Health risks associated with Urban Agriculture

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1. Introduction

Urban agriculture can have both negative and positive effects on the health conditions of the urban population.
This section deals mainly with the potential negative health effects of urban agriculture. The positive aspects on health and environment are dealt with in the sections on urban food security and nutrition and the section on urban ecology respectively.
Like rural agriculture, urban agriculture entails risks to health and the environment, if not managed and carried out properly. It is essential to address the health risks associated with urban agriculture for two main reasons (Flynn 1999):

i. To protect consumers from contaminated foods and farm workers from occupational hazards; and
ii. To secure the support of municipal and national authorities for sustainable urban food production.

City authorities have often been reluctant to accept urban agriculture because of perceived health risks. Nevertheless, in most cities in developing countries, urban agriculture is practised on a substantial scale, despite prohibitive laws and regulations. Hence, rather than general laws prohibiting urban agriculture, which are largely ineffective, policies are needed that actively **manage** the health risks related to urban agriculture.

2. Overview of the major categories of health risks associated with urban agriculture

Birley and Lock (1999) make an extensive review of the literature on health issues related to urban agriculture.
The main health risks associated with urban agriculture can be grouped into the following categories:

a. Contamination of crops with **pathogenic organisms** (e.g. bacteria, protozoa, viruses or helminths), due to irrigation by water from polluted streams, or inadequately treated wastewater or organic solid waste products;
b. Human diseases transferred from **disease vectors** attracted by agricultural activity;
c. Contamination of crops and/or drinking water by **residues of agrochemicals**;
d. Contamination of crops by uptake of **heavy metals** from contaminated soils, air or water;
e. Transmission of diseases from domestic animals to people (**zoonosis**) during animal husbandry, processing or meat consumption;
f. Human diseases associated with **unsanitary post-harvest processing, marketing and preparation** of locally produced food;
g. **Occupational health risks** for workers in the food-production and food-processing industries.

Review of the available literature indicates that, although insight into the potential health risks of urban and periurban agriculture is growing, detailed information on the actual health impacts of URBAN AGRICULTURE is scant.

3. Contamination of crops with pathogenic organisms by reuse of urban wastewater and organic solid waste products

Reuse of urban organic solid waste products

The main use of solid waste is as a soil improver (household waste, market refuse, sewerage, night soil, manure, fish waste, and agro-industrial waste). Agro-industrial waste, household refuse and market waste are also used to produce feed for livestock and fish.
Composting is the most common form of processing urban organic waste products.

Composting reduces several health risks by:

- getting refuse ‘off the street’ and so reducing health hazards related to inadequate refuse collection and disposal (and associated risks such as transmission of diarrhoea and dysentery by houseflies, increased breeding of mosquitoes and contamination through scavenging animals);

- by sanitising waste through heat destruction of some pathogens, including helminth eggs found in night soil.

There are four main health risks related to the reuse of organic waste products:
1. Pathogens may not be destroyed (especially helminth eggs in night soil) if the compost is not properly prepared (too low temperature). The risk is greatly enhanced if organic materials are mixed with human excreta from latrines, manure or hospital waste, causing pathogens to breed.
2. Improperly maintained compost heaps may attract rodents (which may be reservoirs of diseases) and insects (which may be vectors of diseases).
3. Non-biodegradable fragments may cause injuries, skin infections, respiratory problems and other occupational problems of waste pickers, waste selectors and others involved in the composting process.
4. Heavy metal contamination due to mixing of organic materials with industrial waste (caused for example by occasional dumping of industrial waste in open spaces within residential areas).

Irrigation with improperly treated wastewater

Liquid waste from domestic sewage is widely used for irrigation and fertilisation of field crops, perennials and trees, biogas production, and fish ponds. A large part of the wastewater used is untreated or poorly treated.

Wastewater contains various bacteria, protozoan parasites, enteric viruses and helminths. These risks are not limited to official wastewater but often also apply to rivers and other open water sources, as indicated by figures gathered by Westcott (FAO, unpublished, cited in Birley and Lock, 1999): 45% of 110 rivers tested carried faecal coliform levels higher than the WHO standard for unrestricted irrigation.

There are many forms through which untreated wastewater can lead to human diseases in urban agriculture. Coliform bacteria are mainly transmitted to humans from contaminated wastewater that has been used to irrigate crops. Another route is by consumption of contaminated meat from domestic animals that ingested tapeworm eggs from faeces in untreated sewage. Poorly treated sewage may contain viable stages of the hookworms that live in moistened soils and affect agricultural workers who expose their bare skin to the soil.

Transmission of pathogens may also take place by fertilisation of fish ponds with human and animal waste products (e.g. overhanging latrines, overhanging poultry cages, ducks, addition of urban night soil and use of wastewater).

Furedy (1996) points out that official attitudes towards the health risks associated with reuse of urban waste products have historically changed with necessity. Furthermore, she believes that perceived health risks of the reuse of urban waste products in agriculture are overstated and that regulations concerning waste reuse are frequently outdated or lack comprehensiveness.

Armar-Klemesu et al. (1998) indicate that the major sources of bacterial contamination of fresh vegetables may draw from the distribution, handling and marketing system rather than from production.

Measures to prevent and control contamination of crops with pathogenic organisms

Main measures to prevent and control crop contamination with pathogenic organisms are the following:
- Improved intersectoral linkages between health, agriculture, waste and environmental management; well-defined priorities and joint strategies; adoption of clear waste reuse policies for urban agriculture which are based on health criteria and impact assessments of waste reuse schemes in agriculture.
- Waste separation at source; regular collection of organic refuse; prevention of mixing household waste with waste of hospitals and non-agroindustries.
- Establishment of decentralised composting sites; securing the application of proper composting methods (temperature, duration) to ensure killing of pathogens; recognition of the various informal actors involved in the processing of urban waste products and the marketing of recycled products; enabling clean water supply and sanitation services at dump and processing sites.
- Identification of quality standards for municipal waste streams and composts produced from them; monitoring of quality of soils, irrigation water from rivers and wastewater outlets, and of composts; certification of safe production areas; restriction of crop choice in areas where wastewater is used but water quality cannot be guaranteed.
- Establishment of adequate wastewater treatment facilities with appropriate water treatment technologies, e.g. waste stabilisation pond systems rather than sludge treatment plants - the former are cheaper to establish and maintain and retain more nutrients.
- Farmer education on management of health risks, for workers and consumers, associated with reuse of waste in agriculture, including:

a. avoidance of direct exposure to wastewater and soils treated with wastewater, e.g. by using boots and protective clothing, and regular washing of hands and feet;
b. adaptation of crop choice in wastewater-treated land: e.g. it is not appropriate to grow fresh salad crops such as tomato, lettuce, parsley, cucumber and mint in poorlytreated water; these could be replaced by fodder, fibre, wood and seed crops; and
c. application of drip irrigation or other localised irrigation methods (rather than sprinkler, gravity or spraying). Irrigation with wastewater must be stopped three weeks prior to harvesting.

- Consumer education, e.g. scraping and washing of fresh salads; eating only wellcooked crops, meat and fish from wastewater-fed crops, animals and ponds.

4. Diseases transmitted by disease vectors attracted by agricultural activity

Malaria occurs in many environments but particularly in areas where irrigation is practised. Malaria in relation to urban agriculture is a serious risk in Africa only. Adaptation of malaria mosquitoes to urban environments has been observed. Most malaria is found on the periphery of the cities where mosquitoes (the main one being *Anopheles gambiae*) breed in temporary water pools that contain clean, sunlit and shallow standing water in rice fields and poorly drained water surfaces (due to irrigation or interfering with natural drainage) and uncovered water tanks.
The type of crops grown and farming methods used in urban agriculture determine to a large extent whether or not urban agriculture increases malaria risks. The conditions for growing wet crops and forms of ridge cultivation (e.g. rice, sweet potato and yams) are favourable for the breeding of malaria mosquitoes. Cassava growing is only occasionally a problem, when it is grown in cultivation ridges in wet clay soil. In contrast, maize and banana crops, as well as tall grasses, present **no** particular malaria risk, as is often thought in African cities. There are many examples where authorities have traditionally justified destruction of urban crops by saying that anopheles breed in leaf axils (such as those of maize) whereas research clearly indicates the axils of maize plants are never breeding sites for malaria or any other kind of mosquito.

Filariasis is transmitted by the mosquito, *Culex quienquefasciatus*, which breeds in standing water that is highly polluted with organic matter. This occurs typically in densely populated human settlements where conditions include pit latrines, blocked sewage drains, cesspits and septic tanks, soak pits and poorly designed sewage-treatment plants. Filariasis is spreading rapidly due to urbanisation.
The Aedes mosquito, which is the main vector of dengue, breeds in water containers that include much solid waste (e.g. tin cans, coconut husks, rubber tyres, water storage jars).
Chagas disease has recently been emerging in periurban areas mainly in Latin America.
Poor disposal of organic solid waste (animal manure, crop residues and other farm refuse) may also attract rodents and flies that may be carriers of diseases (e.g. plague), and scavenging by domestic animals (e.g. cats, pigs and rats) is associated with a range of foodborne diseases such as amoebic and bacillary dysentery.

Suggested prevention and control measures

Main measures to prevent and control diseases transmitted by vectors attracted by urban agriculture are:

- Co-operation between the health sector and the natural resource management sector (solid waste management, water storage, sewerage, agriculture and irrigation) is essential to reduce vector-borne diseases. Filariasis control is not sustainable until related urban problems, such as solid-waste management, are solved in an integrated way (drains are often blocked by garbage due to ineffective collection systems). Solid waste management is also essential for the control of dengue and dysentery (as well as rodent control programmes).
- Proper design of water tanks and irrigation systems (especially in periurban areas) in order to prevent malaria.
- Application of slow-release floating formulations to control the malarial vector; mosquitoes breeding in latrines and stagnant polluted waters can be controlled effectively by the use of expanded polystyrene balls.

5. Residues of agrochemicals

Urban agriculture provides various potential exposure pathways to agrochemicals including occupational and environmental exposure and consumption. The intensive use of agrochemicals (fertilisers, pesticides, fungicides) may lead to residues of agrochemicals in crops or groundwater, and negative effects on the health of agricultural workers. Because of differences in usage, the level of risk of crop or groundwater

pollution due to agrochemicals is higher in intensive commercial horticulture, especially for vegetables, than in traditional and subsistence farming (WHO Commission on Health and Environment 1992). Acute poisoning due to agrochemicals can cause a range of symptoms which are often not correctly diagnosed (e.g. dizziness, diarrhoea, headache, memory impairment, convulsions, coma, liver and kidney impairment and lung fibrosis). Ingestion of agrochemicals is a common way of committing suicide throughout the world. Chronic illnesses have been associated with residues in foodstuffs due to concentration of agrochemicals in the food chain, including vegetables, red meat, poultry and eggs, and residues can be found in human milk (FAO and WHO 1988).

Prevention and control measures

Measures to orevent and control crop contaminsation by residues of agrochemicals include:

- Farmer education on the proper management of agrochemicals;
- Promotion of ecological farming practices and replacement of chemical pest and disease control by IPM (integrated pest and disease management);
- Better control of sales of banned pesticides;
- Introduction of cheap protective clothing and equipment; and
- Monitoring of residues of agrochemicals in groundwater.

6. Uptake of heavy metals from contaminated soils, water and air

The main causes of soil pollution from heavy metals (including lead, cadmium, chromium, zinc, copper, nickel, mercury, manganese, selenium, mercury and arsenic) are irrigation with water from streams and wastewater contaminated by industry, the application of contaminated solid waste products and the use of former industrial land contaminated by spilled oil and industrial waste products.

Important sources of heavy metals are smelters, refineries, manufacturing plants, vehicles, metalliferous mines, ceramic industry (lead and cadmium), leather tanneries (chromium salts), lignite-based power plants, aluminium industry, electronics industry, and metallurgical industry. Some heavy metals precipitate in sewage sludge, which can therefore contain rather high concentrations.

The heavy metals may accumulate in the edible parts of crops that are consumed by people or fed to animals. Plant uptake of heavy metals varies, which opens up the possibility of adapting the choice of crops in relation to the degree and type of contamination. Generally, the highest amounts of heavy metals accumulate in the leaves, whereas the lowest contents are located in seeds. Beans, peas, melons, tomatoes and peppers show very low uptake figures. Plant uptake of heavy metals (especially of cadmium and lead) also varies with soil pH (Iretskaya and Chien, 1998).

In contrast to pathogenic contamination, the risk of heavy metals in wastewater used in urban agriculture is less conclusive as few studies have examined this issue. The risk depends primarily on the upstream sources of pollution. The extent of industrial pollution in an area is an important factor.

Puschenreiter et al. (1999) conclude that, after considering the several available pathways to reduce the transfer of heavy metals to the human food chain, urban soils with slight heavymetal contamination can be used safely for gardening and agriculture if proper precautions are followed. However, Birley and Lock (1999,) argue that little is known of the chronic health effects of consuming tiny amounts of heavy metals over long periods of time, and that further research is needed. Increased concentration in the human food chain over a long period can provoke detectable damage to health (carcinogenic and mutagenic effects).

Suggested prevention and control measures encountered in the literature, include the following:

- Definition of norms regarding crop restrictions according to type and level of contamination of agricultural soils; testing of agricultural soils and irrigation water for heavy metals;
- A minimum distance is recommended between fields and main roads and/or boundary crops to be planted beside roads to reduce contamination of crops by lead and cadmium;
- Soil treatment for immobilisation of heavy metals: application of lime increases pH and thus decreases the availability of metals, except for selenium; application of farmyard manure reduces the heavy metal content of nickel, zinc and copper (but may increase cadmium levels); iron oxides (e.g. red mud) and zeolites are also known to absorb heavy metals such as cadmium and arsenic;
- Washing and processing of contaminated crops may effectively reduce heavy metal content: good results were obtained for lead (less so for cadmium) in green beans, spinach, potatoes, whereas peas virtually showed no change;

- Use of plants such as Indian grass (*Brassica juncea, L*) for biological remediation of polluted soils or streams (when planted in hydroponic beds);
- More research on chronic health impacts of heavy metals

7. Zoonosis

Zoonotic diseases are infectious diseases transmitted through direct contact of human beings with animals during production processes or ingestion of contaminated animal products.
Two major bacterial diseases carried by cattle are bovine tuberculosis and brucellosis. Bovine tuberculosis is transmitted via the ingestion of contaminated unpasteurised milk from infected cows, and causes symptoms similar to respiratory tuberculosis. Bovine tuberculosis is transmitted via the ingestion of contaminated unpasteurised dairy products or through direct contact with infected animal material (blood, urine) and forms a main occupational hazard for livestock farmers and slaughterhouse workers. It can also spread by air-borne transmission and inhalation (e.g. in the neighbourhood surrounding a slaughterhouse).
Taeniasis and cysticercosis (beef and pig tapeworm) are transmitted by consumption of meat infected with tapeworm eggs congested by animals that scavenge on human faeces, or of crops irrigated with improperly treated sewage. Pig tapeworms create more severe effects in humans than beef tapeworm. Trichinosis is transmitted by consumption of infected meat of pigs that scavenge on food waste and dead animals.
Anthrax is most common in people who work with livestock or work in animal product industries (e.g. tannery). It can be transmitted through a cut in the skin, by inhalation of bacterial spores or consumption of infected meat.
Leptospirosis (Weil's disease) is transmitted through the contact of humans with infected animal urine or contaminated feedstuff or by swimming in or drinking from water supplies contaminated with animal urine.
Salmonella and campylobacter can be transmitted through contamination of animal feed. Animals (especially poultry) shed pathogens in their faeces in slaughterhouses, which may infect the meat. The wastewater discharge from intensive poultry farms can carry heavy loads of these micro-organisms and may contaminate drinking water supplies.

Measures to prevent and control
Recommended measures to prevent and control zoonosis include:
- Collection of better prevalence data for the most important zoonoses;
- Consumer education regarding thermal treatment of all milk and dairy products and proper cooking or freezing of meat products;
- Restriction of uncontrolled movement of livestock in urban areas (e.g. stall feeding) and/or improvement of the urban waste-collection system;
- Strict slaughterhouse regulations; condemning pig carcasses infected with tapeworms (which is sometimes a very high percentage);
- Simple laboratory antigen-testing for anthrax infection of suspect animal products (such as carcasses and hides); disinfection of wool and fur;
- Control of import of dogs and sheep in areas where Trichinosis is rare;
- Prevention of genetic reassortment between avian viruses in pigs and human viruses (e.g. human influenza A) by not linking pigs and poultry in combination with fish pond operations;
- Composting of manure before application.

8. Issues and challenges for further research

The consideration of the public health and environmental risks associated with urban agriculture is an important element in policy decisions on urban agriculture.
However, the review of the available literature indicates that, although insight into the potential health risks of urban and periurban agriculture is growing, detailed information on the actual health impacts of urban agriculture is scant. Many of the health risks that are brought in relation to urban agriculture are not specific to urban agriculture and many of the perceived risks are based on research in rural agriculture. One can encounter cases in the literature where warnings are given about e.g. heavy metals in urban produced food due to use of contaminated soils or irrigation water, when later it turns out that rural produce sold in the same town contains similar levels of heavy metals.
There is little information available that allows comparison of the global burden of disease for each of the categories of health risks mentioned above.
Most of the available data are of the snap shot type and there are few longer term studies

available, which would enable the assessment of the impacts of accumulation over time (e.g. for heavy metals).
Little of the available literature can assist in the formulation of adequate policies to mitigate the health and environmental risks associated with urban agriculture and there are even fewer studies that monitor and evaluate the impacts realised by such policy measures and their cost efficiency.

In order to be able to formulate adequate policies, more research has to be undertaken that specifies:

- The environmental conditions under which health problems related to urban agriculture occur (i.e., type of agriculture, farm management practices, characteristics of the location, etc.)
- The groups that are most vulnerable to those impacts and the factors that determine this vulnerability (e.g. poverty, gender, age, main occupation).
- The factors that currently restrict the urban poor from engaging in less risky agricultural and food practices
- The resources and technical capacity available in cities to implement risk mitigating policy measures.

It is suggested that city authorities make Health Impact Assessments (HIA) of urban agriculture policies and projects in order to provide evidence-based information for decision making. During the HIA the potential health impacts of such policies and projects are carefully analysed in multidisciplinary teams, involving the direct and indirect stakeholders.

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