Recommendations

The contribution of UPA to food security and food and nutrient intakes needs to be quantified, to examine how income, food access and food availability interact to affect malnutrition and micronutrient deficiencies in urban areas, and to explore types of UPA (subsistence vs. income-generating activities) and typologies associated with better food and nutrient intake and food security. The trade-off between increased food security and increased risk of contamination must be further examined, as quantitative data are lacking. Having more quantitative estimates of dietary intake will help in designing better risk-assessment models related to exposure to contaminants, and also in quantifying the potential benefits incurred by reducing the risks associated with inadequate nutritional intake.

Important websites

- www.unu.edu/unupress/food/Unupress.htm
- www.fao.org/infoods/software_worldfood_en.stm
- www.ilsi.org/file/Recall.pdf
- acc.unsystem.org/scn/Publications/UN_Report.pdf
- acc.unsystem.org/scn/Publications/rwns/worldnutritionsituation.htm

6. Health risks and benefits of urban agriculture in the city of Harare

DOMBO CHIBANDA, Assistant Director of Health Services, Harare, Zimbabwe

Urban and peri-urban agriculture includes both formal and informal scales of production and its locations are diverse. Most farmers practising urban agriculture are poor and are farming on land they do not own. Urban micro-farming or agriculture encompasses home gardening of both vegetables and staple foods, micro-scale animal-keeping and semi-commercial crop and livestock production.

With their high rates of population growth and urbanization, cities in Africa face an enormous challenge in their attempts to feed urban populations.

Problems of urban agriculture

Lack of policies and regulations, or inadequate institutional frameworks means that most cities do not manage urban agriculture activities to ensure environmental protection, health, and safety. Access to agricultural inputs is limited to such inputs as wastewater and solid waste. Political and socio-cultural biases mean that too often planners view urban agriculture as an inappropriate activity for the city and one that should be banned.

Council and government departments cannot develop a piece of land where UPA is being practised; thus housing development cannot be carried out on such land. Farmers remove survey pegs when city land is prepared and council has to resurvey the stands when development is due. The urban farmers harm the environment by deliberately cutting trees. Their animals are a hazard when they obstruct motorists on carriageways, and some farming activities block storm-water drainage pipes. An incidental hazard that is increasing is that tall crops provide hiding places for criminals.

Why urban and peri-urban agriculture?

Since independence in Zimbabwe in 1980, rural-to-urban migration has intensified. High-density suburbs have become overcrowded and squatter camps are sprawling despite stringent regulations to stop their growth. Poor urban households and the unemployed can meet their food requirements only through UPA. People in these households farm for self-sufficiency and food security, for commercial production, or to generate income.

Successive droughts and economic structural adjustment programmes have worsened the earning capacity of the low- and middle-income city dwellers. Consequently, the cost of purchasing food instead of growing it has soared.

Law enforcement

In Harare, UPA is carried out on land designated or zoned for use other than agriculture. But if farmers are about to be evicted, politicians have always come to their rescue. The attitude of local authorities towards urban agriculture has shifted from unilaterally enforcing zoning regulations towards tolerating off-plot (open space) cropping. They have deliberately asked farmers to form cooperatives and identify suitable land for farming. Farmers can then subdivide for each individual the plots granted for their use.

Potential environmental impact

Water flows and hydrological regimes of rivers, wetlands and groundwater for boreholes may change as UPA increases. Agricultural chemicals washed into the water system pollute it. Stream bank cultivation leads to siltation of dams supplying the city with water. The vegetation pattern of the area is changing: off-plot cultivation doubled its area between 1990 and 1994 from slightly over 4800 to 9300 hectares, or 16.7% of the city area (home plots excluded).

Advantages

The informal sector is growing, and household incomes are increasing. The agricultural produce supplements the household food supply and improves the nutritional status of children.

Practitioners

Many UPA practitioners are women. They include landlords, unemployed or widowed women, and women whose husbands have low incomes. Cooperatives have formed in UPA, creating both group cohesion and protectionism, which keeps out others who may want to join urban agriculture. Marital status is that 65% of the practitioners are married, and 12.3% have never married.

Health impacts

Changes in ecology have allowed some disease vectors to adapt to the environment. Attributable to urban agriculture are malaria, diarrhoeal disease, leptospirosis and some incidents of pesticide poisoning, for example. Formerly, malaria was not known to occur in Harare but it is now on the increase. This could be partly due to water collecting in ridge and furrow cultivation. With increased use of fertilizers and herbicides, chemicals are being washed into the Mukuvisi River, which feeds into Lake Chivero, a water reservoir for Harare. The result is eutrophication of the lake. Stream water used to irrigate some plots is contaminated with industrial chemicals and faecal matter. Intensified cultivation may also provide food and shelter for rodents on plots.

7. Ecosystem approach to human health

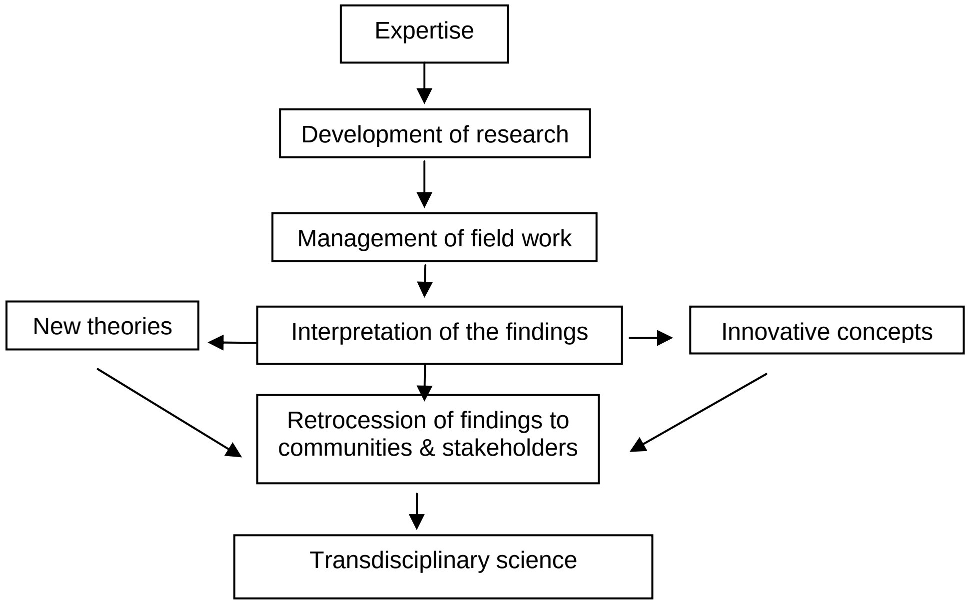
ANA BOISCHIO, Programme Officer, International Development Research Centre, Ottawa, Canada

The ecosystem approach to human health (ecohealth) examines the relation that exists between the various elements of a given ecosystem, in order to define and evaluate the priority elements of human health and the sustainability of this ecosystem. To do this, the Ecohealth program supports research that emphasizes the development of solutions based on alternative management of the ecosystem, rather than on classical target interventions of the health sector. The goal is to improve ecosystem and human health by supporting action oriented research addressing management of ecosystems, from which people depend for their livelihoods; also, by applying this knowledge to the development of the appropriate and effective interventions and policies.

Research methods

The Ecohealth research framework has three features that help to achieve this goal: transdisciplinary, a participatory approach, and a gender and social equity perspective. A transdisciplinary approach , i.e., an integration of a multidisciplinary research, requires that during the course of the research project, researchers from various disciplines use their knowledge to create a new ‘virtual discipline’ with its own hypotheses, theories, models, research protocols and methods. Multi stakeholder participation allows research beneficiaries to have influence and participate actively, on project goals and objectives, methods, and results utilization. By doing so, stakeholders including communities are taking control of the resources that affect them.

A summary of transdisciplinary and participatory strategies is provided below:



Why integrate gender?

Gender analysis provides comprehension of local knowledge and sheds light on the differences that characterize the way in which men and women cooperate and how they divide and control their resources. Through gender analysis it is possible to identify opportunities and constraints that exist because of the social roles assigned to each gender. Social and gender analysis are important to identify the power struggles, conflicts and arrangements that are characteristic among different social groups and gender relations, specifically in relation to ecosystem stressors. The social and gender equity lens permits deriving feasible policies and programmes that are socially equitable and environmentally acceptable.

8. Risk assessment of solid waste and wastewater re-use in UPA

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Risk assessment and solid waste

A typical risk assessment includes 5 components: (1) hazard identification, (2) exposure assessment, (3) dose response & evaluation of risk and influencing factors, (4) risk management and mitigation, and (5) research needs.

1. Hazard identification.

In solid waste re-use the main hazards are *a)* the risk of pathogenic infection related to excreta from humans or animals; *b)* from heavy metals; *c)* from glass splinters or other sharp objects; and *d)* the attraction of flies, rodents or other vermin.

2. Exposure assessment

Exposure assessment assesses people working directly with waste, farmers and consumers, all of whom are affected variously by these hazards, as indicated by letter:

- Waste workers: waste collectors and dump operators by a; waste pickers on dumps (a,c,d); and waste separators in compost plants (a,c)
- Farmers: farming on old dump sites (c); digging dump sites (a,c); applying compost (a,c)
- Consumers: of food produced with compost (a,b); of livestock grazing on contaminated waste (b); of water contaminated by dumps and compost plants (a,b)
- People living near dump sites or compost plants: (d)

3. Dose response

Urban areas produce many nutrients useful for soil nutrition and food production. But they carry certain health risks. Data exist on transmission of pathogens via sludge and excreta. There are, however, large variations in pathogen occurrence depending on compost and waste composition. *Ascaris* eggs are most persistent of all pathogens and can be used as an indicator of risk. For sludge or biosolids, a nematode egg standard of 3–8 eggs/g of dry solids has been suggested. Contamination of soils by heavy metals from compost is possible, but mobility and uptake are location specific and the possible long-term toxic effects in humans are difficult to predict. Several factors influence risk, that is, injury and the transmission of infections. The main ones are the survival time of pathogens, composting time and methods, type of crops grown, and cooking and food preparation habits of consumers.

4. Risk management and mitigation

The following guidelines can minimize risks related to solid waste use:

- Separating waste (market and industrial) minimizes heavy metal content.
- Treating waste through thermophilic composting, extended storage or drying, significantly reduces or eliminates the risk of transmitting gastro-intestinal infections.
- Dressing soil with untreated excreta about two months before sowing specific crops (for example, cereals) is extremely unlikely to cause infections in consumers, but it is likely to harm field workers through worm infection.
- Care should be taken in handling waste and compost by employing such protective measures as hand-wash facilities.

5. Research needs

Assess actual risk caused by heavy metals—the frequency with which they occur in waste, their mobility, availability in compost and soil, uptake by affected tropical crops, effects on humans. A topic of research could be finding viable ways of composting excreta, dried and mixed with household waste or market waste, which would both safeguard health and add high fertilizer value.

Risk assessment in wastewater re-use

Hazard Identification. Hazards in re-using wastewater include:

(a) the risk of pathogenic infection related to excreta; and

(b) heavy metals in wastewater.

Exposure assessment will consider farmers fetching and applying wastewater (*a*), traders handling contaminated crops (*a*), and consumers eating contaminated crops (*a,b*).

Dose response. Data exist on pathogens being transmitted through wastewater. There are, however, large variations in wastewater quality, as well as in levels of human immunity. Helminth eggs, again, are considered the most dangerous and are used as a hygienic indicator. A nematode egg standard of ≤ 0.1 to 1 eggs/litre of irrigation water has been suggested as allowable. Similar guidelines exist for faecal coliforms.

Crops and soils can be contaminated by heavy metals from wastewater, but where industrialization rates are low this is likely to be less important. Uptake by crops and the possible chronic and long-term toxic effects in humans remain difficult to predict.

Low- and high-risk conditions for infections show that risks are location-specific:

Low risk	High risk
Crops not for consumption	Crops eaten uncooked
Mechanized agricultural practices	Hand cultivation
Mechanized harvesting practices	Hand harvesting
Crops dried before harvesting	Movement of sprinkler equipment
Long dry periods between irrigation & harvesting/consumption	Direct contact with irrigation water

Risk management and mitigation

WHO guidelines under review focus on water treatment, protective clothing, crop restriction and safer measures for applying wastewater, such as drip irrigation. These recommendations have been considered as not applicable to many UPA situations in tropical low-income countries. The following reasons apply:

- Treatment is too expensive for municipalities.
- Local opportunities and constraints, such as land insecurity, determine the irrigation method used; drip irrigation, for example, is not appropriate.

- Market demand determines crop selection.
- Farmers oppose protective clothing (‘does not look smart’, ‘too warm’, and so on).

Research needs

- Risk quantification for farmers, traders, & consumers compared with a control group of similar wealth and occupation with special focus on pathogen immunity and actual risk.
- Identification of all risk areas (post-harvest contamination) and quantification of risk-reducing alternatives - on the farm, in the market, and for the consumer.

Conclusion - Risk assessment of wastewater and solid waste use in UPA

Closing the rural–urban nutrient loop. Urban areas produce many nutrients useful for soil nutrition and food production. But they carry certain health risks. Soil treatment through raw excreta may not be toxic to consumers, but it does put workers at risk through worm infection. Devising viable ways of drying excreta and mixing it with household waste or market waste could be a topic of research.

9. Administrative management of urban and peri-urban agriculture - health and social impacts in the Dakar area

DEMBA BALDE, Engineer, Service National de l’Hygiene, Dakar, Senegal, and SEYDOU NIANG, Researcher, Institut Fondamental d’Afrique Noire, Dakar, Senegal

Some form of market gardening has been documented in Dakar since 1937. Chicken farming, started in 1987, is mostly for family consumption. Micro-gardens were introduced in 1999. UPA has several benefits: it increases household income for the poor, provides food for the city and helps fight malnutrition. However, risks are involved such as health hazards related to the use of wastewater and pesticides, accidents caused by straying animals, and unknown quality of produce, particularly milk and eggs.

Constraints in UPA include shortage of water and the use of untreated wastewater to alleviate the shortage, lack of access to land, the health risk of zoonoses from people and animals living together.

Management interventions

To mitigate these health risks, several laws were enacted to fight against the use of wastewater in UPA, to regulate use of pesticides, and to regulate planting of crops that encourage mosquito breeding, particularly in the city. Specific

policies have also been put in place to help mitigate health risks. For example, one policy is designed to hinder the practice of UPA, and another to reduce the use of water contaminated with nitrates. Policies have also been put in place to develop low-cost water treatment systems, to re-use wastewater for UPA and to educate farmers on what crops to raise that do not result in health hazards.

Future prospects

There is a need to diversify research, to follow up and coordinate activities related to UPA in Dakar. We need to ensure that research results are widely disseminated through workshops and mass media and to educate all stakeholders—livestock keepers, market sellers and those involved in selling produce. The capability and numbers of administrative and health authorities in local communities need to be reinforced. We need to encourage and help consumer associations to structure themselves better, particularly in their relationship with authorities, to monitor the quality of foodstuffs sold. We must provide medical follow-up and vaccination against such diseases as tetanus and typhoid fever for people involved in production. Veterinary personnel need to be involved in livestock and chicken farming.

10. Assessment of malaria risks in urban and peri-urban agriculture

EVELINE KLINKENBERG, Associate Expert, Water and Health, International Water Management Institute, Accra, Ghana

City population is undergoing a rapid increase—by the year 2020, two out of three West Africans will live in urban areas. Urban agriculture (UPA) is being promoted to feed growing populations, improve nutrition and alleviate poverty. Malaria is considered a rural disease, low in incidence in urban areas. Urban agriculture, however, may create breeding sites for malaria vectors.

But is there an increased risk of malaria due to UPA? Does UPA allow malaria mosquitoes to enter the city? Mosquito breeding is confirmed in UPA sites (Accra, Bouaké, Cotonou and Dakar), as is higher mosquito density around UPA sites (Bouaké and Kumasi). But the prevalence of malaria is still unclear and data are urgently needed.

Risk factors

Rain, temperature, humidity and land-use system in place (e.g. irrigated or non-irrigated farming) affect whether a given UPA site is a conducive atmosphere for breeding sites for mosquitoes. Other risk factors are socio-economic: Socio-economic status determines people's health status, housing quality and location, and preventive mechanisms. These factors make people vulnerable to malaria at different levels.

Community risk factors include lower prevalence in urban areas, lower immunity of city dwellers, increased resistance of the parasite to antimalarials, socio-economic status, preventive measures and risk perception. Environmental factors include the creation of breeding places with UPA, particularly in irrigated farming, and resting sites in crops for mosquitoes.

Risk assessment

In assessing risk, a number of factors need to be taken into account:

- UPA communities vs. control communities
- Malaria prevalence and incidence (determined by blood-film)
- EIR: How many malarial incidents there are, as determined by analysing blood screen
- High-risk farming and irrigation practices
- The risks posed by different systems and areas

Options for control

If risks increase, breeding sites should be controlled either by managing the environment or by using biological control. Protection programmes should be put in place for the population at risk such as by promoting the use of bed nets and through educational programmes.

IWMI's past and ongoing work

A pilot study in Kumasi confirmed mosquito breeding and increased densities in and near UPA, but many questions remain unanswered. An ongoing study in Kumasi and Accra involves carrying out an epidemiological and socio-economic assessment in communities with and without UPA. And the plan is to carry out entomological surveys for another year.

11. Health risks and benefits of urban and peri-urban agriculture in sub-Saharan Africa: the Ghanaian experience

AGATHA AKUA BONNEY, Metro Director of Health Services, Kumasi, Ghana

Several factors have contributed to the growth of UPA in Ghana, including a high population of 18 million people and a drive called Operation Feed Yourself that the government promoted. The urban annual rate of growth is 4.5%, and the rural is 2.6%. This means there is a need for more food production to feed urban dwellers. People thus were encouraged to carry out backyard gardening for food and livestock production.

UPA contributes to food security, creates jobs, and contributes to the economy of urban households. Livestock production ensures that meat, chicken and other animal products are available at the doorstep of city dwellers and the green beautifies the city. However, these benefits are threatened by health risks that can contaminate produce during its growth, harvesting and distribution. Irrigation water, normal surface water and piped water stored in ground reservoirs can all lead to breeding sites for the malaria vector, and an increase in mosquito population causes transmission of the parasite, which may lead to an epidemic. For example, in irrigated sites in Kumasi there is a prevalence of *Anopheles gambiae* subspecies, the main malaria vector of the area. The use and misuse of fertilizer inputs and incorrect handling and storage of produce at points of sale also pose a risk to the health of those handling such materials.

Health risks

Different farming systems pose different health risks to the community. Irrigated urban farming creates a breeding ground for mosquitoes; 44% of outpatient department patients were infected with malaria, which is particularly common among children under five and pregnant women. Diseases that had been eliminated have resurged, for example Bancroftian filariasis. Yellow fever is also on the increase. People wading through water risk infection, as even fresh water may carry some vectors. Urban livestock farming brings to urban dwellers such infections as hookworm and diarrhoeal diseases. People are now being diagnosed and dying more frequently from microbial diseases and cancers, and a strong suspicion is that their food has been contaminated by inputs such as growth promoters and steroids used in poultry feeds.

Risk mitigation strategies

Urban dwellers and farmers need to be informed about meat and food hygiene. Disease outbreaks need to be controlled and managed through information campaigns using mass media. Human and animal health authorities and local government authorities need to collaborate, and municipal, government and local authorities should help urban farmers meet health requirements. The scope of activities to address UPA health risks should be scaled up and broadened.

Public health education. Communication strategies should include municipal health authorities and farmers; they should use person-to-person contacts, symposia, leaflets, posters, and drama. Much research has been done but it has been shelved. It is time to start disseminating our research results at the grassroots level. We need to advocate for legislation and implementation. Communication strategies should be in local dialects. Timing is also important; during the day most people are out in the fields or carrying out other activities. We also need to be aware of gender issues as we communicate.

Zoonoses control programmes are needed. In Ghana, where 80% of all ruminants are imported into the country, zoonotic diseases such as TB and brucellosis are now common.

12. Plenary Discussion – Day 1

Discussions on the presentations given ranged widely and are synthesized here under various headings to show the issues discussed at the meeting. This structure has been used for notes from all plenary discussions.

Policy

In Accra a minister gave the order that anyone caught using wastewater should be arrested. In Harare the health department ordered farmers to stop using wastewater when there were disease outbreaks in some sections of the city and not in others. In Senegal various laws have been put in place to regulate UPA. The law stipulates certain crops to be grown in UPA.

When it comes to public health, sometimes such ultimatums have to be made. But, are policies not being restrictive here? In Senegal, the crops not allowed in UPA may be those that farmers actually need. Researchers and policy makers should develop a better understanding of the poor peoples farming systems (socio-economic, biophysical, institutional) to improve on UPA.

Integrated management and multidisciplinary teams

What is the level of interaction among policy-makers? Does every department do its work independently, or do departments sit and discuss together, and if they do, what have they come up with?

There is a need to work in multidisciplinary teams to help peri-urban farmers. On the one hand are agriculturists asking farmers to improve yields? On the other, are nutritionists educating people to eat better? City councils are asking ‘farmers’ to stop making the cities unsightly, but are at the same time collecting levies from livestock farmers.

Most administrators and researchers have been operating using a top-down approach. It is now time to involve those at the grassroots to identify problems and solutions in decisions that affect them. The municipalities need to go to the people and seek their views. Unless you involve the people at the bottom they will continue with their practices until experience teaches them otherwise.

Harare has many departments within its municipality. The success of these departments depends on governance. The local authority is autonomous and reports to the Minister of Local Authority. The Authority has involved urban farmers by educating them on why they should not cultivate within 30 m of a stream or riverbank. Urban agriculture is under the Department of Housing and Social Welfare. The health department is represented in the boardroom and informs the Authority of the health issues that need to be addressed. Before, farming practices were not controlled and people ended up with many diseases. Now the same sewage is being used to irrigate crops. The municipal government has adopted the principle of ‘hazard assessment critical control path’ (or HACCP) to control UPA.

Except for Nairobi, urban centres in Kenya lie administratively within districts. Under district development committees are district agricultural boards. Nairobi is unique in that it is a province in itself. Most issues are not addressed intersectorally, but there is a committee, the Nairobi Physical Planning Liaison Committee, that has been collaborating with other departments on the physical planning of Nairobi, including on urban and peri-urban agriculture.

There is need to collaborate to coordinate research in order to avoid duplication of activities and to share resources and experiences.

Need to educate people on treatment of solid waste and wastewater

The amount of pathogens in compost depends on the age of the compost. When compost has held temperatures of 60–70 °C over a long period, the pathogens are usually destroyed. Depending on demand, farmers or people in the informal sector who compost waste for a living allow it to compost for only a short time, and so the possibility of pathogens still being present is high.

Ecological sanitation has been introduced in informal settlements in some countries. Human waste can make very good fertilizer if liquid and solid waste are separated efficiently and at least six months is allowed for it to decompose. In informal settlements, essential micro-organisms are being used in pit latrines and conventional sewage works to digest sewage and to control smell and the breeding of flies and mosquitoes.

Research should address problems and opportunities of high priority to the urban poor, and be designed with close interaction with and participation of the stakeholders and beneficiaries.

Other biological ways of treating wastewater

Convincing farmers to change from their traditional practices is not simple. There are good, low-cost water-treatment processes available that are simple to manage, do not require specialized workers, and require little maintenance. Only a little land is needed. As long as the water table is not deep, algae can be used to reduce nitrates in contaminated water, as is done in many countries in Asia. Some plants also reduce heavy metals in water. Water quality is not always known, and untreated water can contaminate food crops, particularly vegetables.

A lot of land is needed to stabilize a sewage system, especially with rapidly expanding cities. In Senegal, use is made of plants such as *Typha,* which has a high rate of transpiration, as a low-cost way of treating wastewater. These plants are grown in ponds, obviating the need for land.

Researchers and policy makers should advance environmentally sustainable and cost-effective means of addressing risks and hazards in UPA.

Use of organic fertilizers

Pesticides feature as a real problem. Can farmers opt for organic farming to mitigate the pesticide problem? How can we find out from farmers whether there is a real need to use fertilizers?

Many farmers use pesticides they do not need. Some, not knowing the difference, even use insecticide for fungicide, for instance. Researchers in Senegal are working on changing attitudes and training farmers in the proper use of both insecticides and fungicides.

In Ghana, some farmers are using neem extracts to control pests. But neem makes the product bitter. The Ghana Organic Agricultural Network (GOAN) is teaching farmers to use neem and compost. But it is bulky and inconvenient to work with, and farmers opt to use commercial NPK instead. Farmers say if they use the pesticide Dursban, it eliminates the pest, so why use neem extract, which makes a product bitter?

The need for quality control in composting waste

In Kenya research has been done on different methods of composting, which results in composts of varying quality, and with varied levels of nutrients and heavy metals. In dumpsite mining, a group sorts at the end of the dumping process, removing the inorganic material from the dump and taking the organic to use as compost. Others start the process at the beginning. The technique used affects quality. These self-help groups mine the dumpsites for various reasons, but they have little knowledge of what constitutes quality or of the risks of handling the waste. Groups should be trained so that they can both reduce their risks when sorting waste and get a better product.

Ascaris eggs are known to be very persistent and anthrax spores can survive for many years. Is this a concern in urban systems when using manure?

Anthrax kills quite rapidly and victims are safely buried. Emphasis should be on *taenia* eggs that cause tapeworm.

Research on produce and waste sites

In studies done in Uganda, UPA is carried out in areas receiving industrial water or industrial effluent. This waste has high concentrations of heavy metal compared with water in wastewater channels and discharged from households. Where pH of the soil is low, the metals are less soluble. Dumping sites have high concentrations of heavy metals but these may not be soluble because of the high organic matter content at the site.

Different plants have different abilities to take up metals. Dicotyledonous crops are found to accumulate more heavy metals than monocots such as maize. And different plant parts accumulate different levels of heavy metals. For example, maize accumulates more heavy metals in the root than in the grain, cocoyam accumulates more in the root (which is not eaten) than in the tuber and leaf, and rice accumulates more in the grain. Vegetables accumulate more in the leaf than in the root. Some leafy vegetables take up higher concentrations from the soil than do grain crops because they suffer from multiple exposure—uptake from the soil and deposition from motor vehicle and industrial emissions in the atmosphere. More research is needed to look at different plants and plant parts, and to determine which areas, such as areas away from roads, would be safer for farmers to grow crops. Maize would do well on the roadside, but the Kampala city council does not allow tall crops on roadsides.

Sources of contamination at dumping sites vary; some comes from municipal garbage, but the most risky sites for farming are those containing city metallic waste and hospital waste. The concentration of organic matter in some hospital waste is high. Studies were done in Kampala at dump sites on scrap and waste metal that was incinerated and the ash dumped on the soil. This ash had very high concentrations of heavy metals. Hospital waste is highly contaminated with aluminium and copper. A site receiving waste material from a railway workshop had high concentrations of cadmium and copper.

Research should be linked to the sustainable livelihoods of the urban poor who depend on each ecosystem.

Risk assessment of malaria in UPA

Anopheles prefers clean water for breeding and urban centres are becoming increasingly contaminated with unclean water. In general, malaria incidence is higher in rural areas than in urban areas. Most malarial mosquitoes bite at night. Only 10% are anopheles and fewer than 8% of these will cause malaria. Increased resistance to malaria medication may be due to misuse of medicines. Streams and rivers are already present in some areas, so introducing irrigation from UPA is not necessarily the cause of mosquitoes. If farmers irrigate with wastewater, the risk of malaria diminishes—the health risks with wastewater are contradictory. Crops could provide mosquito resting sites. But anopheles does not breed in maize. Research done in market gardens found that during the early crop stages, farmers leave stagnant rainwater on their farms, and these puddles could be the breeding sites.

Caution needs to be exercised about mosquitoes breeding in waste matter. An International Water Management Institute (IWMI) study found that anopheles mosquitoes occurred more frequently in home water containers. But culex mosquitoes, which transmit filariasis, breed in dirty water.

In a study done in Senegal where people are carrying out UPA, anopheles mosquitoes have been found in wells. There are two kinds of wells: shallow wells, which farmers use to irrigate crops, and deep wells, dug to provide household water. Farmers do not use wells where anopheles are present. It was noted that when wastewater was added into wells there were no anopheles, but culex were present and the risk of filariasis in these high-density-population areas is real.

The term “wastewater” also needs to be clarified. What level of purification is acceptable?

When Zimbabwe authorities killed tsetse flies and wildlife to control trypanosomiasis, the tsetse started feeding on different animals. When the host was killed the incidence of disease went down initially but the tsetse fly adapted to a new environment and before long trypanosomiasis and human sleeping sickness, which had also reduced in incidence, were back. Mosquitoes are adapting similarly. In some places, villagers tell you that when mangoes are ripe or when there is a lot of maize there is a prevalence of malaria. Malaria has also become a common ailment in some high-altitude areas where malaria had been unheard of until smallholder farming was introduced. Probably it is time researchers worked out the association between mangoes, maize and malaria. Domestic animals could be playing a role if mosquitoes feed on them.

Mosquitoes have a preference for particular breeding sites. In Kampala, for example, there are large banana plantations—has there been research on the type of mosquitoes breeding there? Data collected on mosquitoes breeding in banana plantations in backyard garden and in tyres are unpublished.

Research and research sites

It is important that experimental sites, conditions and controls be similar, and that the variables be in farming methods. In IWMI’s assessment of malaria in UPA, GPS coordinates of every household from which samples were taken were linked to the UPA site. Enhanced use should be made of geographical information systems (GIS) and other monitoring and information generating tools to aid in decision making.

Effects of health risks on UPA

How are health risks associated with farming risks in UPA?

In a study carried out in Nairobi, farmers complained of low demand for their livestock such as goats and pigs, in farm areas where animals are scavenging. Some farmers complain that guests in their homes refuse to eat their food. Urban dwellers also do not buy crops grown using wastewater, and when farmers do not have their usual market they sell their produce to unsuspecting clients. Some consumers are now aware of the potentially deleterious effects of UPA produce and are shunning it.

In Kumasi, researchers are looking for a possible cause of the increase in typhoid. An overview was carried out on the quality of vegetables in the city produced with wastewater from the north, the middle-belt and the southern parts of the country and it was found that crops irrigated with wastewater had high levels of faecal coliform bacteria - more than twice the recommended level. Fast-food sellers now prepare and sell salads with lettuce, cabbage and spring onion along the streets in Kumasi, and this may be linked to the upsurge of typhoid. We are beginning to look with concern at the many cases of people coming to hospital with Widal tests saying they have typhoid, although this could be due to the proliferation of private laboratories that occasionally come up with dubious results. More research is also being carried out on cases of jaundice, because new diseases are coming with UPA.

Policy influence

There is a need for policy on UPA. UPA is not likely to be banned, because politicians get their votes from the constituency who practice it. Similarly, only the poor person's vegetable supply would be slashed and destroyed, but local authorities will not do the same in up-market areas belonging to politicians. There is a role for the poor in producing, processing and marketing street food. Policies need to consider the role of UPA in improving the socio-economic status of the urban poor, and should aim to reduce the risks suffered by the urban poor. Polices are also needed to address this bias towards the poor.

Communication

In Ghana, health education provided in local languages using mass media helped reduce the number of cholera cases in one suburb from 557 reported cases resulting in 9 deaths in 2001 to 4 reported cases and 0 deaths in 2002. Communication on prevention of diseases is important. Concerned government agencies should be incorporated to coordinate activities in planning and implementing disease management programmes.

Gender

Women and children under five appear particularly vulnerable to disease. Men and women perceive health risks differently. Whereas a man interviewed during field research said he had not suffered from any disease and did not need protective clothing (although he was wearing gum boots), a woman farmer said she and her children were always sick from working with untreated sewage. It is important to listen to both men and women's perceptions of health risks.

Day 2

1. Assessment of health risks and benefits of urban and peri-urban livestock production in Kampala, Uganda

GEORGE W. NASINYAMA, Head, Department of Veterinary and Public Health, Makerere University, Kampala, Uganda, and collaborators

In Kampala, urban and peri-urban agriculture is a pro-poor livelihood strategy practised by the poor in urban slums and in marginal areas. The limited amount of land favours rearing small ruminants, cattle, pigs, rabbits and poultry. UPA has been recognized under a presidential initiative. However, policy on UPA and urban livestock production is lacking, resulting in adverse health effects such as disease and environmental problems (e.g. land degradation and pollution).

Many studies done on UPA address awareness or the problems and potential harm of UPA, or identify policy reforms to improve or recognize UPA. A few quantitative studies have been done to assess the risks and impact of urban livestock production (ULP) on producers and consumers, but none has been done in Kampala. In April 2002, a project was set up to 'Assess the benefits and health risks associated with ULP in Kampala'. The objectives were to characterize ULP from production to consumption in Kampala, to identify its health benefits, to assess the health risks, and to propose mitigation strategies.

Methods used

Linking UPA projects in Kampala. Three programmes exist in Uganda: Strengthening urban agriculture in Kampala (led by CIAT with Urban Harvest support); Kampala health and urban agriculture project (led by CIP with CIDA support); and Livestock health impact assessment project – zoonosis (led by ILRI with Urban Harvest and IDRC support). This presentation focuses on the zoonosis component and urban livestock production (ULP).

Process of microbiological risk assessment. This process involves hazard identification and characterization to find out what can go wrong, and the likelihood and magnitude of things going wrong, exposure assessment and risk characterization.

Risk assessment and management identifies problems, risks, options, decisions, actions and evaluation with stakeholders—farmers, market agents, policy-makers, Kampala City Council, and local government.

Benefits and hazards of urban livestock production in Kampala

ULP consists of production (food, livestock, manure), marketing (processing of animal products) and consumption (fast-food restaurants, household consumption and street vendors).

The benefits include providing food and nutritional security, and household income, generating power and taxes to local government, serving as an educational tool for schoolchildren and others to learn from, providing manure, and generating community well-being. The hazards include brucellosis and TB from milk, salmonella from eggs and chicken, jiggers from pigs, and respiratory and allergy problems from dust.

Data for exposure assessment

Quantify the prevalence and concentrations of pathogens at each stage of the pathway and the consumption pattern. Compile a household food account or inventory over a set period. Disaggregate by subpopulations.

Mitigation measures

All stakeholders should be educated in the production-to-marketing and the processing-to-consumption stages, which should guided by supportive laws and policies. At the production stage is improved management of housing, feeding (with use of growth promoters) and waste. At the processing and marketing stage, use should be made of treatment (cold/hot) and improved sanitation in handling and personal hygiene. At the consumption stage is sanitary control of street vendors.

Further insights

To understand the dynamics of ULP, it should be mapped in Kampala using GPS and GIS. Food basket studies should be carried out to obtain consumption data, and prevalence of diseases associated with ULP should be studied. The actual zoonotic disease burden in humans in urban and peri-urban areas needs to be compared with that in rural areas, and this information must then be linked with studies on animals and animal foods.

2. Community and municipal perception of health risks and benefits of urban and peri-urban agriculture and livestock: the case of Kampala City

DAN TWEBAZE, Project Coordinator, Kampala Urban Sanitation Project, Kampala, Uganda

Uganda has a population of 24 million people, 15% found in urban centres. Kampala, lying on the shores of Lake Victoria, has a population of 1.2 million residents that varies from two- to threefold between day and night.

Malaria is the leading cause of ill health. A long period of destruction from war resulted in the decay of many infrastructural facilities. Good governance since the mid-80s has resulted in economic recovery and significant rehabilitation of systems and legislature. Data for this study were collected from documents, site visits, three purposive informant interviews and researchers' own experience of the subject.

Disease status

In Kampala, malaria causes 25% morbidity and 18% mortality, particularly among children under five and pregnant women. However, age-specific disaggregated data between adults and children show AIDS is the highest killer among adults. Diarrhoeal diseases follow with 21%, and respiratory tract infections with 20%. 38% of children under five have chronic malnutrition and 5% acute malnutrition, and qualitative studies show that the urban poor have the highest rates of malnutrition in the country.

Infrastructure

Only 9% of the city is connected to a central sewer line and no expansion of the sewer system has been carried out. Most industries carry out on-site sanitation but often it is not done properly; 30% use septic tanks and the rest use pit latrines, and the waste is drained into Lakes Victoria and Kyoga and the River Nile. Blockages resulting from solid waste also pollute drainage systems.

Most urban poor settlements are located in wasteland, and the cost of constructing a pit latrine is therefore high. Kampala city generates 90 000 t of waste monthly, but only 30 000 t is collected and dumped in a central site. About 20% of the residents compost, and they could potentially use this compost for urban agriculture.

Status of UPA

In Kampala about 30% of the households practise UPA: 85% have backyard gardens that measure less than an acre; 10% have land measuring 1–3 acres; 5% more than 5 acres, commonly found within the peripheral parishes of the district; and 75% of the persons involved are women. One woman with less than an acre of land in Kampala grows tomatoes and mushrooms and keeps a cow, and in four months she earned US$ 240, which is good money in this area. However we have not done a detailed analysis to see the extent to which UPA contributes to the economy.

A number of benefits are perceived from UPA. Within the city, 40% of the food consumed and 70% of the poultry eaten were being produced by UPA, so it contributes to household food and nutritional security by providing fresh and nutritious foods. About 50% of the households within the city supplement their household incomes through UPA as either primary producers or secondary traders. Approximately 20% of the households recycle and convert biodegradable domestic waste into compost and livestock feed. UPA is also a source of revenue to the local government in the form of levies imposed on sale of products, and it provides employment opportunities for the urban population.

UPA also has perceived and potential risks. Health risks are biological such as crops being exposed to contaminated water and soils, zoonotic diseases associated with urban livestock keeping (especially with cows), and hazards from direct application of untreated solid waste. Chemical risks include crops and agricultural produce being exposed to chemical and industrial waste. Before 1998 it was not mandatory to carry out a health impact assessment, so industries established before this time use this excuse. Physical risks include injuries (in some neighbourhoods a prevalence of tetanus has been observed), free-range livestock causing accidents or being aggressive in crowded settlements, which can result in cases of disease such as rabies. Psychosocial risks include conflicts (in Kampala residents have taken each other to court over stray pigs), land tenure issues, insecurity, stigmatisation, and harassment by law enforcers because previous laws did not recognize urban agriculture. Environmental risks include vector breeding and epidemic outbreaks brought on by poor farm waste disposal methods, encroachment upon or destruction of wetlands, and misuse of agro-chemicals.

Recommendations

Optimize benefits and minimize negative effects on health from UPA by focusing on generating and disseminating information, inaugurating and monitoring regulatory mechanisms, using health management information systems, forming partnerships between policy-makers and urban farmers, networking with stakeholders, and considering issues of gender and susceptibility to disease**.**

3. Risk perceptions, communication and mitigation: community participation and gender perspectives

DIANA LEE-SMITH, Regional Coordinator, Urban Harvest, formerly Strategic Initiative on Urban and Peri-urban Agriculture (SIUPA), Nairobi, Kenya

Urban farming, which has been documented since the 1980s, is a strategy to alleviate poverty. In East Africa research shows children in urban farming families are better nourished than those from non-farming families.

Health risks

The health risks of urban agriculture range widely—pathogens are found in solid and liquid waste; diseases such as malaria and those transmitted by animals result from UPA practices; heavy metals and toxic materials discharged into wastewater contaminate the soil, water and air; and occupational health hazards also exist. Available but limited data show that both men and women are aware of the many health risks associated with urban agriculture, but are often not able to do much about them due to poverty and the lack of alternative means of livelihood or survival.

In East Africa it has been observed that both men and women are subject to health risks, but women are more so. Men are involved in cash production and women in subsistence production. Women tend to be more involved in participatory appraisal strategies.

Participatory urban appraisal found people were aware of the health risks associated with using wastewater. Both men and women were aware of pathogenic contamination and of the risk of contamination but did not realize that cooking the food would remove the pathogens. Knowledge is important, but poverty constrains the ability to act on knowledge. The participatory urban appraisal of UPA in Kampala found that people were aware of health risks, but constrained by poverty.

Perceptions of solid waste and strategies for its management

Although data are extremely limited, it appears from case studies that women more than men are aware of the details of waste management in homes and communities. In both East and West Africa, women more than men are responsible for handling all domestic wastes as well as water and food supply and preparation for the home.

Communication and mitigation strategies can effectively focus on occupational health risks, and women should be targeted because woman also play a role in urban livestock keeping.

Community risk assessment

Risk assessment is always relative, and risks and benefits are traded off. The trade-offs people make depend on knowledge and values; on what people have and do not have (that is, on assets, or the lack of them), and on who they are – rich or poor, male or female, and so on.

4. Strategies for institutional partnership on risk analysis in urban and peri-urban agriculture

SHINGARAYI MUSHAMBA, Assistant Professor and Senior Programme Officer, Municipal Development Partnerships, Harare, Zimbabwe

The presentation covered the following topics: understanding the key concepts; the need for institutional partnerships in UPA; structure; typologies of partnerships. Examples of institutional partnerships were given and actors involved in the process of building institutional partnerships were identified. Key stages in the process of developing institutional partnerships were highlighted, together with factors that can contribute to the success or failure of partnerships. Recommendations on the way forward with partnerships in UPA risk analysis were also given.

Definition

Risk is the probability that a substance or situation will produce harm under specified conditions. The *risk analysis* philosophy traditionally encompasses risk assessment, risk management, risk communication and risk surveillance. *Partnership* is an agreement between two or more partners to work together to achieve common aims. It is an umbrella term for alliances, coalition, consortium, collaboration. The choice of partners lends legitimacy and credibility to the research or activity that is being undertaken. Partnerships can be carried out at the local, community or regional level; they can be formal or informal. A partnership is likely to fail if time was not invested to build it with assurances of its sustainability. Credible leadership—men and women held in high esteem in society—ensures its success. People make or break partnerships because of differences in personalities, background, level of understanding of the issues, or levels of professionalism. *Urban and peri-urban agriculture* is the production, processing, marketing and distribution of agricultural products and services in intra- and peri-urban areas using largely human and material resources, products and services found in and around that urban area.

Need for institutional partnerships in UPA

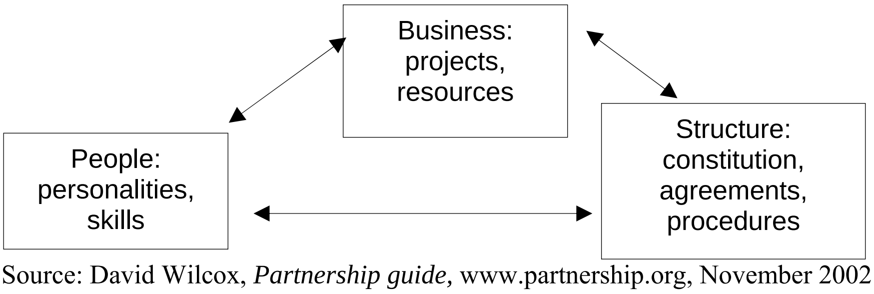
No single partner has the capacity or the competence on its own to undertake risk analysis in UPA efficiently and effectively, but partnerships can overcome the difficult obstacles the task presents. Institutional alliances can share information, knowledge and expertise.

Structure of institutional partnerships

Three main pillars constitute a partnership: business of the partnership, its structure, and the people involved (see following figure).

Typology of partnerships

We can make choices about the type and character of the partnership: will its lifespan be long term or short term? Will its scale of operation be local or global? How many partners will be involved: two or a multiplicity of partners? Will the partners cut across sectors or be drawn from a single sector?



Source: David Wilcox, *Partnership guide,* www.partnership.org, November 2002

Key actors and their roles

The Inventor articulates the vision, sells the idea, defines the focus, and should be persistent. *The Integrator* forms alliances, brings diverse people together, builds the team, listens and acts, and resolves conflict. *The Entrepreneur* identifies opportunities, frames ideas, and gathers resources—people, ideas, money, political support. *The Negotiator,* who is assertive and self-confident, prepares the facts, anticipates barriers and thinks of alternatives, is flexible but knows and observes bottom lines, maintains perspectives, and delays decisions until partners have had time to consider options. *The Manager* tracks progress and communicates changes, gets the job done, shares responsibility (including problem resolution) with others, and encourages others, making the most of their talents and skills.

Key stages in partnership building

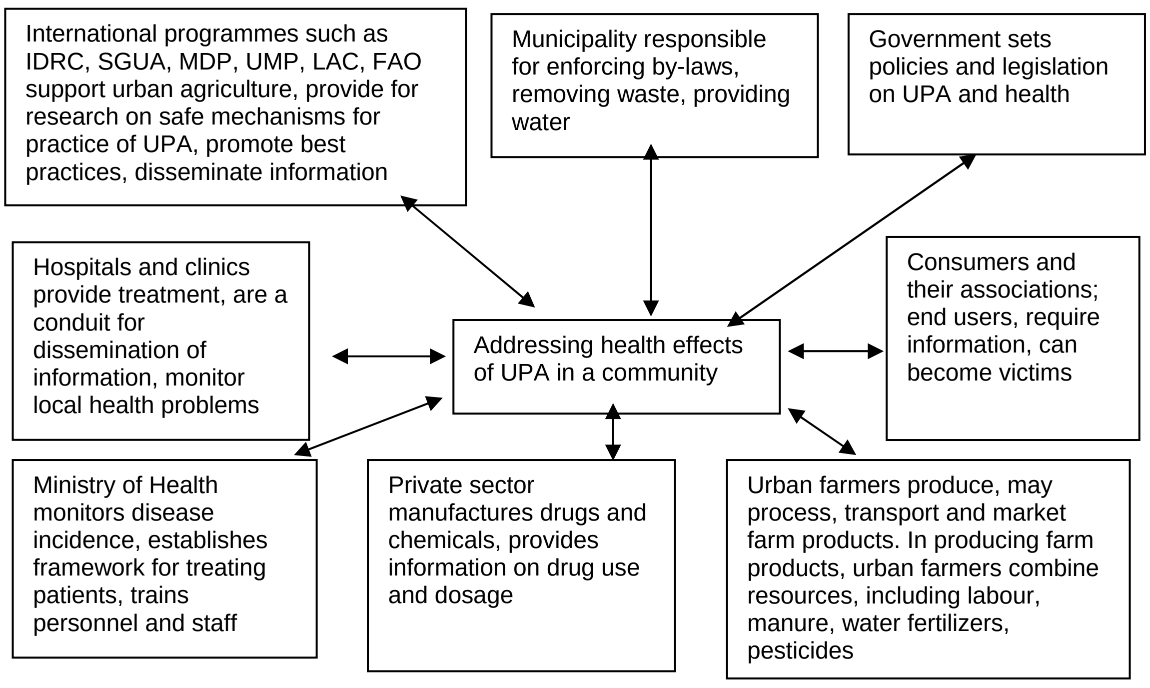
Four key stages are characterized:

1) Initiating: Individuals start the process. The spark for starting could be funding or a problem identified. The initiation should reflect the typology of the partnership desired, such as if it will be light and short term or substantial and longer term.

2) Starting: Find out what is already happening in the field. Learn lessons from other partnership on projects or ideas. Get to know the potential partners and means of working. Cultivate a vision of the undertaking, get to know its problems, projects and activities. Set up arrangements for making decisions and managing the project; make planning a joint activity.

3) Doing. Develop and start projects. Pay attention to partners and the people involved.

4) Following through or finishing. Reflect on what is working and what is not. Plan for the longer term—is the partnership still needed? What is the value added?



Need for institutional partnership in UPA risk analysis

Three main areas in UPA risk analysis require institutional partnerships. These are (1) in building partnerships to overcome insurmountable obstacles in UPA risk analysis; (2) in creating institutional alliances to achieve legitimacy and credibility and build critical mass in the risk analysis; and (3) in sharing resources, information, knowledge and expertise.

Factors that enhance success from partnerships

First, parties must agree that a partnership is necessary. The different interests must respect and trust each other. Leadership should be in the hands of a respected person or persons. Mandates or agendas must be shared, and commitment to key interests must be developed through a clear and open process that derives a shared vision of what might be achieved. Building a partnership takes time. The partners need to develop compatible ways of working, and be flexible towards each other. Good communication is essential, perhaps aided by a facilitator. Decision-making should be collaborative, with a commitment to achieving consensus. Organizational management must be effective.

Recipe for failure

These are characteristics of failed attempts at partnership, or warnings that something is going wrong: a history of conflict among key interests, one partner who manipulates or dominates, lack of clear purpose, unrealistic goals, differences of philosophy and ways of working, lack of communication, unequal and unacceptable balance of power and control, key interests missing from the partnership, hidden agendas, and financial or time commitments outweighing potential benefits.[9]

Conclusions

Institutional partnerships are necessary for effectiveness and efficiency in risk analysis in UPA. No one institution can successfully undertake risk analysis on its own. Successful partnerships in UPA risk analysis will have to be fundamentally inclusive, given the nature of roles and responsibilities in risk assessment, risk management, risk surveillance and risk communication. As such, risk analysis in UPA should bring together government, business, academic and NGO communities.

Early on, there should be careful stakeholder analysis, clarity in strategy, inclusion of key players and issues, and clear, measurable goals.

5. Benefits and health risks of urban agriculture in Nairobi: policy research issues

A.R. GACUHI, Department of Research Development, Ministry of Planning and National Development, Nairobi, Kenya
(paper was handed out rather than read, as the speaker could not attend the workshop)

Urban agriculture (UA) provides benefits to the economy, environment and well-being of both those actively involved and urban residents. It has a role to play in programmes and projects that target health and nutrition, the environment, enterprise development, income generation, water and sanitation, youth and women, and food production and supply. If Kenya has to export agricultural products to earn foreign exchange then UA can feed the urban population while rural farmers concentrate on export. With the current urban environmental crisis in Kenya, UA with intensive production technology and capacity to absorb urban waste will be essential to avert urban environmental disasters. Urban agriculture is illegal in most towns in Kenya. Where it exists in spite of the law, it is unregulated and its safety therefore not assured. Despite the benefits of UA, the risks of injury to health and environmental pollution are greater than those for rural agriculture for two reasons: urban farming systems are more intensive, and their proximity to dense human population makes mistakes or failures more costly and risky. Thus, the UA system must be designed more carefully and monitored more stringently. However, authorities have usually responded to these problems by prohibiting the farming activity rather than trying to resolve the problems. Banning UA is not an effective solution to the potential problems posed. If health and environmental problems are to be prevented, UA activities must be legalized and the institutional capacity to regulate them created or strengthened. Enforcement of existing regulations can prevent the problems. But because there are a dozen regulating agencies, coordination of monitoring and enforcement is difficult. A new partnership among central government, local government, NGOs, CBOs and farmers' associations may be the key to solving the problem. The key to unblocking the various constraints that work against UA is to increase awareness of the important role that UA can play in the urban economy.

Urbanization and urban agriculture in Nairobi

Nairobi has registered Kenya's highest rate of urbanization (4.5%) with a population of 2.2 million in 2000 projected to reach 3.2 million in the year 2010. Presently, 50% of the people in Nairobi live below the absolute poverty line of 2648 Kenya shillings per month.

Most of the urban poor are concentrated in the informal settlements and are engaged in urban agriculture. A national study of six Kenya towns including Nairobi revealed that 29% of all urban households cultivated food crops while 17% kept livestock. Recent case studies in Nairobi and Kisumu reveal that urban livestock keeping contributes to food security, income, employment generation, savings and a system of insurance, and social status. Urban agriculture is a widespread and long-established activity in Nairobi; however, it is still undervalued and public officials resist it.

Opportunities and risks of urban agriculture

Urban agriculture encompasses producing food and non-food plants and engaging in animal husbandry in both urban and peri-urban areas. The benefits of UA include the potential of providing cheap, fresh and nutritious food, and less need to package, store and transport food. It reduces the cost of collecting, treating and disposing of waste; it protects the environment and maintains open public spaces. It has the potential to create agricultural jobs and incomes, and it

[9] Source: *Building effective local partnerships, the partnerships handbook.*

gives poor consumers non-market access to food. These opportunities are important in implementing the economic recovery plan.

The risks of urban agriculture include environmental and health risks from inappropriate agricultural and aquacultural practices. Waste management approaches are needed in which collecting, sorting, treating and recycling waste take place at the community level in cooperation with local organizations. To prevent food contamination, new standards and procedures need to be instituted for processing and treating waste as well as for applying them to farming. Standards developed by FAO, WHO and some industrialized countries can provide a start.

In both urban and rural areas, the chemical and organic pollutants are of concern. In urban areas the control needs to be more stringent because farming is in close proximity to dense human activities. However, enforcement may be easier to carry out because the activities are not dispersed in remote areas and are more accessible to hygiene specialists.

Food safety standards have been published by several international agencies, but these are global and must be adapted to match our local conditions and farming systems. Regulations are needed to control which crops are grown where and which farming methods are used. The contribution of urban and peri-urban agriculture to the well-being of urban citizens is dependent upon the advantage taken from the opportunities listed above, and an awareness of how the risks can be monitored and controlled.

Policy research issues

While good qualitative and case study data exist and contribute to the understanding of UA, a more comprehensive set of basic data is needed. Surveys are needed to generate data on its current state as well as projections of its future potentials. These data are needed to convince investors, supporters and promoters of the benefits of UA and as input into the process of formulating policies and interventions for this sector. The effect of future interventions can also be measured against these baseline data. A number of broad-based surveys have been undertaken in the past few years in Kenya. It may be necessary to review the best of these, and to identify and transfer best practices, pilot projects and technologies.

Institutional capacity-building issues

In Nairobi and Kenya in general, the need is urgent to integrate UA into urban management and planning, review and recommend appropriate UA laws, regulations and standards, and develop policy and planning framework. Improving the scope of UA requires changes in government policy as well as in the functions and priorities of some agencies and institutions. National policy has an important role to play: governmental designation of UA as a beneficial urban land-use and economic activity is likely to provide critical impetus to the sector's growth and success. In Nairobi policy tends to make the practice illegal. More logical policies are needed as to the type and location of cultivation and livestock that are permitted. The choice of policy tools available to municipal and central government includes legislation, public education, structural incentives and restructuring agencies to regulate and support UA. In Kenya, UA does not come under the exclusive agenda of any ministry or government department; it therefore falls between the cracks. Coordination and information sharing are needed for a comprehensive policy approach. The appropriate department to oversee UA varies from country to country but where UA is part of a national government's agenda, it most commonly is part of the agriculture ministry. A comparative study would be useful to compare the administrative organizations and regulatory frameworks of international cities that support urban agriculture. The differences in health codes and enforcement, food regulations, environmental regulations, policies accountability waste management administration and so on should be examined. Comparative studies should provide important input in designing alternative institutional structures needed to manage UA. Training is needed to build the institutional capacity to provide effective oversight of sectoral activities. Most crucial will be training for central government and local authorities personnel who will monitor the riskier techniques used in UA. In particular, the use of solid and liquid waste in UA will need to be managed carefully.

Conclusion

As the urbanization trend continues, urban hunger is increasing, especially among the urban poor. And as cities are growing urban environments are deteriorating. AU has the potential to address hunger, poverty and urban environment degradation. Capturing the many potential benefits of UA, solving the problems associated with the poor practices associated with it, and reducing the constraints hindering its development requires policies and programmes to promote and regulate appropriate UA. Ultimately this will benefit both public and private interests.

6. Understanding environmental sanitation challenges in Nairobi

DAVID KURIA, Programme Officer, Intermediate Technology Development Group, Nairobi, Kenya

Nairobi has a population of 3 million people, of whom 60% live in informal settlements. Problems of these settlements are mainly to provide adequate sanitation and clean water. The Intermediate Technology Development Group (ITDG) aims to provide low-cost and sustainable ways to dispose of waste and to provide clean sources of water and adequate sanitation.

In the informal settlements 'toilets' are constructed in a manner such that all effluent enters the river basin. The private sector also dumps its waste into these rivers rather than make the 15-km journey to the designated dumping site. The three main rivers in Nairobi are now contaminated with human waste and industrial discharge, and yet food crops and fodder are planted along the river basin. Because of the lack of space also, a new phenomenon, flying toilets, has also taken root. Studies show there is only one toilet per 500 people in slum areas. This means families conveniently relieve themselves in paper bags and simply throw away the paper bags at night. A main problem in informal communities is to provide land to accommodate the dense human population. This lack of space has led to sanitation facilities being used in common.

With partners, ITDG is providing proper and sustainable sanitation. The main questions in provision of these facilities are: are the normal sewer and septic tank systems the only options? Are they ecologically and economically friendly? With increasing scarcity of water in Africa, should treated water continue to be used in our sanitation facilities?

The following interventions are being made in slum communities:

Integrated sanitation facility—a building with offices, dry toilets and bio-latrines. Technology transfer can help recycle grey water and produce biogas for domestic energy. The recycled water can be used for urban farming. After the methane biogas is produced, the sludge residue can be used as fertilizer for farming. Rooftops of the building can be used for agriculture. We are assessing the best technologies that can be replicated further. On the ground floor of the building is a community resource information centre that the community will manage.

Waste management—a key feature in informal management. Women and young people in slums collect garbage. How do we optimize the economic benefits? Is it possible to have an intermediate treatment or recovery mechanism? We are evaluating organic composting systems. This is key to urban agriculture, and it can contribute a lot to its sustainability. This is being done through the government of Kenya's environmental task force that also aims to legislate composting.

Plastic agglomeration and moulding—Plastics, paper, and cans are major problems in the city. We have community-managed aggregation centres in Kisumu and Nairobi. The community can recycle or treat plastic to get basic products out of it. We aim to go to the higher level of making products by moulding. Aggregation is a process of producing chips to sell to bigger companies. Moulding adds value by producing building materials such as cheap boards for building. ITDG also helps in baling and recycling waste paper to ease transportation from the small-scale collectors to the processor.

Use of wastes—for example, jewellery is being produced from bones. With the communities, we aim to explore technologies that add value to products for ease of marketing, such as making charcoal briquettes for the domestic market.

ITDG is also trying to influence legislation against flush toilets, given the growing global water crisis. It should be noted that most sewers are not treated in Nairobi and the tendency is to build them near low-income and high-density areas. And water is cheaper in high-income areas than in the low-income areas. We aim at providing options to the community that are acceptable. The community identifies different sanitation methods, identifies the site, is involved in designing and constructing the facility, and helps in constructing and managing it as an income-generating activity.

ITDG's partners include the Nairobi City Council, DFID, UNEP, the Government of Kenya, Waste-Net, Urban Harvest (formerly SIUPA), African Asian Eco-partnerships programme, UNDP and GTZ.

7. Plenary Discussion – Day 2

UPA, the rich and the poor

The notion of urban agriculture being a preserve of the urban poor may not necessarily be correct, although it is good to emphasize the link between urban agriculture and poor sections of the population. We should also not neglect the potential of UPA as an important economic sector that can contribute meaningfully to the bigger picture. In Tanzania, even ministers are keeping chickens in their backyards, so it is not simply a question of only the marginalized earning incomes from UPA. Resources like land and capital are limited and often out of reach of the urban poor. And there is a real fear that in this type of competition, the urban and peri-urban ‘poor’ producers risk being pushed out because of rising property values.

Information analysis and knowledge management

Information needs to be better analysed. In Kampala, data show that malaria causes 25% morbidity and 18% mortality, particularly among children under five and pregnant women. However, age-specific disaggregated data between adults and children show AIDS is the highest killer among adults.

The power of information is in its effective dissemination. How is this being carried out and what are the reactions of people? Do we stop the law-making process and link it with research that is coming up that analyses risks and benefits?

How can data and information be searched for in Sub-Saharan African countries?. Are you planning to develop databases on ULP diseases in Kampala? What are the problems you foresee in collecting such data?

We are planning to use an office in the Faculty of Veterinary Medicine in Makerere University as a resource centre, and we intend to create an information centre with a database on UPA. This is a monumental task as there are no systems in place. We will share this database with stakeholders; farmers, researchers, policy-makers, but this is a long-term objective. There is an urgent need for a dedicated point of information.

Who should we be addressing when talking about risk pathways? Do we consider the household or the community? Do we address women or the household head, who is usually the man of the house?

Often in health studies we consider women as the caregivers who look after the children. In our malaria study we mainly talked to the mother or the caregiver about the children’s health.

In agricultural systems, although men control the finances, it is the women who know the production systems in livestock and crops. Although more men are involved in livestock production, it is the women who inform the men about livestock disease, which means that they actually know the diseases. Another strategy would be to talk to both men and women and stimulate debate and disagreement in the process, which might translate into more information being given. It would also be useful to talk to the different groups separately.

Resources are limiting, so how do you go about interviewing everybody?

Interviewing in households depends on whom you find in the house. You may interview different people and if you find differences you will try to tie up the loose ends after the interview.

Policy

The Kampala research team has a big challenge to catch up with policy-makers who want to move on with the law-making process. Researchers do not yet have all the data they need to draft good laws. The fear is that laws being made may not be congruent with research on the ground.

In Uganda, there is a need to see what information is available to help make decisions using a bottom-up approach. It should be noted that changing a law is a process that can take up to one year, passing through the hands of different people, and during this time much can change. Decision support tools should be developed that improve access of the decision makers to the best available knowledge on the socio-economic and environmental sustainability of UPA.

Malaria and ecological sanitation

Regarding the high death rate from malaria in Uganda, what measures are the public administration taking to curb this rate? Is there a problem of resistance to medicines? What is the politics of impregnated nets? What is ECOSAN?

ECOSAN (or ecological sanitation) toilets are environmentally friendly with many benefits, are cheap to construct, and protect the environment. We have carried out demonstrations in the last six months and we hope to have finished this phase in 18 months. We are getting tremendous positive response to the use of these toilets.

We are promoting the use of impregnated nets to curb malaria infection. It should be noted that before 2001, people paid for health care and some would wait until they were very sick to come to hospital, by which time little could be done. Resistance to chloroquine is as high as 30–40% and to Fansidar 18%, but we are changing drug regimens to see which ones work. Patients have been known to come from as far as 200 km to Kampala for treatment, and this may raise the mortality figures because they have bypassed other health institutions.

Policy vs. research

Which leads, policy or research?

This is a dialectic issue: policy drives and funds research, and research results also drive policy forward. Remember that initial impressions count and motivate policy makers to respond. Information modelling should be part of any information management system and this concept is being advanced to help in better management of UPA. Existing policies will not change without evidence of success.

Waste treatment

Very often people do not distinguish between dangers involved in livestock waste as different from human waste. Livestock waste is decomposed before it is put in the field, when many of the pathogens would have been destroyed. At what level do we consider livestock waste a hazard?

Qualitative data show that when people were asked what are the health risks of keeping livestock, they failed to mention the risk pathway of proximity to the animals, although they were aware of the hazard of using livestock waste on crops that was raw or not yet decomposed, which they say ‘burns’ their crops. But they did not see that the way they handle it could be injure their health. Similar work done in Senegal shows that people are aware of the relationship between food and waste. But they do not relate insect vectors to transmission. They are also aware of waste in water and test it by tasting the water with their tongue before using it on their fields.

Gender at work

Men are more involved in cash-generating activities in UPA and women are more involved in subsistence agriculture. The men do a lot of controlling, but it is the women who do the work. Experience shows that women usually give more data as they are key in agricultural work. At least 80% of the interviewees should be women to get better results if we want to change behaviour and attitudes, because the women are also the decision-makers. If constrained by individual interviews, one could structure a few focus group discussions.

With regard to gender perspectives in handling solid waste, research is ongoing with various self-help groups in Nairobi made up of young men and women, and also older women. One group has women and male youths. The males only want to write and keep records, and the women do the mixing and turning of composting waste. In a group of young men and women, it is the men who do the manual work of handling the compost, and the women do the covering, because they feel it is dirty work to touch waste. Here the men have accepted to do the manual work, so they keep the women in the group. Is this health risk causing a division of labour?

In informal settlements in urban areas, research has shown that women manage 60% of the community assets. In Nairobi slums, most households are women headed. Research should emphasize the women. But again it should be noted that perceptions differ from community to community. We should consider the status of women in a community: are their views respected? In urban appraisals, the views of both male and female farmers are important. In some households, the man may marry a less educated partner, and will not consider her views, however valid they are.

Partnerships

It is important to dissociate personalities from projects so that if an officer leaves, there is still someone who knows what is going on. In some municipalities situations are common where some officials personalize projects. Projects should not be identified with an individual but with an institute. This can be achieved by signing a memorandum of understanding.

What is the role of the private sector and how do we involve it in promoting UPA?

The private sector manufactures drugs, chemicals, and other material resources used in UPA. They have to raise awareness by providing information on the contents and use of the products. The private sector can also help financially in carrying out a risk analysis. Local governments are regulatory bodies but the private sector is the driving force. Nakasero market in Uganda is found in the worst part of city. It is the duty of municipalities to provide for public safety and a healthy environment. Research is required to ensure that UPA farmers benefit from market opportunities through access to applicable and practical research, credit facilities, and enabling policies.

Land tenure

Informal settlements are a booming economic activity where returns are very high and landlords recover their costs within 18 months as opposed to the traditional building sector, which takes 15 years to recoup costs. That is why they are mushrooming. Some of these settlements lie on land belonging to very senior people who are resistant to making any decisions on the informal settlements.

Land tenure systems in Uganda are complicated and have historical implications. There are three systems in Kampala: public land that is well planned; freehold land such as for churches and for the few individuals who did some development on their land; and the *mailo* system, which provides settlements for individual people and this is where informal settlements have developed in the last 40 years. The mailo settlements are not city-planned frameworks, but there are slum improvement programmes to provide roads and water facilities. This is a big task, requiring much input to lay down proper policies for sustainable development. The government should take bold steps to own land. Unfortunately, most governments in Africa do not have money for most resources, including buying back land that was originally freely given.

Land should be looked at as a human rights issue. The massive urbanization has to be dealt with and land and services issues resolved.

Working Group Discussions

Workshop participants divided into three groups by theme:

Group A: Zoonosis and malaria risk related to UPA
Group B: Solid waste and wastewater use
Group C: Nutrition and diet

Each group engaged in a process of discussion and knowledge-sharing, working together for several sessions to come up with shared understandings and a list of suggestions and needs in risk management.

Groups A and B discussed hazards and exposure, health consequences and risks, and communication and mitigation strategies in risk management in relation to their themes. The nutrition group discussed dietary assessment, anthropometric measures, and communication and mitigation strategies in risk management.

Groups worked together over the course of two days, and presented their findings in a plenary session. Results from each working group are reported first, and then the main topics of the plenary discussion are presented.

1. Group A: Zoonosis and malaria risk related to UPA

1. Hazard identification: **Zoonosis (related to urban livestock)**

- Anthrax
- *Brucellosis
- *Campyllobacteriosis
- *Cryptosporidia (more serious in combination with HIV/AIDS)
- E. coli 0157 (diarrhoea)
- Echinococcosis (hydatid disease) (final host dog, tapeworm)
- Glanders
- Jiggers (pigs)
- Mad cow disease
- Newcastle disease
- Psittacosis/ornithosis
- *Salmonellosis
- Swine erysipelas
- *Taeniasis (tapeworm infection)
- *Tuberculosis

* Major illnesses are marked with an asterisk. These illnesses are then considered in a set of four tables, below. The first table characterizes the illnesses. The second table lays out ways of screening for each illness, who to partner with, and what some confounding factors are.

A third table shows research and policy gaps, and a fourth and final one addresses risk assessment, perception, and mitigation for each illness.

Table 1. Disease Characterization (Group A – Zoonosis and Malaria Risk associated with UPA)

Disease	Causative agent	Species	Lifecycle	Animal host	Transmission pathway	Disease manifestation	Susceptible population
Brucellosis	Bacterium	*Brucella abortus; B. meditensis*		cattle, goats, sheep	through milk, handling aborted material, handling uteri (abattoir), contaminated meat (improper handling in abattoir)	undulant fever, joint pains, swellings; might be under-diagnosed as symptoms could be mistaken for other common febrile diseases, especially malaria	• abattoir workers • livestock keepers • veterinary officers • consumers (raw milk, contaminated meat)
Tuberculosis	Bacterium	*Micobacterium bovis,* possibly *M. aviam*		cattle, possibly poultry (*M. avium*)	major: milk; also possible via eating (undercooked) meat	persistent cough for more than 3 weeks, chronic form: weight loss, fever, respiratory disease	• consumers • more risk for immuno-suppressed people (HIV/AIDS) • abattoir workers • meat sellers. handlers
Taeniasis	Tapeworm	*Taenia saginata, T. solium*	HCH; HPH; PHH H=human C=cow P=pig	Cattle, pigs	human–cattle or pig: eating undercooked meat, human–human: faeco-oral	loss of weight, anaemia, constipation	consumers; faeco-oral route puts children at higher risk of infection
Salmonellosis	Bacterium	*Salmonella* spp.		poultry, livestock	eating meat, milk, eggs and their products; plus contaminated vegetables	diarrea	consumers, esp. YOPI
Cryptosporidia	protozoan	*Cryptosporidia parvum*	water-borne from faecal contamin-ation	Ruminants	faecal contamination, mainly via water	diarrea	consumers, esp. YOPI
Campyllo-bacteriosis	bacterium	*Campylobacter jejuni* and others		Poultry	undercooked meat	diarrea	consumers, esp. YOPI

Table 1 cont'd. – Disease Characterization

				Sources		Problems	
Residues	pesticides, antimicro-bials			spraying of animals; failure to observe withdrawal times	meat, milk, eggs and their products, even crops	acute poisoning; drug resistance; allergies	All
				Breeding sites			
Malaria	protozoan	*Plasmodium* spp.	part in human, part in mosquito	irrigation structures (wells, furrows); banana, maize axils; resting sites in maize, hedges, etc.	bites of infected mosquitoes	fever, joint pain, headache	especially children and pregnant women

Note: manure considered under liquid and solid waste

Table 2. Diagnosis, methods and relevant factors for assessing zoonosis and malaria (Group A: Zoonosis and Malaria Risk Related to UPA)

Variable	Test	How to obtain	Partners	Confounding factors
Brucellosis				
• prevalence (yes/no) • milk consumption data • meat handling pathway • infection in cattle • infection milk • gender role • geo-coordinate sample collection cases, households	• serum agglutination test • questionnaire • ELISA • milk ring test, ELISA	• cross-sectional community survey • pathway analysis survey: community, meat handler • cross-sectional survey: cattle • some data available on brucellosis but not for UPA setting	• farmers (livestock keepers) • veterinary officers (should be trained to include Brucellosis in routine) • public health reference lab (testing and validation of results • researchers (expertise) • MOH • MOFA • municipal, local authority (technocrats and councillors) • consumers • meat handlers (butchers, cleaners, sellers (formal, informal) • development partners • NGOs • partnership between veterinary and medical doctors	• can be mistaken for malaria • what percentage of animals slaughtered from rural, urban? • what percentage of urban cattle infected? • informal slaughter places • milk from rural areas • milk ring test: vaccination will influence result • women milking? higher risk
Tuberculosis				
• prevalence and incidence of atypical TB and TB attributed to *M. bovis* • percentage of cattle infected • milk screening • geo-coordinate sample collection cases, households	• screening of people with suspected *M. bovis* symptoms by culture, PCR • PPD test • culture	• active survey in UPA communities to assess percentage of *M. bovis* • follow up TB cases from hospitals, clinics • cross-section survey: cattle • some data available on TB but not in UPA setting	as above plus TB programme	• what percentage TB due to *M. bovis?* • HIV prevalence as these patients test neg. for TB • HIV patients often have lymphadenopathy (also without having TB) and persistent cough • proportion infected milk from infected cattle around 40%
Taeniasis				
• prevalence/incidence due to which species • percentage of infected cattle • percentage of infected pigs (that eaten human faeces) • percentage meat eaten from town • geo-coordinate sample collection cases, households	• parasitological examination of faeces • post-mortem inspection, live test (antigen ELISA), pigs, physical examination of tongue • questionnaire	• cattle, pig survey • stool examination in hospitals, clinics includes type of worms to get prevalence of worm types	as above	• mistaken for other abdominal discomfort diseases and anaemia • infected meat from rural areas

Salmonellosis (non-typhoid)				
• prevalence data human, animal • concentration data in products • geo-coordinate sample collection cases, households	• culture, serotyping • molecular studies (can link food types to human prevalent types)	• cross sectional surveys • include screening of bacteria type in routine analysis in clinics, hospitals	as above	• how much produce comes from UPA setting • where does UPA produce goes • patient do not go to hospital but practise self-treatment, only in severe cases seek treatment • self-treatment with antibiotics can lead to drug resistance • source of contamination quite varied • many species of animals carry this bacteria also non livestock
Cryptosporidiosis				
• prevalence and incidence in cattle and humans • types of water sources infected (pathway analysis) • geo-coordinate sample collection cases, households	parasitological technique			• percentage attributed to UPA • types of water sources infected, e.g. run off manure fertilizer fields to streams • role of wildlife (parks) • other diarrhoea causative agents • differentiation between HIV caused diarrhoea and cryptosporidia • effect of composting unknown
Campylobacteriosis				
• prevalence in humans and animals • concentrations in foods and contact surfaces • geo-coordinate sample collection in human cases, households	• bacteriological culture • serotyping			• percentage attributable to UPA • preparation practices
Malaria				
• malaria incidence, prevalence parasitaemia • EIR (insect bites person receives over time) • breeding and resting site productivity • geo-coordinate sample collection cases, households, distance to breeding sites (GPS/GIS)	• bloodfilm • larval surveys • adult surveys	• epidemiological surveys • entomological surveys (larvae, adults) • breeding and resting site analysis (presence, importance, high-risk agric practices) • mapping • little data in entomology on prevalence, incidence related to UPA	as above plus malaria control programme	• malaria a general problem; what percentage attributed to UPA? • use of general malaria stats difficult • malaria affected by many factors • travel to rural area • other diseases that present like malaria, non-specific symptoms • other breeding sites in towns can also produce anophelines • different locations, agric practices and species

*Need: to improve laboratory diagnostic capabilities at hospitals and research facilities (universities)

Table 3. Research and Policy Gaps for Selected Illness

Disease	**Research and Policy Gaps**
Brucellosis	under-diagnosis, possibly mistaken for malaria considered disease of pastoralists and not a problem in UPA
Tuberculosis	contribution of bovine TB in human population can humans also infect cattle?
Taeniasis	faecal examination for parasites should be done routinely quantification of the problem related to UPA meat inspection of all slaughter places, esp. informal places
Salmonellosis	quantify the problem (% of diarrhoea attributed to salmonella) enforcement of by-laws on food hygiene and handling
Cryptosporidiosis	screening of water sources and humans and animals to quantify the problem
Campylobacteriosis	quantification of the problem, where, how, how much
Malaria	quantification of effect on malaria prevalence in different settings assessment of most important breeding places, e.g., relative importance UPA breeding sites, banana leaf axils as breeding sites assessment of UPA as breeding grounds in different regions
For all:	Quantification of the problem: Where, how, how much; lack of data

Table 4. Risk Assessment, Perception, and Mitigation Strategies

Risk	Level	Perception	Mitigation strategies	Challenges	Communica-tion
Contamin-ated milk or meat	house-hold	little perception in risk of zoonotic diseases; people will eat animals that died without wondering about risk; high economic value of meat and milk and other products as food	education on risk related to animal products (buy pasteurized milk, boiling milk, proper cooking of meat)	literacy rate different for men than for women	women's groups, radio, TV, health programmes at structured times in local languages to reach all, through religious bodies, print media, etc.
	house-hold	gender: women decide on food to be eaten	targeting of disadvantaged group, e.g. women (small kitchen radio)	organizing women into groups	same as above
Infected animals	house-hold	not aware of animal diseases and that they can also cause risk	• education on health risks • awareness of veterinary service • quality vet. service by continuous on-the-job training	• accessibility, availability and quality of veterinary service • urban livestock considered illegal, help not sought	
	medical staff	variable level of appreciation of zoonotic diseases by medical staff	• professional partnership between medical and veterinary sector • incorporation of zoonotic disease unit in medical training		
Contamin-ated milk or meat	commu nity, muni-cipality		legislation and enforcement of pasteurization law, meat handling laws	with promotion UPA to prevent increase in zoonotic diseases	
	Process-ing level	Not aware of the risk of their actions	• targeted education (employ TQM, personal hygiene, protective clothing) • obliged course for meat and milk handlers by local authority in conjunction with ministries (health, agric, vet) • review and enforcement of by-laws related to abattoirs	by law enforcement	
	national policy level		education on food safety should start at primary level		
	Local authority level		review and enforcement of by-laws		

Group A: Closing comments

What should be done?

- Assess attributed risk of diseases through UPA.
- Review and enforce by-laws.

Malaria

Perception: In some countries concern about mosquito breeding sites and perception of the exposure route are poor. Malaria may not always be considered a big problem (like the flu, I get it few times a year, no problem).

Mitigation: People need to be made aware of preventive measures and educated in their use. Pregnant women and children especially need these measures. The price of bed nets needs to be reduced, breeding sites filled, and a combination of environmental and biological control programmes established.

Policy level: Educational campaigns should be conducted and control programmes initiated. Environmental health officers need to go around and survey existing conditions. Bed nets should be subsidized.

2. Group B: Solid waste and wastewater use in urban agriculture

Hazard Identification

Table 1. Type of Hazard

Biological agents	Chemical Agents	Physical Hazards	Psychosocial Obstacles
Bacteria: -*V. cholera,* -*S. typhi* -*S. typhimurium* -*E. coli* -salmonellosis -*S. dysenteriae* -*Clostridium* -*Campylobacter* -*Klebsiella* **Helminths:** -ascaris, trichuris, taenia, schistosoma, ankylostoma **Viruses:** -hepatitis, polio **Protozoa:** -amoeba **Microfauna:** -larvae of *Anopheles, Culex* -cercaria	**Nutrients:** -nitrogenous compounds -phosphorus compounds -minerals -insecticides -pesticides -fertilizers -fungicides -herbicides **Heavy metals**	-sharp objects -lack of safety	-discrimination -insecurity (due to lack of safety) -lack of land tenure

Table 2. Hazards by Exposure Group

Exposure Group	Hazard Experienced	How affected	Order of Priority for Action
Farmers & workers	all hazards	dermal, inhalation, ingestion	1
Waste pickers	all hazards	dermal, inhalation, ingestion	2
Neighbours	all hazards	dermal, inhalation, ingestion	3
Consumers	chemical, biological, physical	ingestion	4
Processors	chemical, biological	inhalation, ingestion	5
Sellers	biological	dermal, ingestion	6

Consequences - Types of Hazard

Biological variables

Biochemical Oxygen Demand (BOD 5)

Faecal coliform

Faecal streptococci

Eggs/larvae of parasites

Physiochemical variables

pH, COD, macroelement (for example, N, P, K, CA2+, Mg 2+, microelements (for example Fe, Zn, Cu), heavy metals (Pb, Hg)

Agrochemicals

Organochemicals

Organochlorine, organophosphorus, pyrethrinoids, carbamates

Psychosocial: neurobehaviour

Table 3. Exposure levels to Hazards

Variable	Levels of exposure	Recommended levels
BOD5	400–1000 mg O_2/litre	2–100 mg O_2/litre
Faecal coliforms	+108/100 ml	1000/100 ml
Helminth eggs	3–2500 eggs/litre	< 1/litre
COD	7–2000 mg/litre	150 mg/litre
PH	7–8	7
NK	150–250	
Cd	0.01 mg/litre	
Pb	0.05 mg/litre	
Organochlorine	3–5 times the standard	
Organophosphates		
Pyrethrine		
Carbamates		

Terms for evaluating the situation

- Inventory of farmers using wastewater and compost (Ghana, Kenya, Senegal)
- Characterization of the type of wastewater and compost (Ghana, Kenya, Senegal)
- Level of contamination of crop—market level (Ghana); farm level (Ghana, Uganda)
- Health impact assessment at household and farm levels (Ghana, Senegal, Uganda)
- Tracing of the contamination pathway (Ghana)
- ECOSAN (Ghana, Kenya, Senegal, Uganda)
- Socio-economic analysis of farmer communities (Senegal, Uganda)
- Wastewater treatment system (Ghana, Kenya, Tanzania, Uganda)
- Experimentation on type of irrigation on crop and impact of contamination (Senegal)

What should be done

- Share experiences and methods in health in UPA
- Assess diseases attributed to UPA
- Improve knowledge and practices in UPA through partnerships of all stakeholders
- Identify barriers for partnership among all actors and enhance coordination among them
- Map urban land use to inform planners

Challenges

- Lack of clear policies for UPA
- Land tenure issues
- Quantifying real impacts of UPA
- Inadequate resources
- Use of treated wastewater
- Source separation of solid waste

Gender issues

- Gender analysis of all key variables
- Adopt gender analysis in the UPA implementation

Mitigation strategies

- Appropriate low-cost sewage water and wastewater treatment technology
- Public awareness: education on UPA health, crop and site selection, potential farming practices, food handling and hygiene, safety, and related topics
- Formulate and review policy, regulations and enforcement

Table 4. Some Actors in Risk Assessment

Level	Actors*
Hazard identification	
Exposure assessment	
Risk estimate	Researchers, farmers
Risk management and communication	Communities, government agencies, policy makers

* Depends on risk pathway and degree of exposure

Communication strategies

- Media (print and electronic)
- Community theatre
- Field trips
- Exhibitions
- Public campaign
- Workshops and seminars
- Schools

3. Group C: Nutrition and diet

The working group on nutrition and diet discussed research approach and type, as well as challenges faced with undertaking dietary assessments. They then discussed the benefits of UPA, focusing on Food Security. Finally, they considered measurement tools for nutritional assessment, and sorted these according to which element of food security they could be used to assess, and what stage of development the method is at.

1. Dietary assessment

Research Approach

- Dietary assessment is a process. Partnerships are needed once community is mobilized and the process is made ready for others to enter.
- Development must be seen as holistic and sustainable.
- The assessment is complicated and sensitive, so it must be regarded in several ways, where possible, to validate observations.
- The approach must be participatory as the community must take part in the process.
- The community is the teacher, we are the pupils.
- There are many complexities involved in sampling in urban areas.

Qualitative appraisal can include:

- Sources of food in markets (rural vs. urban production)
- Number of households farming
- Type of food bought vs. produced
- How food is classified - as a commodity, as an asset, or for consumption?
- Food security as opposed to income where a market economy does not exist. Look at frequency of hunger and frequency of use of coping strategies, in addition to household assets.

Quantitative appraisal can include:

- Recall or food frequency questionnaires
- Anthropometry tools
- Biochemical indicators

Intervention

- The community identifies its issues—it is not for us to impose our ideas.
- Find out what the community perception is. If it is not your focus, how do you negotiate?
- It is important to be sensitive as to what the problems are: for example, in Ghana water is the principal problem and you may be trying to introduce vitamin A.

Challenges

- Participatory approach: involving the community in identifying its problems and setting its priorities is the biggest challenge. One must facilitate priority setting by identifying what is of immediate benefit and what is long term.
- If the community identifies water as the first problem but you want to introduce vitamin A, you can do so with time and patience.
-

- With nutritional work the effects are not always immediately perceived, but the work can still be done, and there are examples of success (E.g. “Our children don’t cry so we can do our work”; decreased frequency of hospital attendance).

2. Benefits of UPA

It was recognized that in order for people, especially policy-makers, to recognize the value of UA, it is necessary for the benefits of UA to be quantified. Some nutritional research is quantitative and can contribute in this way. The discussion was about the many benefits of UPA.

Framing the benefits

We want to move beyond a pro-poor emphasis to farming as an economic activity. We need to quantify the contributions:

- Building of social capital: forming cooperatives and lobby groups, benefits associated with being an example of best practices and receiving visitors and increased pride
- Importance of forming partnerships: allowing dissemination and formation of data information systems plus interventions and in measuring food consumption and distribution and other interventions to be offered to participants

Food security benefits

Community food security refers to the ability of a community to feed itself and takes into account such issues as the cost of transporting food over long distances (e.g. the increase in pollution from trucking and increased food waste produced, for example when bananas are brought in from rural areas). We can quantify the savings in reduction of pollution.

- The urban harvest contributes to the city food basket. There should be a balance between imports from rural areas and food produced within city boundaries. An area for methodology development is to determine what circulates within the city and what is exported beyond city boundaries.
- Urban food production is increasing in diversity.
- Policy-makers need to be sensitized to the reality of food production. The privileged tend to be the ones who end up becoming the policy-makers, and they have often been removed from the food production system and agriculture in general and think milk comes from the supermarket.
- The amount of spoilage is reduced because the produce does not travel so far.

Economic benefits

- Urban agriculture takes advantage of a redundant workforce. It can thus reduce idleness, HIV positivity among the youth.
- It reduces the percentage of household expenditures spent on the basic necessity of food, and the money can go into such expenditures as school fees.

Nutritional benefits

- To find out more, need to survey nutritional levels of the community, household and individuals.
- Need to Identify what a meal is—food is more than nutrients.
- We need to be able to reduce food bias; i.e. determine intra--household distribution of food and seasonal effects.

Identifying the challenges

- How to handle insecure land tenure in a sector that is growing.
- Respondent fatigue: we can’t continue just to survey, we need to offer interventions, such as training and capacity building, to respondents.

3. Measurement tools for nutritional assessment

Table 1. Measurement tools for determinants of nutrition at community, household, and individual levels

Determinant	Sub-determinant	Measurement tools
Community level		
Market availability		participatory appraisal
Environmental services		participatory appraisal
Health services		participatory appraisal
Household level		
Household food availability	home production	participatory appraisal in-depth questionnaire
	distribution (consume vs. sell)	in-depth questionnaire
	income, assets including food security and coping strategies	in-depth questionnaire
Household behaviour and care	intra-household distribution	direct observation in-depth questionnaire
Household hygiene		participatory appraisal in-depth questionnaire
Individual level		
Food and nutrient intake (food security)		dietary + direct observation food calendar for children
Nutritional status (nutritional security)		anthropometry
Health status (health security)		functional, biochemical

This session worked on a framework to identify:

- data objective
- measurement tools
- strategies to reduce bias
- range of tools
- potential use of data

Measurement tools include dietary, anthropometric, and biochemical measures; participatory appraisals; in-depth studies and questionnaires; and the use of geographic information systems (GIS) to map, for example, production, consumption, anaemia rates, or prevalence of inadequate intakes.

Overall philosophy

Use a participatory approach where the community is the teacher and we are the pupils. It is import to allocate a budget for community mobilization, including formation of partnerships and potential interventions. Using mobilization as a communication method and to develop rapport is crucial if a new project needs to allocate resources or if you are selecting partners working in the communities to assist in this process.

Form partnerships to allow increased sharing and application of results, in addition to increasing the potential for offering some sort of intervention (whether through pilot demonstration sites or from other organizations where work seems to make sense to go with the intervention). In data collection, recognize respondent fatigue and the importance of having the community buy in, to ensure high-quality data.

The intervention needs to go beyond being pro-poor; it must be beneficial at multiple stakeholder levels. In an ecosystem health approach we recognize the importance of inclusivity and multiple viewpoints when we identify issues and potential solutions—always paying special attention to gender issues.

In the table below are listed some contributions of UPA to the following components of food security: availability, access, adequacy, acceptability, agency, as well as proposed interventions. Additional considerations are design issues: random selection vs. purposive selection and defining the research objective.

Table 2: Measurement Tools for Nutritional Assessment, sorted by the 5 A's of Food Security

Research question	***Components, sources, variability***	***Measurement tools***	***Data source***	***Stage of method development***
Availability				
Market availability	seasonality, prices, source of production	PUA* market survey questionnaire	market, kiosk, distribution centres, etc.	some developed, need to compile
	gender and factors related to marketing	same	Same	same
Contribution to city food basket	source of food and distance travelled	GIS combined with monitoring survey data	market agents and brokers, households	needs development and adaptation
	waste from imported food that must be managed by municipality			needs development
Increased diversity of urban food production		market survey, farm survey		compile data
Source of food	purchased, grown, gift etc	questionnaire, recall component		literature review, compile data
Access				
Distribution (consume vs. sell)	trade-offs	cost–benefit analysis		review economic literature
Income assets	how much generated beyond cash?	questionnaire		review economic literature
End use of UPA income	for school fees, health care, etc.	questionnaire		review economic literature
Percentage household budget spent on food		questionnaire		review economic literature
Household care: intra-household distribution		observation, recall, gender analysis		review literature
Household intake		observation, questionnaire		review literature
Adequacy				
Food security	incidence of hunger and use of coping strategies	questionnaire		method developed
Food/nutrient intake	source of food	recall, record		method developed
	seasonality	recall, record		method developed
	dietary diversity	questionnaire, FFQ		method developed
	dietary quality	FFQ, recall, record		method developed
	predicted prevalence inadequate intake	recall, record		method developed
Nutritional status	growth and body composition	anthropometry		method developed
Health status	biomarkers	vit. A, iron, zinc, folate, B_{12}		method developed
	common illness, health status	questionnaire, malaria, worms, clinical signs of malnutrition		method developed

Research question	*Components, sources, variability*	*Measurement tools*	*Data source*	*Stage of method development*
Acceptability				
What is a meal?				method needs development
Agency				
Cooperatives formed				method needs development
Sensitization of population to agriculture				method needs development
Building social capital				method needs development
Intervention				
Effective community mobilization				review literature
Effective communication strategies in UPA setting				method needs development
Process of coalition and capacity building				review literature
Trials of improved practices		behaviour change through communication followed by trials of improved practices		adapt methods to UPA

* PUA – participatory urban appraisal

4. Plenary Discussion – Working Groups

Research on by-products

There is a need for continued research on processed products from both backyard processors and established firms. When there was antagonism between established milk-processing plants and informal sector small-scale processors in Kenya, research was carried out in three different towns to find out whether the quality of milk from the informal sector was low, as claimed by the large processors. Analysis showed that the milk and milk products from the two sectors were in fact equally contaminated. It turned out that the established milk-processing plants simply wanted to put the informal sector processors out of business. One litre of fresh milk sold raw was sometimes cheaper than half a litre of pasteurised milk. Consumers were therefore choosing the fresh (raw) milk, which they said was creamier, had a better taste, and lasted longer. We should also appreciate that most tea consumers boil their tea with milk and water together and any pathogens present actually die in the process. So domestic preparation here has helped overcome some of the health hazards associated with raw milk. Smallholders should be helped to commercialise and this is where low-cost technologies come in, to help them overcome some trade barriers.

Research done in Kampala also showed similar results with ice cream. Urban livestock keepers also process ice cream in their backyards. The level of contamination in ice-cream products from some of the established milk processors was higher than that from backyard processors, and it is a wonder they are still operating. Consumers should be protected against health risks from animal products. The need to ensure safety standards is often ignored in backyard processing, and policies in processing should be set and standardized. Zoonosis studies should be carried out.

Nutrition

The benefits of improved nutrition are not always immediate, but qualitative research can still be done. We have examples of successes where mothers say that their children no longer cry as they did and the mothers thus have more time to do their work. Similarly, frequency of hospital attendance can also provide a measure of the health of consumers. Food is not only a commodity or asset but also must be valued as nutrition: an egg can be sold for cash or consumed as part of the diet. Studies on diet can be quite difficult to carry out as some of the questions asked are sensitive, and the approach in these studies should be more participatory.

Partnerships

If we run a risk-assessment framework we want partners to identify the different hazards. People have different perceptions of hazards in UPA, so we need to involve the community and policy-makers in identifying hazards. Several partnerships already exist between institutions and between disciplines.

Policy vs. research

We need to clarify whether through the discussions and results from this workshop we are aiming at identifying research gaps for the purpose of continuing with more research, or whether we intend to inform policy-makers on the priority issues, or are we seeking to do both - in other words to have a joint research agenda? Are we trying to come up with recommendations on actions that policy-makers should take, or are we coming up with a research agenda to be undertaken jointly by policy-makers and researchers?

The response was that IDRC supports research that informs policy, which in turn influences changes in practice for the better. This is the philosophy that underlies the workshop. Research should inform policy, and policies should be made that enable certain activities to happen. We need to raise awareness in the community about sanitation and clean water. We should aim to bridge the gap between policy and action at the community level.

Priority setting

If the community has been involved in priority setting, then the three elements, research, policy and action, should be seen to be together. They should be identifiable right from the beginning. We should be explicit about policy research and community policy agenda. It should be noted that in some places although innovation and evaluation can be carried out, policy and actions cannot be recommended to the community without involving the responsible local authorities.

On farms, priority interventions should be with the workers; in the cities it is the consumers' safety that should be a priority.

There should be careful stakeholder analysis, clarity in strategy, inclusion of key players and issues, and clear measurable goals at the beginning of any intervention. It is necessary to find out from the communities their perceptions of the problems they have and then help them to negotiate and prioritise. A researcher may go to an area to find out about the water problems, when Vitamin A deficiency is the immediate problem within the community.

Because there is a lack of data, it is difficult to prioritize issues. Policy-makers need to be provided with as much data as possible so that some characterization and decision-making can take place.

Waste management

Waste is considered a benefit in agriculture in some places. In Pakistan, areas with wastewater are three times more expensive than those without it. We need to consider the benefits of wastewater in terms of nutrients. Waste in zero-grazing units should also be considered. Research should be linked to the sustainable development of the poor who use this waste for a livelihood.

Information and communication

Appropriate information should be provided through trusted channels such as local and community radio, in language and format that the general population can understand. In Uganda, health and agricultural information is provided in the school curricula and it is hoped that the schoolchildren will ultimately pass on this information to their parents. Indigenous knowledge should also be integrated into such programs. Research and education should go together to publicise research outcomes.

Day 3 - Field visits

Field visits were made to the SOS Children's Village wastewater purification plant and to raw sewage farming site at Komarok–Kangundo road.

Site A: SOS Children's Village

The SOS Children's Home is located in Buruburu Estate in Nairobi. The village cares for and protect young children who are abandoned, neglected, abused or orphaned. It has 16 families, each with a house of its own. Each family house has a mama and each mama takes care of 8 to 10 children.

The home practises wastewater use for subsistence agricultural production. About four acres of land is irrigated using sprinkler irrigation. Wastewater from the houses and toilets within the compound is purified in stabilizing ponds using water hyacinth and water cabbage. Farming activities are carried out by the members of each family and each family has its own plot.

Site B: Komarok–Kangundo road

Sewage farms are located at Komarok–Kangundo road, about 15 km east of Nairobi city in Embakasi Division. The farmers use wastewater, which is mainly from the nearby Komarok and Kayole estates. However, the main Nairobi underground sewage system comes up to the ground at this point and farmers block it to get nutrient-rich water for crop irrigation. For a period of about three months during the rainy season, the sewage water mixes with water from a seasonal river. The sewage farms extend for a length of about 5 km along the sewer line. Farmers use rented land, which costs them between 500 to 1000 Kenya shillings per month. Plot sizes range from a few square metres to 1 acre. Given the local water shortage, to avoid conflicts over the use of wastewater, the community has divided the sewage farms into four blocks for easy regulation of water supply. Block A receives its supply on Monday, block B on Tuesday, block C on Wednesday and block D on Thursday; and the rotation starts again. The regulation is done by blocking the flow trenches using sacks filled with soil. The sewage farming community is organized into a self-help group.

Risks and hazards identified

Site A

- Risk of pathogenic organisms comes from handling raw solid waste. All waste is put together and sorted out at the site for making compost.
- Health risk from wastewater is low because the water goes through a purification process and because the crop grown is maize, which is less likely to take up the contaminants.
- Do they consume the produce locally? What percentage of their diet does this produce account for?
- Risk from injury by wild animals is low because the area is fenced.
- With the solid waste dumping upstream, runoff from the dump during heavy rains would end up in Nairobi River downstream and along its banks.
- Chemicals from household solid waste and wastewater drain into the area.
- Disease vectors? Culex mosquitoes are found in the bushes and around ponds.
- Occupational health hazards from handling solid waste are minimized as workers use gloves and gumboots and masks.
- Injury may be sustained from broken bottles sorted out from solid waste. How fast and frequently does the municipality come in to remove the unused waste?

Site B

- There is evidence of heavy metals from industries around the area.
- Although farmers say they do not get sick, the water looks as if it could contain faecal coliforms. Human waste from the sewer is strewn all over the area. Discussion with a worker at the site showed that the farmers were aware of pathogens and metals as risks to health.
- Because of the wastewater shortage, women sometimes irrigate at night and have been attacked while they were at work.
- The area was once a park where some wild animals had been kept. The owner gave up keeping wild animals and released them into the wild. The presence of hippos and crocodiles in the area is a hazard.
- Psychosocial hazards: farmers do not know when they will be asked to leave the land. They pay the landlord during the farming season but also during the dry season when no farming takes place. Previously farmers were using these farms for free, when the landlord was a member of parliament, but now, after he lost his parliamentary seat, they are paying rent. Politicians can manipulate the land tenure situation.
- The group is actually well organized. They have blocked water to enter a pool, and they then divert it from the pool into the crop fields. They are attempting to improve themselves financially. They have a common pool of resources that they were managing, and they are managing their environmental resources.

The perception of health risks and benefits is different for each of the two sites.

Benefits

Site A

- The present purification process is not expensive and should be encouraged.
- There are environmental benefits: Although much wastewater is produced, it is being re-used in a good way. In other areas, wastewater is not purified in such a series of ponds.
- All year round there is water to irrigate food crops and there is a regular supply of produce, meeting the food supply for some households.

- Educational benefits: some participants said they have not seen such good use of wastewater and the visit was enlightening. Participants were informed that various groups visit the site for educational purposes and the village is always very accommodating.
- The level of cleanliness of the water is high at the end of the recycling process.
- The many green plants growing add oxygen to the atmosphere and make the place beautiful.

Site B

- The farmers are aware that the wastewater contains some nutrients, as their crops are big and look healthy.
- The area is said to provide employment to over 2000 people, but this figure needs to be verified. Relatively old women and a number of young people were employed.
- Food supply: although the crops are produced for sale, some of the food is consumed at home.
- The farming is a source of income, which enables farmers to buy needed things and pay school fees.
- The enterprise improves sanitation in the area by diverting the wastewater and putting it to good use.
- Irrigation water from this source comes without cost. Under other circumstances, farmers may use clean water but have to pay for it.
- This source of income helps provide clothing. It was noted that the children were adequately clothed.

Challenges for further research, mitigation and control measures

Site A

- There is need to learn about the quality of purified water.
- The ponds should provide high degrees of purity.
- Sorting of household waste at source is recommended.
- The village needs help on how to manage stabilization ponds.
- They can diversify and start fish breeding and farming in the ponds.
- The area around the ponds should be cleared so that people can walk about safely.
- Unfortunately, they stopped chicken project, which produced manure; they should revive it to diversify produce.
- They need to be informed about the possible hazards of these activities.
- They could grow flowers for sale, earning money for the village.

Site B

- Use of wastewater and dealing with resource recycling could be risky. What alternative means of gaining access to water are available?
- Can underground water be exploited? Which would be safer: low-cost appropriate technologies or acquiring water to be made available to these people?
- The farmers usually plant vegetables, which pose a health risk to consumers. Industrial water should not be released while still raw. It should be treated before being released.
- It was recommended that hospitals or municipalities organize to buy one incinerator for the waste.
- If the municipality cannot use low-cost stabilization ponds or lagoons, they can carry out primary treatment of wastewater, which would get rid of 35% of Biochemical Oxygen Demand (BOD).
- Use of water hyacinth for removing pollutants and filtering can be extended to other areas.
- Marketing can be a problem as the plots are far from town.
- People are not willing to buy because they know the produce is grown using wastewater.
- There is no diversity of crops, which limits economic empowerment.
- Extension services should be provided to the farmers, for instance, on which are the right crops to grow as some crops are more likely to take up the heavy metals deposited.
- A cost–benefit analysis that considers more than just finances is needed, to compare urban agriculture with using the land for other activities.
- Have a socio-economic analysis done to determine opportunity costs.
- Challenges for research depend in part on how people (visitors) pose questions.
- Policy-makers should go to the farmers, interact with them, and find out what they are doing.

Closing Remarks

The facilitator, Ana Boischio, thanked the presenters and the participants in general for the high level of commitment and engagement in the workshop. The knowledge synthesized through the presentations, group work and plenary debate will be captured in the meeting report and circulated to everyone. Later, when the final versions of the papers are ready, an edited volume will be published. Key experts from the meeting will be invited to serve on the editorial committee.

Ms Boischio thanked the Urban Harvest programme of the International Potato Center, CIP, for its excellent logistical support, including the work of Regional Coordinator Diana Lee-Smith and her tireless assistant, Peter Kingori. She also thanked the backroom workers of CIP and ILRI for their services.

Finally, Ms Boischio announced that a few small competitive grants (about CAD 40,000) will be awarded later in the year as a follow-up to the workshop. Participants may organize teams and submit proposals. A further announcement will be made in August and circulated to the workshop participants. The subject is ‘Health risks and benefits of urban and peri-urban agriculture and livestock in sub-Saharan Africa’.

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*Contact information and affiliation have been updated as of 2006 wherever possible.

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APPENDIX B: Workshop Programme

Day 1: Monday, June 9, 2003

0900–0920	Welcome address Connie Freeman, Regional Director, Eastern and Southern Africa Regional Officer, International Development Research Centre, Nairobi
0920–0940	Keynote speech Dinesh Mehta, Head, Urban Management Programme, Habitat, Nairobi Kenya
0940–1000	Keynote presentation: Healthy cities, UPA and environmental risk assessment Ahmed Nejjar, Regional Adviser, Health and Environment Unit, WHO–AFRO, Brazzaville, Congo
1000–1020	Official opening address Councillor Lawrence Ngacha, Deputy Mayor, Nairobi City Council
1020–1040	Introduction of participants and overview of the workshop's objectives and expected outputs Ana Boischio
10.40–11.00	Coffee break
	Panel session I: Health assessment in UPA—risks and benefits
1100–1120	Health risk assessment in urban and peri-urban agriculture Donald Cole, Associate Professor, Department of Public Health Sciences, University of Toronto, Toronto, Canada
1120–1140	Health risks and benefits of urban and peri-urban agriculture and livestock in Kenya Alfred Lang'at, Chief Public Health Officer, Ministry of Health, Nairobi, Kenya
1140–1200	Assessment of risks and benefits of UPA: nutritional and dietary perspectives Fiona Yeudall, Assistant Professor, School of Nutrition, Faculty of Community Services, Ryerson University, Toronto, Canada
	Questions and discussion
1200–1220	Health risks and benefits of urban agriculture in the city of Harare
	Dombo Chibanda Assistant Director of Health Services, Harare, Zimbabwe
1220–1240	Plenary
1240–1300	Lunch break
1310–1330	Ecosystems approach to human health Ana Boischio, Programme Officer, International Development Research Centre, Ottawa, Canada
	Panel Session II: Health risks: specific issues in UPA
1330–1350	Risk assessment of wastewater and solid waste use in UPA Philip Amoah, Research Assistant, International Water Management Institute, West Africa Office
	Questions and discussion
1430–1500	The administrative management of urban and peri–urban agriculture—health and social impacts in the Dakar area Demba Balde, Engineer, Service National de l'Hygiene, Dakar, Senegal, and Seydou Niang, Researcher, Institut Fondamental d'Afrique Noire, Dakar, Senegal
	Questions and discussion
1500–1520	Coffee break
1520–1600	Assessment of malaria risks in UPA Eveline Klinkenberg, Associate Expert, Water and Health, International Water Management Institute (IWMI), Accra, Ghana
	Questions and discussion
1600–1630	Health risks and benefits of urban and peri-urban agriculture in sub-Saharan Africa: the Ghanaian experience
	Agatha Akua Bonney, Metro Director of Health Services, Kumasi, Ghana

	Questions and discussion
1630–1650	Housekeeping and wrap up
1800–	Evening cocktail reception

Day 2: Tuesday, June 10, 2003

0830–0850	Briefing on the day's agenda
	Panel session II (continuation): Health risks: specific issues in UPA
0850–0930	Assessment of health risks and benefits of urban and peri-urban livestock production in Kampala, Uganda George W. Nasinyama, Head, Department of Veterinary and Public Health, Makerere University, Kampala, Uganda and collaborators
	Discussions and Questions
0930–1000	Community and municipal perception of health risks and benefits of urban and peri-urban agriculture ad livestock: the case of Kampala City
	Dan Twebaze, Project Coordinator, Kampala Urban Sanitation Project, Kampala, Uganda
	Questions and discussion
1000–1015	Coffee break
	Panel session III: Health risks and benefits: community and institutional considerations
1015–1055	Risk perceptions, communication and mitigation: community participation and gender perspectives Diana Lee-Smith, Regional Coordinator, Urban Harvest / SIUPA, Nairobi, Kenya
	Questions and discussion
1055–1125	Strategies of institutional partnerships for risk analysis in urban and peri-urban agriculture Shingirayi Mushamba, Assistant Professor and Senior Programme Officer, Municipal Development Partnerships, Harare, Zimbabwe
1125–1205	Questions and discussion
1205–1210	Benefits and health risks of urban agriculture in Nairobi: policy research issues
	Alex Gacuhi, Department of Research Development, Ministry of Planning and National Development, Nairobi, Kenya
1210–1235	Understanding environmental sanitation challenges in Nairobi
	David Kuria, Programme Officer, Intermediate Technology Development Group (ITDG), Nairobi, Kenya
	Questions and discussion
1235–1400	Lunch break
	Group sessions
1405–1425	Group discussions—overview of discussions and outputs
1425–1625	Thematic working groups:
	Group A: Zoonosis and malaria wastewater use
	Group B: Solid waste use and wastewater use
	Group C: Nutrition and diet
	Issues to be discussed: Groups A & B: hazards and exposures
	Group C: Dietary assessment
1625–1645	Coffee break
1645–1730	Groups reporting at plenary sessions
1730–1745	Wrap up

Day 3: Wednesday, June 11, 2003

0800–0830	Briefing on field visit
0830–1200	Field visit
	Wastewater use for UPA in Nairobi – a visit to Maili Saba area
1200–1300	Lunch break
1300–1600	Group sessions: Groups A, B: health consequences and risk estimates, Group C: anthropometric measures
1600–1615	Coffee break
1615–1715	Groups reporting at plenary
1715–1730	Wrap up

Day 4: Thursday, June 12, 2003

0830–0845	Briefing on agenda for the day
0845–1045	Group sessions 3: Groups A, B, C: risk management: communication and mitigation
1045–1100	Coffee break
1100–1200	Group reporting – plenary sessions
1200–1300	Plenary discussions on synthesis of the three group sessions
1300–1400	Lunch break
1400–1500	Research priorities and gaps – the agenda
1500–1530	Evaluation of workshop and remarks from the participants
1530–1600	Wrap up and closing of workshop

APPENDIX C: Abbreviations and acronyms

AFRO	The WHO Regional Office for Africa
BOD	Biochemical Oxygen Demand
CBO	community-based organization
DFID	Department for International Development (UK)
EIR	Entomological Inoculation Rate
FAO	Food and Agriculture Organization of the United Nations
FFQ	food frequency questionnaires
GIS	geographic information system
GPS	global positioning system
GTZ	German Technical Assistance
HIA	health impact assessment
HRA	health risk assessment
IDRC	International Development Research Centre
ITDG	Intermediate Technology Development Group
IWMI	International Water Management Institute
MDP	Municipal Development and Partnerships
NGO	non-governmental organization
SIUPA	The Strategic Initiative on Urban and Peri-urban Agriculture
TQM	total quality management
UA	urban agriculture
ULP	urban livestock production
UMP	Urban Management Programme
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UPA	urban and peri-urban agriculture
WHO	World Health Organization